Capacity Modelling for Marine Products Air Cargo Delivery from Indonesia

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Abstract

Indonesia, as an archipelago country, is highly dependent on air cargo. One of Indonesia's main export products that are transported using air cargo is marine products. This product must be transported using air cargo because of its perishability. Unlike the rest of the world, very few airlines use freighter aircraft for their cargo business in Indonesia. So that cargo will always be the second priority after the passengers. Because of the complexity of air transportation, cargo will be the first thing to be sacrificed if excess capacity occurs during a flight. This study uses simple linear regression analysis with SPSS to create a model to help airlines preserve their marine product shipment capacity. The price per kilogram per kilometer is used as the independent variable, with the capacity needed to be booked for delivering marine products using air cargo as the dependent variable. The R-Squared value showed that this variable is a good determinant for the dependent variable. The model can help an airline forecast the capacity needed for marine air cargo shipment from Indonesia. It can reduce delays in delivering goods that will damage the products and lose consumer trust.

Keywords
Capacity modelling, Air Cargo, Indonesian Marine Products

1. Introduction

The Republic of Indonesia will always highly be depending on the existence of the aviation industry. Indonesia is an archipelago country. Currently, Indonesia's total number of islands is estimated at 16,056 islands. This fact gives Indonesia its own uniqueness for the movement process of goods and people in Indonesia. If transportation costs can be reduced in other countries by optimizing toll roads or railways, it is not that simple in Indonesia. The vast landscape and region separation by water requires that people and goods' movement must be carried out using sea and air transportation.

Air transportation is one of the alternatives and the primary choice for the movement of people and goods in Indonesia. In this case, air transportation uses airline commercials to transport people and products and continues to grow very rapidly in Indonesia. Nowadays, Indonesian Air Carrier, which is an organization for airlines in Indonesia, currently has 35 members consisting of 11 Scheduled Commercial Air Transport Companies, 22 Unscheduled Commercial Air Transport Companies, and 2 Cargo Air Transport Companies (INACA, 2019). Nowadays, there are 349 airports around Indonesia, and the number will keep on growing. The aviation business's growth is also in line with the Nawacita program. The Indonesian government currently runs to continue developing airports around Indonesia as one of the drivers of tourism and economic growth (Rachmansyah & Nahdalina, 2017)

Cargo has grown into new revenue channels for airlines in Indonesia. The need for aviation cargo has continued to grow in Indonesia in recent years. In the last 20 years, the trend shows air cargo growth in Indonesia, with air cargo 1traffic in 2018 reaching 1,131,900 tons-km (Worldbank, 2019). Data for air cargo growth in Indonesia for the last ten years can be seen in Figure 1. The emergence of air cargo, followed by the rise of e-commerce in recent years, coupled with a seemingly unlimited world that makes the marketing process of a product, can be done easily using the online network. This phenomenon contributes to the tremendous increasing need for air cargo services.

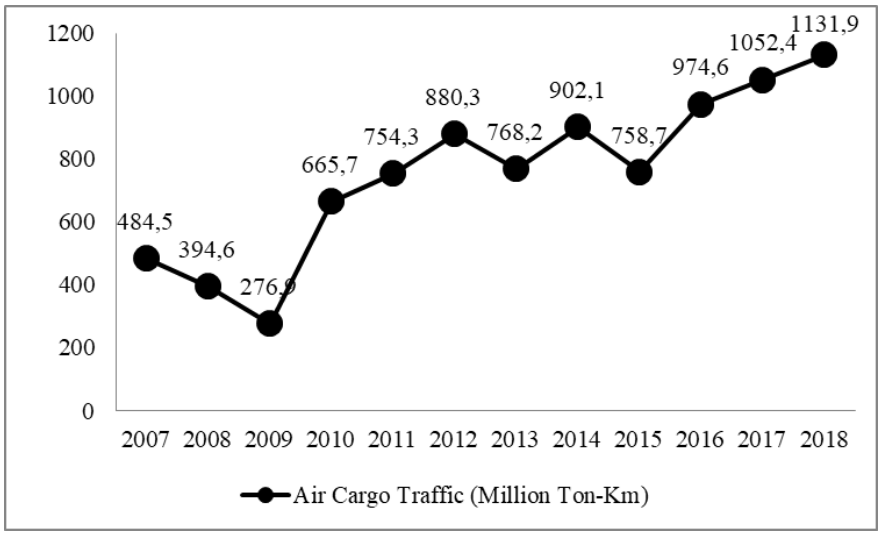

Figure 1. Air cargo traffic from Indonesia (2008-2018)

