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Domestic Container Shipping Market Profile: A Case Study of Indonesia

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| **Article Info** | **Abstract** |
| **Keywords:**  Domestic container shipping  Herfindahl-Hirschman Index  Market equilibrium  Supply and demand analysis  **Article history:**  Received: xxx  Last revised: xxx  Accepted: xxx  Available online: xxx  Published: xx  **DOI:**  https://xxxxx | As the largest archipelagic country globally, the shipping industry has played important roles in supporting Indonesia's economy. However, the Indonesian Ship Owners Association (INSA) stated that Indonesia's commercial shipping was experiencing an oversupply. This research was conducted to determine the equilibrium between Indonesia's container shipping market's supply and demand. The analysis was carried out on nine major container shipping liner routes in Indonesia. The methods used include regression analysis, relational analysis, supply and demand curve analysis, market equilibrium analysis, market structure analysis, and voyage calculation analysis. The research data input is based on Ship Arrival and Departure Report (Laporan Keberangkatan dan Kedatangan Kapal/LK3) data and the generic data from simulation results with business actors. The results show that the demand curve for containers is inelastic with a value of 0.31, which indicates that the cargo-owners have no choice but to deliver the goods at a freight rate determined by the shipping company. Meanwhile, the supply capacity curve is elastic with a value of 3.16, which indicates that the shipping company can adjust the capacity of the supply quantity. The demand curve on the Surabaya-Makassar route and the supply curve has an equilibrium point at a quantity of 99 million TEUs.Nm and a price of IDR 2.16 million / TEUs. As for the Jakarta-Surabaya route, the demand curve does not intersect the supply curve due to an over-supply. The supply curve should shift to the left to find its equilibrium by reducing the supply capacity by 258 thousand TEUs..  Copyright © 2021 KAPAL : Jurnal Ilmu Pengetahuan dan Teknologi Kelautan. This is an open access article under the CC BY-SA license (<https://creativecommons.org/licenses/by-sa/4.0/>). |

1. **Introduction**

Indonesia is the largest archipelagic country in the world, with more than 17,000 islands, of which 6000 islands are inhabitant. Indonesia has built more than 1500 ports to provide distribution access, where 120 of them are run by state-owned enterprise and equipped with Container Handling Terminal. With the increasing number of container throughput at the port from 7,2 million in 2009 to 14,7 million in 2019, the rate of containerization is still expected to continue in the future. The trend also depicted the importance of the container shipping industry in Indonesia. At present, there are more than 860 liner routes for container shipping provided by more than 50 companies across Indonesia.

Indonesia has a merchant fleet of 24,046 vessels with a capacity of 38.5 million GT. However, this number cannot yet be identified for each type of ship, especially for container ships. According to INSA (Indonesian Ship Owner Association), Indonesia's commercial shipping was experiencing an oversupply [1]. Therefore, further research is needed on the domestic shipping industry's condition to determine the conditions of demand and supply of domestic container shipping.

This paper extends the supply and demand analysis on the domestic container shipping industry. It is mainly focusing on three problems. Problem 1 is how to measure the demand curve in domestic container shipping, to find out whether the demand side is elastic or inelastic towards the market trend. After analyzing the demand side, the same analysis applied to the supply side. Problem 2 discusses a domestic container shipping's market structure, including how the supply capacity responds to market trends. Problem 3 is about combining the demand and supply side into the dynamic of the supply and demand curve.

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1. **Review of Literature**
   1. **Demand of Container Shipping Industry**

Many study results have found that the demand for marine transportation services is derived from economic activities. It can be captured through cargo production in and out of ports [2]. Various research used regression method to calculate the demand for the container shipping industry. There are many combinations of the variable used, but [2] extended the analysis of the causal variables within 4 categories—i.e., macroeconomic condition, cargo commodity type, random shock, and the new emerging technology.

The demand analysis of the container shipping industry is often used to forecast the trend. [3] used a multiple regression method to forecast the cargo demand of ports in Turkey. He measured the GDP, foreign trade, and population within the previous 5 years as independent variables then regressed them to forecast ports throughput to up to 9 years. [4] modified the regression model of two variables, GDP and port throughput, by adding a non-stationary contribution coefficient to deal with the forecast error problem.

Although there were many varieties of variables used in the demand analysis, the most common way is to derive the demand for cargo from economic output or Gross Domestic Product (GDP). Therefore, in this paper, the authors use the GDP only as an independent variable in the regression analysis.

