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THE CHARACTERISTICS OPERATIONAL COST OF FREIGHT TRANSPORT IN SOUTH SULAWESI PROVINCE - INDONESIA

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Abstract
Infrastructure development of the freight transport system has a vital position in accelerating Indonesian economic growth. This study aims to analyze one of the dominant characteristics of freight transportation, namely freight transportation costs in South Sulawesi Province. A questionnaire-based interview survey of operators was conducted to determine operator characteristics, vehicle characteristics, trip characteristics, and commodity characteristics. They are analyzing data using a descriptive statistical approach, building a cost and distance relationship model using a regression model approach while analyzing the priority of freight transport selection using an Analytical Hierarchy Process (AHP). An AHP is a decision-making model with multiple criteria. The analysis shows that the high costs are the component costs of the operator's salary, fuel costs, and vehicle maintenance costs. Operating cost modelling provides a good level of models, both in terms of modes and commodities transported. In contrast, the travel time model based on modes and types of commodities shows inefficient. Based on the results, the pickup mode is optimal in cost and travel time with a weight of 39.8% and 50.3%. Trucks 3-4-5 Axles are the optimal mode of transportation when viewed in terms of distance (58.8%) and transportation volume (65.5%). In contrast, the two Axles Truck has characteristics between Pickups and 3-4-5 Axles Trucks. This result is better developed for a more comprehensive model of the cost of freight transport in South Sulawesi Province, Indonesia.

Keywords:
AHP;
Costs;
Freight transport;
Regression;
South Sulawesi;

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INTRODUCTION

Research on freight transport in every country has been doing a lot, both land, air, and water [1] [2]. The study aims to know and provide more accurate information about the transportation of goods, the level of efficiency, and strategies used. So, they can provide a reference for policy-making for users, government, and industry [3], such as knowing travel time, travel distance, mode selection [4], and the role of roads and their effects [5]. Even it can provide an alternative of using modes of freight transport based on quantity, distribution models that can use for competitiveness between modes of transportation [6]. Therefore, it can increase economic growth for human welfare and various kinds of effects caused by freight transport [7] [8]. Land transportation is an economic activity in which a company uses land transportation to transport passengers or goods.

Data regarding imbalances in using modes of transportation to move goods where the most significant cost component has been dominating by land transportation is over 72% compared to other elements of the use of freight transport [9]. The phenomenon of the use of freight transport in Indonesia has been founding in the field. It is including [10] that the behaviour of freight

transport has many problems in terms of costs, transportation, and regulations in the provision of freight services between the central and regional governments.

Meanwhile, to understand the behaviour of the characteristics of infrastructure and its development, the model of freight transportation needs the concept of infrastructure budgeting. It has carried most studies out in Java [11], Sumatera and Kalimantan [12, 13, 14].

In particular, research on the behaviour and characteristics of freight transport in South Sulawesi Province is still little carried out and has not been exploring in depth. Previous studies attempted to observe the aspects of freight transport in South Sulawesi Province and only focused on developing container ports in South Sulawesi Province [15][16]. While the authors have attempted to describe the characteristics of freight transport operating in the Metropolitan area of Mamminasata, South Sulawesi Province [17], and a study of the behaviour of freight transport in Indonesia South Sulawesi Province [18].

This study aims to describe the characteristics of operational costs, the relationship between operational costs and the distance travelled for the transportation mode and commodity categories transported. It also provides alternative criteria for the selection of modes of freight transport based on cost, time, and volume on the freight transport network in South Sulawesi Province with a synthesis of the AHP.

METHOD

This study uses data collected from interview surveys about the operational characteristics of freight transportation. The data from this survey have been partially describing and analyzing. The freight transport survey includes an interview survey conducted 24 hours a day for five days, starting at 6:00 a.m. until 6:00 the next morning.