The export of products and commodities has become one of Indonesia's backbones gross domestic products that drive Indonesia's economy. One of the primary commodities exported abroad is marine products. As an archipelago country with the second-longest coastlines globally, Indonesia has substantial marine product potential. The Ministry of Fisheries and Maritime Affairs targets the growth of these marine products' contribution to reach 12% of Indonesia's GDP in 2019 (BKPM, 2019). The same report states that Indonesia's maritime economic potential came 1.33 trillion dollars, with products such as tuna, shrimp, and crabs being the most exported seafood products abroad today.

Air cargo has a massive role in shipping marine product exports from Indonesia to other countries. The transportation of perishable products is one of three segments of cargo products whose demand proliferates throughout the world (Tozi & Muller, 2006). Air transport was preferred because marine products are classified as perishable products, which, if the shipment were conducted using sea cargo, could damage the product being shipped. Another thing is that these products are much preferred in fresh conditions, so it is better and preferable for consumption. According to this reality, the existence of air cargo is vital for the success and sustainability of the marine product export process from Indonesia.

There are still many obstacles to maximize air cargo shipments from Indonesia. Freighter or aircraft that is devoted to transporting goods is not a common thing for airlines in Indonesia. At present, air cargo transportation in Indonesia is mainly done using commercial passenger aircraft, so cargo is not a priority to be transported by the airlines. This condition is compounded by the state of airports in Indonesia, which in general are still not good in terms of infrastructure and have runway hardness that is less than optimal. This phenomenon will cause the take-off weight not to be maximized by airlines on every flight. And if the aircraft is overloaded, the first thing that will be unloaded is cargo. This approach will cause a decrease in satisfaction and, inevitably, the confidence of cargo agents and customers in airline services. Considering these facts, airlines can still be helped by using modelling techniques to help estimate the space requirements on passenger planes used to send cargo. If this modelling is successfully obtained, the airline will determine the space requirements and ultimately maximize the price charged to marine product shippers from Indonesia. And in the end, it will help optimize the export process of Indonesia's marine and fishery products by using air cargo shipment.

1.1 Objectives

Indonesian marine cargo products can become one of the primary commodities that can be exported and contribute to the GDP of Indonesia. Because of its perishability and the neediness to be delivered in mint condition, shipping by air cargo is the first and most appropriate choice to ship these products. Airlines still face a significant challenge to promptly deliver every shipment of marine cargo product due to lack of capacity and take-off weight constraints. This research aims to create an approach to forecast the capacity needed to be booked for Indonesian marine and fishery product shipment.

2. Literature Review

Considering its nature, the perishable product is one of the most challenging commodities to be delivered. It is discovered that Freshness of products and timeliness of delivery are two critical factors that have an impact on customer satisfaction in terminal delivery of perishable products and try to overcome this problem by creating a priority function based on customer satisfaction and use the hierarchical clustering method to identify customer service priority to decrease total cost within the specific shelf life of a product (X. Wang et al., 2017). In their research, to improve the distribution route of perishable foods using a vehicle routing problem with a food safety Risk coefficient and a Time Window (VRPRTW) to help increase the efficiency of distribution of cold chain distribution reduce total distribution costs (Y. Wang et al., 2020). There is only a finite amount of time during which the product can be delivered to the customer, using an integrated production and distribution scheduling problem (IPDSP) with a single product, single machine, multiple customers, and batch delivery on their research to determine the production scheduling and transportation routing (number of vehicles and routes for each). This was done to satisfy a set of known customer demands distributed over a geographic region to minimize the total transportation cost (Zu et al., 2014).