* 1. **Market Structure of the Shipping Industry**

Market structure is a concept that describes the elements and the situation of a market. [5] stated the most common three elements of the market—i.e., the size distribution of sellers/buyers, the degree of product differentiation, and the condition of entry into the market. Various research has conducted studies to measure market structure, mostly by calculating the CR4 ratio or Hirschman-Herfindahl Index (HHI). [6] carried out HHI analysis on the aviation industry, while [7] on the banking industry, and [8] on the internet and media industry.

While in the shipping industry, [9] calculated the HHI and CR4 ratio on the global liner industry before and after the consolidation process from 1995 to 2008. He concluded that the market becomes more concentrated within the period. Thus, the hypothesis of an oligopoly market in the shipping industry is confirmed to be positive. Questioning whether the global container shipping market was still competitive for its participants, [10] also used the CR4 ratio and HHI as a parameter of measurement, which directed to the same result as [9]. Still using the same method, [11] found that the increase in the sample used to analyse will lower the value of HHI.

Based on previous research, there is a similarity in its conclusion that the container shipping industry's market structure is an oligopoly market, with some companies controlling the majority of the share in the market.

* 1. **Dynamics of Supply and Demand Curves in Container Shipping**

The economist tried to explain market conditions using demand and supply curves visually. The curve consists of price as the y-axis and quantity as the x-axis. That basic curve could explain how the market interacts when there is a shortage or oversupply in the market. H.L. Moore was the first researcher who introduced the demand curve by deriving the curve from statistical data around 1915. The demand curve is characterised by the line from the upper left downs to the right, while the supply curve was the opposite.

On the shipping industry, [2] explained the special characteristic of the shipping industry's supply curve. He carefully analysed the supply curve of an individual ship and the shipping industry as a whole and concluded that the supply curve for an individual ship is a J-shape curve. That individual curve then stacked and combined with another J-shape individual curve to form the shipping industry's supply curve. Therefore, the shipping industry's curve is an aggregate of individual ship curve and has a flatter shape than the usual supply curve. On the other hand, the main characteristic of the shipping industry's demand curve is a steep line due to inelasticity towards the supply side.

[12] proposed a supply-demand interaction model in China's shipping industry. The higher the demand will lead to a higher freight rate (price), while the increase in supply will lower the freight. In the short run, the supply side cannot adjust quickly in response to the market. While in the long run, the supply side shift slowly adjusts the market's increase and lower the freight. [13] use the cobweb model to analyse the interaction between supply and demand in the container shipping industry. At the time when the freight is high, the quantity demanded is lower than the quantity supplied. The oversupply will reduce the price. At the new lower-price level, the quantity demanded becomes higher than the quantity supplied. This excessive demand will lead to an increase in freight. The interaction cycle then continues from the beginning.

1. **Methodology**

The analysis was carried out in 3 stages of analysis demand-side analysis, supply-side analysis, market equilibrium analysis. The first step is the demand side analysis. This stage aims to determine the condition of the demand for domestic container shipping. The analysis was carried out by regressing the components in the GRDP with data on domestic container production at the port. As for the projection process on the demand side, the growth of Indonesia's GRDP published by the World Bank is used and then regressed with container production in Indonesia. Thus, as explained in the literature review, the author used the regression model as follows:

|  |  |
| --- | --- |
|  | (Eq.1) |

where c0 is the coefficient that connects the demand for sea transportation services with GRDP.

Furthermore, the demand curve analysis was carried out with the input of container demand data from LK3 and processed data from interviews with business actors who own goods. During the interview, a simulation was conducted on the effect of freight rate changes on the number of goods to be shipped. The results of the interview are structured to form a demand curve for the domestic container shipping industry. Thus, the quantity component is the amount of container demand, while the price component is the expected price from interviews with business actors. To determine the elasticity of the demand side, elasticity analysis was performed using the mid-point elasticity method as follows:

|  |  |
| --- | --- |
|  | (Eq.2) |

On the supply side, the analysis starts with identifying the market structure, using the HHI value on the 9 routes analysed as follows:

|  |  |
| --- | --- |
|  | (Eq.3) |

Where Si indicates the market share of each company identified. The market structure is identified to validate the simulated domestic container shipping demand curve data from the interview results.