The survey uses forms that have been designing and tested before. It interviews with vehicle operators at vehicle stops such as at the weighbridge or on the side of the road, which has usually been occupying by a stopover along the road between Barru Regency and Parepare City, South Sulawesi Province, then interviewing based on the question items in the questionnaire. The question items in the questionnaire include the origin-destination trip, the time of departure, estimated cost and time of travel, the type and number of commodities transported, and the freight vehicle along with the value of the cargo, etc.

Data collected were about 400 respondents of freight transport operators, were for the two axles Trucks modes of 216 or 54%, Pickup of 92 or 23%, and the 3-4-5 axles trucks were 92 or 23%. It can be said that the two axles Trucks modes dominating from other modes. Then, the data is describing and analyzed statistically against some items. The items are the phenomenon of the operational costs of freight transportation in aspects of transportation modes and commodities being transported. After that, based on the data is also developing a model of operational costs of freight transport against the distance travelled using a simple linear regression modelling approach.

In contrast, the AHP is a method of decision making involving several criteria and alternatives chosen based on consideration of all related criteria [19][20]. The AHP provides alternative criteria for the selection of modes of freight transport based on operational costs, travel time, transport volume, and hauling distance, the purpose of which is to determine the optimal mode of freight transport used. It can be seen in Figure 1, the AHP stage, and the hierarchical structure of the AHP modelling for freight transport.

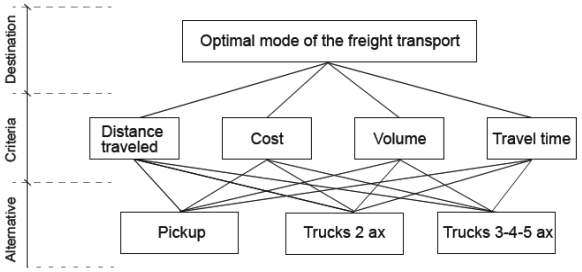

Figure 1. AHP modelling hierarchy structure

RESULTS AND DISCUSSION

Characteristics of Operational Transportation Costs

The results of the survey of freight transportation and data compilation, a characteristic representation of the operational costs of freight transport, are showing in Figure 2 for the transportation mode used. Figure 3 shows the commodity being transported.

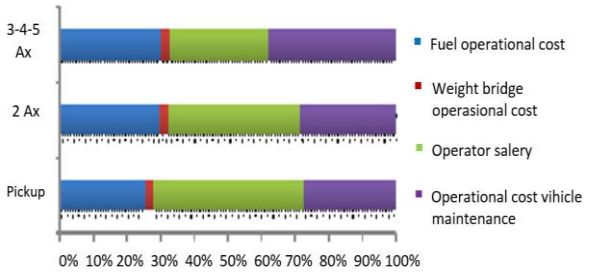

Figure 2. Model and Degree of Freedom with Bar

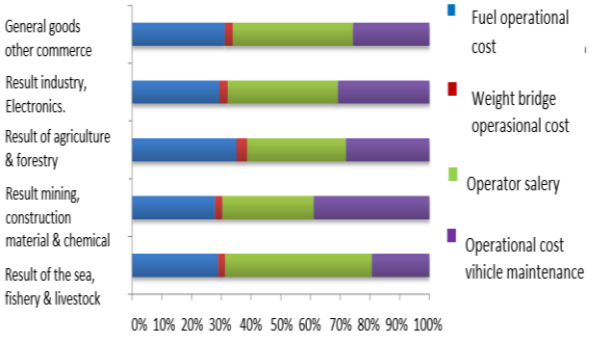

Figure 3. Model and Degree of Freedom with Bar

Figure 2 shows that fuel operating costs, operational costs for operator salaries, and operational costs for vehicle maintenance, are operational costs that dominate operational costs in the transportation mode of freight transportation. In contrast, other relatively small additional costs are payments at weigh stations. The pickup mode of operator salary costs is more dominant than fuel costs and maintenance costs. Likewise, in a truck, two axles operator salary costs are more dominant than fuel costs and maintenance costs, which both have almost the same portion. For 3-4-5 axles, operational costs for vehicle maintenance are more dominant than fuel costs and operator salary costs, both of which have a no different part.