Planning is a crucial thing in optimizing air cargo delivery shipment. One of the research tries to use a mathematical programming approach based on origin and destination of air cargo shipment to create a revenue management model to increase the consistency of planning and operations of an airline (Bartodziej et al., 2007). The statistical approach was used for enhancing the load planning process to increase cargo compartment utilization of military air cargo shipment and found that an airline can save a lot of money and increase profitability by implementing proper planning (Carlson et al., 2018). Planning an overbooking of cargo shipment can be a great way to improve the expected revenue of an airline, and a model was created to help airlines reduce inefficiencies due to many spaces that do not use by utilizing overbooking (Singhaseni et al., 2013). In order to increase the effectiveness of the overbooking process, two-dimensional characteristics of volume and weight of the booking requests were used to develop air cargo overbooking models to find the optimal overbooking level in order to minimize the total cost (Wannakrairot & Phumchusri, 2016).

Capacity modelling can be one of the alternatives that can help a timely manner of cargo delivery. By using a mathematical model in the research, it was found that if the shipowner follows the rate concept and the cargo demand forecast modelling, the shipowner can improve his company's profitability and select the proper capacities and speeds for the ships used (El Noshokaty, 2019). Analysis of the time series model using holt-winters and ARIMA shows that the air cargo chargeable weight needs to be forecasted due to demand changes that are susceptible to external market and economic factors (Klindokmai et al., 2014). By creating a discrete choice model, It was found out that the rate of shipment, time of transit, cost-per-pound shipped, quantity shipped, perishability, and delay rate of the model are significant factors influencing mode choice shippers (Mitra & Leon, 2014).

There are many variables that need to be considered when conducting an international shipment of a perishable product. Using a case study of edible oil shipment from Italy to Canada, it is found out that the quality of products is affected by manufacturing/processing and logistics activities within the food industry. Transportation is the most critical step throughout the "food journey" from the farm to the customers because of the potential stresses that affect the products during shipment and storage activities (Manzini et al., 2014). By using simulation in their research, thermal insulation will affect international shipments due to quality changes in the product (Ayyad et al., 2017). A two-stage Heckman model can be used to analyze the export progress of European Union export for five years to improve the logistics performance index from a member of the European Union (Puertas et al., 2014).

3. Methods

3.1 Variable

In day-to-day operations, airlines are using dynamic pricing to maximize space and profit from their cargo business. The price per kilogram charge for any cargo shipment will be used and analyzed to forecast the Gross weight shipment for Indonesia's marine and fishery products.

The dependent variable in this research is the Gross weight shipment of marine products from Indonesia. The Independent Variable in this research is the Price per Kilogram per Kilometer charged for marine product shipment from Indonesia.

3.2 Simple Linear Regression

In simple linear regression, we understand that one dependent variable will be influenced by one independent variable. Regression analysis is conducted to find the correlation between two or more variables having cause-effect relations and make predictions for discussion topics (Uyanik and Guller, 2013).

Within this research, the independent variable will be the price per kilogram per kilometer for the air cargo shipment of the marine products, and the dependent variable will be the capacity or weight that need to be booked or preserved on an aircraft to meet the needs for marine products cargo shipment from Indonesia. Understanding the influence of the independent variable used in this research will impact the dependent variable is the main reason why simple linear regression was used in this research. The correlation of the dependent variable and independent variable will also be calculated within this research.

It is convenient to view the regressor X or independent variable as controlled by the data analyst and measured with negligible error. In contrast, the response Y or dependent variable is a random variable (Montgomery, 2012).

The formula that used in single linear regression is:

$$y = \beta_0 + \beta_1 X_1 + \varepsilon$$

Where:
β_0 is the Intercept.
y: Dependent Variable
X_1: Independent Variable
β_1: Parameter
ε: Error

Before conducting single linear regression, assumptions must be fulfilled: normality, linearity, and freedom from outlier or extreme values. All the independent variables used in this research will be analyzed using multiple linear regression using SPSS software from IBM. The flowchart of this research can be seen in Figure 2.