Next, an analysis was carried out using a generic voyage calculation model to determine the size of the capacity of Indonesia's container ships fleet, both in TEUs and TEUs.miles. The model can also be used to determine the unit cost on the supply side. The unit cost will be used as a benchmark for market conditions to determine the shipowner's profitability in operating his ship and prove the relationship between the supply capacity variable and the unit cost. The voyage calculation model was prepared by taking into account ship age, ship size, ship speed and fuel consumption, crews, and others as follows:

|  |  |
| --- | --- |
|  | (Eq.4) |
|  | (Eq.5) |
|  | (Eq.6) |
|  | (Eq.7) |
|  | (Eq.8) |

To complete the voyage analysis on the calculation of the domestic container ships fleet, a sensitivity analysis of the unit cost was carried out against the load factor and fuel price. Both variables greatly influence the freight rate fluctuation. Then the supply curve analysis is carried out. The quantity component is the container fleet's capacity, while the price component represents the prevailing freight rate. Freight rates are obtained by conducting interviews and collecting primary and secondary data. An elasticity analysis using the mid-point elasticity method is also carried out (Eq.3).

The next stage is analysing market equilibrium, which is based on short-run conditions. The input at this stage is the calculation output generated in the previous stage, both from the demand and supply side. The combination of the two is carried out and analysed to determine the domestic container shipping industry's equilibrium. The market has its equilibrium only if there is an intersection point between the demand and supply curves. If there is no intersection point (equilibrium point), then the market is said to be unbalanced. An unbalanced market means that the market is experiencing an oversupply (when the demand curve is above the supply curve) or shortage (when the supply curve is above the demand curve). The supply curve will shift horizontally to meet the demand curve at an equilibrium point, ensuring a balance in the market. If there is an imbalance, the supply side will adjust accordingly to restore the imbalance.

The analysis is carried out mathematically using the parabolic equation method. The x-axis is the quantity variable, while the y-axis is the shipping rate variable. The demand curve is arranged into a demand function with a quadratic equation as follows:

|  |  |
| --- | --- |
| *ax2 + bx + c* | (Eq.9) |

Then the supply curve is also arranged into a supply function with the quadratic equation as follows:

|  |  |
| --- | --- |
| *x2 + jx + k* | (Eq.10) |

Furthermore, by using the quadratic non-linear equation method, the x roots of the demand and supply function equation are obtained as follows:

|  |  |
| --- | --- |
|  | (Eq.11) |
|  | (Eq.12) |

The x root of the function above is the intersection between the demand and supply curves. In addition, by substituting the non-negative x root into the demand or supply function, the y-axis (price) of the equation can be found. Suppose the two equations do not have the same root, where 0, the supply curve will shift horizontally to the left. The shift in the supply function f (s) is determined by adding the constant z, which is the value of the quantity supply to be reduced which is obtained by calculating the load factor ratio on other routes where there is an equilibrium.

1. **Results**
   1. **The Demand Side Analysis**
      1. **The Relation between Economic Variables and Shipping Demand**

This section discusses the analysis of the relationship between economic conditions and the demand for sea transport services, which is used to test the influence of economic variables on the growth of containers in domestic shipping. The GRDP (Gross Regional Domestic Product) variable represents economic variables in this analysis. The routes chosen were the nine busiest of all liner routes. The analysis was carried out by combining the GRDP variables of the two regions on each shipping route and then connected with the amount of loading flow on each of the analysed routes. The combination of two GRDP from each origin and destination area is due to the cargo carried on that route, which is basically loading and unloading cargoes. The merger of loading and unloading is accompanied by a combination of GRDP of the origin and destination regions. The following are the results:

Table 1. Relationship between Economic Variables and Shipping Demand

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Route | RSQ | CORREL | Equation | |
| Slope | Intercept |
| JKT-BLW | 0,89 | 0,94 | 0,05819 | 204206 |
| JKT-SBY | 0,92 | 0,96 | 0,07189 | 55787 |
| JKT-PNK | 0,87 | 0,93 | 0,05598 | 94997 |
| SBY-BNJRM | 0,97 | 0,99 | 0,13257 | -65057 |
| SBY-MKS | 0,90 | 0,95 | 0,01891 | 379607 |
| SBY-SMRND | 0,93 | 0,97 | 0,06558 | -6883 |
| MKS-JKT | 0,97 | 0,99 | 0,01886 | 124129 |
| MKS-AMB | 0,89 | 0,94 | 0,05090 | 16340 |
| MKS-BIT | 0,92 | 0,96 | 0,03996 | 10589 |

The analysis results show that the coefficient of determination (RSQ) is 0.87 to 0.97 on the analysed routes. This value indicates that the GRDP variable influences 87% to 97% on the container load variable.