In Figure 3, the three costs are fuel operating costs, operational costs for operator salaries, and operational costs for vehicle maintenance, which has high funding of the commodity being transported. As with marine products, fisheries, and livestock, industrial, electronic and automotive products and general commercial goods, operator salary costs dominate more than other costs in agricultural and forestry commodities. The fuel costs are more dominant. While in mining products, construction materials, and chemicals, vehicle maintenance costs are more dominant than other expenses.

Operational Cost Model Against Distance Travelled Based on Modes of Freight Transport

Table 1 and Figure 4 show that the results of modelling the relationship between operational costs and distance for the transportation modes of freight transportation using simple linear regression, as presented in Table 1 have a significance level where all models have a coefficient of determination (R2) that is close to 1 which is 0.8 - 0.9.

Table 1 and Figure 4 show that the operational cost model line for truck modes 3-4-5 axles has a higher slope line than the other two model lines. This condition is showing by the parameter value β_1 (4,708.0), which is higher for The 3-4-5 axle Trucks modes than the two axles Trucks and Pickup.

Table 1. Parameter Values of The Linear Regression Model Based on Types Of Modes

Model Category	Parameter Value		Determination Coefficient (R^2)
	β_0	β_1	
Mode Pickup	461.729	2.680,5	0,9026
Mode 2 Axles Truck	605.264	3.233,5	0,9223
Mode 3-4-5 Ax Truck	450.451	4.708,0	0,8811

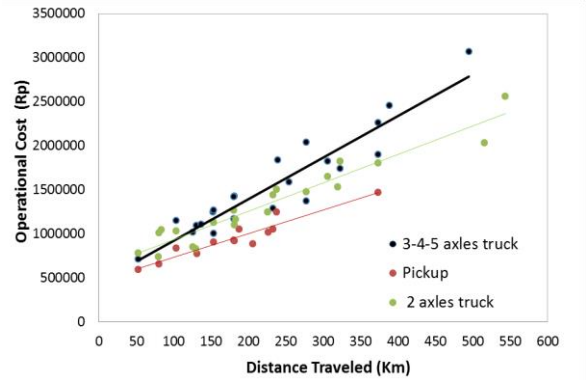

Figure 4. Linear regression of modes types

Whereas for the two model lines, namely for the two axles trucks modes with parameter value β_1 (3,233.5), it has a higher slope than the pickup mode model line with the parameter value β_1 (2,680.5). This situation shows that the operational costs of freight transport using the 3-4-5 axle Truck mode are higher than the other two modes. Likewise, operational costs for the Truck two axles are higher than the Pickup mode. The greater the engine capacity and transport capacity of the model used, the greater the operational costs of operating.

Operational Cost Model Against Distance Travelled Based on The Freight Transport Commodities

Table 2 and Figure 5 show that the results of the modelling of operational costs of freight transport to the distance travelled for the commodity transported have a coefficient of determination (R2) close to one which is over 0.9095 indicating that the model has a reasonable level of significance using simple linear regression.

Table 2. Parameter values of the linear regression model based on the type of commodities

Model Category by Commodities	Parameter Value		Determination Coefficient (R^2)
	β_0	β_1	
Marine, fishery & livestock	298.310	3,219.9	0.9409
Mining, Construction & Chemical	397.443	4,996.8	0.9333
Agriculture and forestry	243.164	3,421.5	0.9095
Electronic, automotive & industrial	657.557	2,949.7	0.9349
Other commerce goods	239.014	4,329.5	0.9419

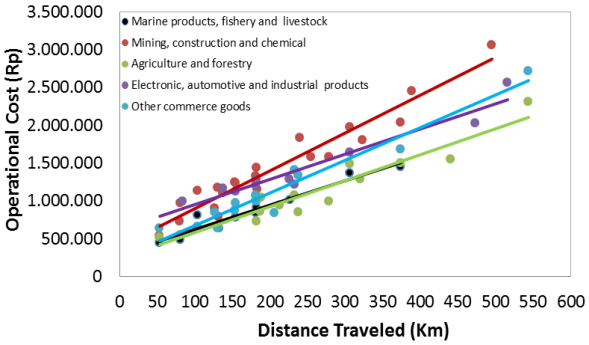

Figure 5. Linear regression of commodities types

Modelling the operational costs of freight transport for mining, construction, and chemicals has a higher line than the other four commodities. The parameter value β_1 is 4,996.8 higher than the parameter value β_1 for other commodities. The parameter values, model lines for trade, agriculture and forestry goods, marine products, fisheries, and livestock products, electronics, automotive, and the industry is subsequently below them successively.