4. Data Collection

The data used in this study are secondary data from an airline in Indonesia during 2019 from January to December. The data will be checked for the research to ensure that all data analyzed are data of shipping marine products from all over Indonesia to abroad. Data from this period of time were selected because it will give the best condition that an airline will be faced right before Covid 19 pandemic hits the world. Data from 264 shipments from Jakarta and Denpasar as the main Hub of cargo shipment from Indonesia to deliver cargo to Singapore, China, Thailand, Malaysia, Australia, Japan, Korea were analyzed to help create a model to forecast capacity needed to be preserved for indonesia marine product cargo shipment.

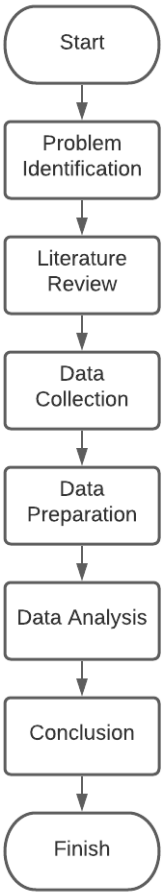

Figure 2. Research Flowchart

5. Results and Discussion

5.1 Data Preparation

Before all the data analysis process started, All the shipment data for marine and fishery products from Indonesia were analyzed for normality, linearity, and outlier. The 264 shipments data used in this research are normal, linear, and free of an outlier. Therefore, further analysis of single linear regression can be done by using the data.

5.2 Capacity Model Creation

The first thing to determine when creating a model for the independent and dependent variable in simple linear regression is whether the model is significant or not. In Table 1, it can be seen the calculation for P-Value for the model created using price per kilogram as the independent variable and weight of shipment for marine products from Indonesia is less than alpha or 0.05. Hence, the model developed in this research is significant, and the independent variable will influence the dependent variable.

Table 1. Model Significance Calculation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	153.872.158.099,217	1	153.872.158.099,217	2.135,091	,000[b]
	Residual	18.953.932.261,390	263	72.068.183,503		
	Total	172.826.090.360,607	264			

a. Dependent Variable: Weight of Marine Product Shipment

b. Predictors: (Constant), Price/Kg/Km

Simple linear regression uses to analyze whether the price per kilogram can significantly predict the weight of marine product shipment carried by airlines. By analyzing the adjusted R-Squared value from the output of SPSS provided in Table 2, It can be determined that the independent variable, which is the price per kilogram variable, can explain 89% of the variance of the weight of cargo shipment.

Table 2. Capacity Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,944[a]	,890	,890	8.489,2981749604

a. Predictors: (Constant), Price/Kg/Km

Table 3. Coefficients of The Equation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	228,467	573,238		,399	,691
	Price/Km	4.130,027	89,381	,944	46,207	,000

a. Dependent Variable: Weight of Marine Product Shipment

After we determined that the model is adequate. The next step is to create the model to help an airline forecast the weight of marine product shipment based on the price per kilogram they charge. From Table 3 we can see that the constant value for the model is 228,467 and the value for price per kilogram per kilometer variable is 4.130,027. By inputting these values into a simple linear regression equation, the model for predicting the weight of marine product shipment is:

$$y = 228{,}467 + 4.130{,}027\, X_1 + \varepsilon$$

6. Conclusions

This research aims to help an airline predict the capacity needed to promptly deliver marine cargo shipments from Indonesia. Using simple linear regression, a model was created to help airlines estimate marine product shipment from Indonesia. The dependent variable in this research is the price per kilogram per shipment of the marine products shipped by air cargo on the capacity or weight that needs to be booked or preserved on an aircraft to meet the needs for marine products shipment from Indonesia. It can be determined that price per kilogram per kilometer is

a good predictor for shipment weight and capacity needed for Indonesia marine product shipment. From the R-Squared value, the independent variable can explain 89% variance of the dependent variable. Using the model, an airline can be helped when creating the decision to preserve certain capacity needed for fishery and marine products' shipment. The airlines can decrease the lead time for the shipment of marine products. Since these products are perishable, a shorter delivery period will reduce the potential of damaged goods and, in the end, increase customer satisfaction.

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