* + 1. **Demand Curve**

The demand curve is a curve used to determine how the graph forms between the number of goods needed in the market (quantity) and the expected price (price). To determine this curve in the domestic container shipping industry, the Q value is represented by the volume of container demand on each route, multiplied by each route's distance. The value of price is determined by interviewing the shipper association, which was then converted into a demand curve based on reality in the field. Thus, the following results were obtained:

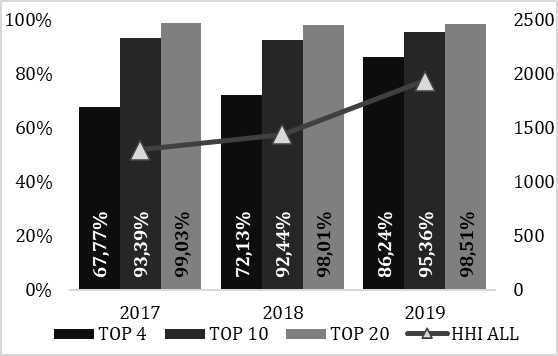
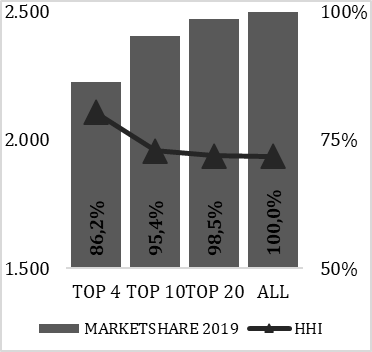
Figure 1. Demand Curve of Domestic Container Shipping

The curve above shows the shipping demand curve and how it moves against the prevailing shipping rates. The demand curve consists only of two routes—i.e., the Jakarta-Surabaya route and the Surabaya-Makassar route. Furthermore, an analysis of elasticity on the demand curve is carried out to determine the market characteristics of the domestic container shipping industry's demand. This analysis was performed using the midpoint elasticity method. This method was chosen because it could measure the value of elasticity between two points in a certain period. The two points used are the lowest and the highest points on the demand curve in Figure 1.

Based on the calculation, it is known that the elasticity value of the demand side of the domestic container shipping industry is 0.31. This value indicates that the demand side is inelastic to price changes (Elasticity <1). The goods owner has no other choice when ocean freight is increased by the shipping company other than sending at the rate set by the shipping company. This forces the goods' owner to send his goods at the rates imposed by the shipping company. The demand curve's elasticity is not completely inelastic because there is still a slight change in the quantity when the tariff is increased. If the tariff is too expensive, it could not be feasible for the end-users to purchase the goods.

* 1. **The Supply Side Analysis**
     1. **Market Structure Analysis**

This analysis uses the Herfindahl-Hirschman Index (HHI) calculation method. This index is used to measure market concentration and conduct evaluations. HHI is obtained by squaring each company's market share and then adding up the results of all these squared numbers. In 2019, the conditions for the domestic container shipping market were as follows (Figure 2):



As for the time series analysis from 2017 to 2019, there is an upward trend in the value of HHI. It indicates that the market conditions are increasingly concentrated (from 1,297 to 1,937) within the period given. It can be seen that the 4 largest companies have a positive trend in dominating the market (from 67.7% to 86.24%) in a given period. On the other hand, other than the top 4, they are actually experiencing a decrease in the value of HHI, which shows that apart from the 4 largest companies, the company is getting weaker in controlling the market and thereby increasing market competition in the non-4 largest market segments.

After reviewing the HHI as a whole nation, the authors compared to HHI score for some liner routes. As can be seen in Figure 3, none of the liner route can be categorised as the competitive zone among the largest routes for domestic containers. Considering that all HHI index values are above 1500 which indicates the higher market concentration, the high number of players is not an indicator of a competitive market. To prove this, the Jakarta-Surabaya route with an HHI value of 3692 can be taken as an example. On that route, there are 10 shipping companies. However, even though the number of existing shipping companies is large, 80% of the market is controlled by one particular company.