The diversity of operational cost modelling lines shows that mining, construction materials, and chemicals have the highest operational costs of all commodities transported, then followed by other commodities according to the height of the modelling line.

The results of the model line of the operational costs of freight transport against the distance travelled by the mode of transportation and the commodity being transported illustrate that the operational costs of freight transport vary depending on the mode of transportation used and the commodity transported. This condition shows that the choice of transportation mode is sensitive to the product being taken into consideration for the owner of the mode of freight transport.

Cost Models Against Choices in The Process Hierarchy Analysis

Figure 6 The results of the analysis with the AHP that from the criteria reviewed it has seen that cost was the highest weighting criteria in the choice of transportation mode (35.3%) followed by transport volume (25.4%), travel time (23.4%) and distance travelled (15.8%).

Figure 6. Weight of Importance of Criteria in Selection Mode of The Freight Transport

Figure 7. Weight of Alternative Assessments of Global Goals

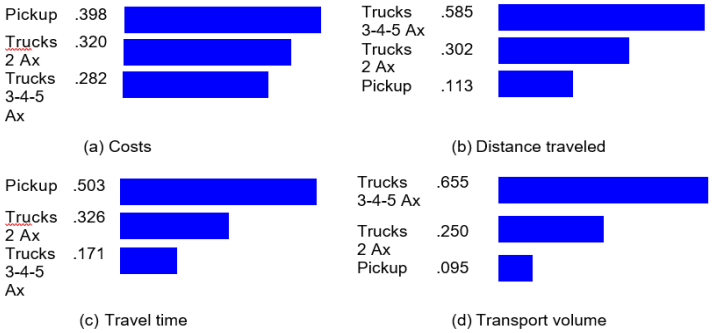

Figure 8. Alternative Weight Assessment of the Criteria (a) Costs (b) Distance travelled (c) Travel time, (d) Transport volume

From the weight of the criteria, the AHP shows that the three alternatives do not have different weights if these alternatives have reviewed against global objectives, as shown in Figure 7. The alternative weights to the destination are Trucks 3-4-5 axles (39.9%), Trucks 2 axles (30.1%), and Pickups (30.0%). This situation shows that each alternative has advantages and disadvantages.

The results of the alternative synthesis that the pickup mode is optimal in terms of cost and travel time with weights of 39.8% and 50.3%, respectively as depicted in Figure 8. On the other hand, 3-4-5 axles Trucks are the optimal mode of freight transport when viewed from the aspect of distance (58.8%) and volume of transport (65.5%). Whereas two axles Trucks have characteristics are between Pickup mode and 3-4-5 axles Trucks.

CONCLUSION

Operational salary costs, fuel costs, and vehicle maintenance costs are the three components of freight transport operating costs, which are dominantly from the total operational costs of freight transport. The amount of operational costs for freight transport is quite sensitive to the mode of transportation used and the commodity transported. The model shows that the more the mode of transportation capacity, the more operational costs of freight transport, where the 3-4-5 axles truck transportation mode has the highest operational costs, namely in mining commodities, building materials, and chemicals. In contrast, the results of the criterion model in the dominant mode of freight transport are the pickup mode choice of 39.8% in the variable costs and 50.3% in the travel time variable while in trucks 3-4-5 axles at 58.8% and 65.5% on travel distance and transportation volume variables. The model of the results of the operational costs of freight transport obtained in this study becomes one of the bases in developing the model of selecting freight transport modes in South Sulawesi Province, Indonesia, in further research.

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