The different results of HHI as a whole industry and HHI in smaller views per-route indicate that the four large companies dominating the market actually do not compete directly on certain routes. The large companies tend not to have market shares that overlap each other within the same routes they operated. Under these conditions, the analysis of HHI per-route will give high results (concentrated market and weak competition) as that of HHI as a whole industry. Similarly, if the analysis was conducted on the aggregate level nationally, the value of HHI is much lower (1,558).

Figure 3. HHI Score for Every Route

Moreover, a high HHI value cannot always be interpreted negatively. The routes on the right side of the graph, for example, are basically non-commercial routes. These routes are operated on the principle of transport to promote trade. Therefore, a high HHI on this route indicates that there is no market competition. The state generally subsidizes ships that operate in these routes.

* + 1. **The Flexibility of Supply Side in the Liner Shipping Industry**

Based on data processing of Ship Arrival and Departure Reports (Laporan Keberangkatan dan Kedatangan Kapal/LK3) at Ports in Indonesia for the 2017-2019 period, the capacity of ships sailing on domestic routes is obtained, and the results are as follows:

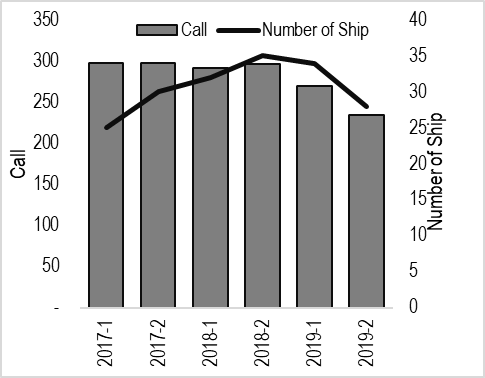
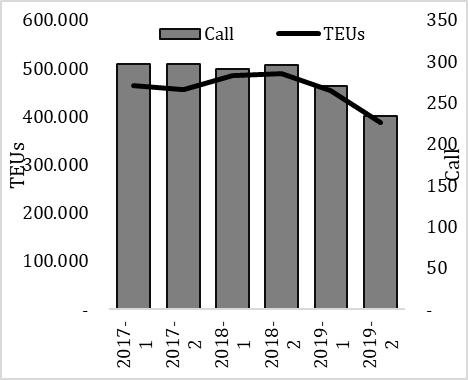


Figure 4. Relation between Capacity-Call and Relation between Ship Number-Ship Call

As shown in Figure 4, domestic container shipping companies serving domestic routes have relatively the same dimensions in each period. However, if further analysis between the call ships and the number of ships serving the route in the same period shows the opposite result, it will show that there is no relationship between the number of ships and the call ships. Further analysis of the determining factors of both showed a value of 0.03. This means that vessels operated on domestic container shipping routes have a high degree of flexibility and can be changed at any time to another route. In other words, ships that operate on domestic liner routes are not fixed. Shipping companies can substitute, reduce, or add ships to respond to the dynamic market conditions.

* + 1. **Supply Curve**

To create a chart of offers consisting of the price (price) and quantity (number of services offered) is determined based on freight and the number of container shipments from each port under review. The amount of Q value used is determined from the value of containers sent during the first semester of 2019 and the second semester of 2019. The P-value or freight rate is determined based on interviews with container shipping business actors, forwarder companies, or information from goods owners who are accustomed to using sea container shipping services.

Figure 5. Supply Curve of Domestic Container Shipping

As shown in Figure 5, the shape of the domestic container shipping industry's supply curve is flat at first lower left and then climbs steeply upwards. This is also explained by [2] that basically, the supply curve is the aggregate form of the supply curve for each ship with a J-shape. The higher the price as the quantity increases is explained due to the limitations on the ship's dimensions. Therefore, when the quantity increases, at a certain point, it will require business actors to invest in acquiring new vessels so that the price will also rise higher. The authors use a logarithmic scale to avoid numerical error between the two variables.

Furthermore, an analysis of elasticity on the demand curve is carried out to determine the market characteristics of the domestic container shipping industry's demand. This analysis was performed using the midpoint method. This method was chosen because it can measure the value of elasticity between two points in a certain period. The two points used are the lowest and highest points on the demand curve in Figure 5.

The elasticity of the supply side of the domestic container shipping industry is 3.16. The elastic condition means that the shipping company can adjust its quantity (increase or decrease) in response to market conditions. This value indicates that the supply side is elastic related to price changes. This elasticity is supported by the previous sub-chapters analysis results, which explain that the vessel capacity's market characteristics are dynamic in nature. Ships from one route can be moved to another route to respond quickly to the market. Therefore, the capacity from the supply side can quickly adjust to the latest market conditions.

* 1. **Market Equilibrium in Domestic Container Shipping**

After obtaining the demand curve and supply curve in the domestic container shipping industry, as shown in Figure 1 and Figure 5, the two curves are combined to see how they interact. The results are as follows:

Figure 6. Market Equilibrium

As shown in Figure 6, there is an intersection point between the demand curve and the supply curve on the Surabaya-Makassar route, while on Jakarta-Surabaya route shows the opposite. The equation of the supply curve and the demand curve were then analysed to find the joined equation's roots. The two-equation will intersect at 7.99 and 6.33. As the graph was on a logarithmic scale, they need to be converted into the real scale. Using the power formula, the intersection of two graphs occurs at a quantity of 99,764,654 TEUs.Nm, and a price of Rp 2.16 million.

On the other hand, the demand curve does not intersect the supply curve on the Jakarta-Surabaya route. The demand curve on the Jakarta-Surabaya route floats above the supply curve. Although the graph was not common in practice and theories, the demand above supply curve condition indicates that the market on the Jakarta-Surabaya route is experiencing a capacity surplus. Referring to the demand side characteristics, it is known that the demand side has control over the quantity, while the supply side has control over the price. The demand side will adjust the freight at any price given by the supply side, while the supply side will adjust the capacity at quantity given by the demand side. Therefore, when the demand and supply side does not intersect caused by the lack of quantity demanded, the market mechanism should be aimed at reducing the ship's capacity so that it will move the supply curve moves horizontally to the left to find its equilibrium.

Figure 7 shows the supply curve that shifts horizontally to the left to intercept the demand curve on the Jakarta-Surabaya route at points 7.78 and 6.35. The intersection point is calculated by finding the roots of a joined equation between supply and demand equation. As the number is on a logarithmic scale, it is equivalent to the quantity of (Million TEUs.Nm) 61,535 and a price of (Rp/TEUs) 2,262,945. The curve shift is a representation of the reduction in the supply quantity of 100 million TEUs.Nm, or the equivalent of 258 thousand TEUs per year due to a surplus.

Figure 7. Movement of Supply Curve

The initial capacity when the surplus was 186 million TEUs.Nm, or 481 thousand TEUs per year. This shift increases the average load factor on the Jakarta-Surabaya route from 0.31 to 0.71. Currently, the route consists of 59 container ships managed by 10 shipping companies. The total capacity of the 59 vessels is 22,183 TEUs. Based on LK3 data for the ports of Tanjung Priok and Tanjung Perak, it is known that the total productivity of the 59 ships reached 788,123 TEUs / year. However, the average load factor was only around 0.2.

1. **Conclusions**

The following conclusions can be drawn from all the data processing and analysis activities that have been carried out in this research. On the demand side, the domestic container shipping industry is known. It has an elasticity value of 0.31. The inelastic nature indicates that the goods owner has no other choice but to deliver the goods at any rate determined by the shipping companies. The market characteristics on the supply side of the domestic container shipping industry has a medium to high concentration, with a Herfindahl–Hirschman Index (HHI) score between 1833 and 10000. This shows that all the characteristics of the domestic container shipping industry market are an oligopoly. The top four domestic container shipping companies do not have an overlapping market as they operate on different routes each. The market was already segmented among those four companies. The high value of HHI at the micro-scale view can also be the indicator of a non-commercial route, as government subsidizes only very limited companies to operate within the routes. The supply curve of the domestic container shipping industry has an elasticity of 3.16. It shows that the shipowners can flexibly adjust their ship's capacity to respond to market conditions. The market equilibrium of the domestic container shipping industry indicates that under the dynamics of supply and demand curves, the demand side controls the quantity, while the supply side has control over the price. The equilibrium points on the demand and supply curve, for an example, in Surabaya-Makassar route, it has 99,764 and 2,164,845. In other words, it has a quantity of 99.7 million TEUs. Nm and a price of Rp. 2.16 million that the equilibrium occurs. Therefore, the market on the Surabaya-Makassar route has an equilibrium between supply and demand.

As for the Jakarta-Surabaya route, the market does not have an intersection point between the supply and demand curve due to a surplus on the supply side. The supply curve must shift horizontally to the left by reducing the supply capacity of 258 thousand TEUs / year to balance the market.

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