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ATTITUDES AND PERCEPTIONS ON TRAVEL MODE CHOICE IN AN EMERGING URBAN AREA OF INDONESIA: THE CASE OF SOUTHERN SUMATERA

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ABSTRACT: Trans Sumatera toll road connects the southern end of Bakauheni to Palembang for 450 km and has been operated almost for a year. With a right of way width of about 100 meters, the government planned the railway line to be built parallel to the toll road: with a cheaper investment cost because almost without land acquisition and access location is already open. Railway mode is possible immediately built on the Bakauheni – Bandar Lampung corridor to compete with the dominance of conventional modes such as AC-bus, non-AC bus, auto, and motorcycle. The state preference technique has been applied to the study area to explore the attitude and perception of more than 500 respondents regarding the operation of new mode railways in line with toll roads operating earlier. The railways will stretch for 109 km linking the port of Bakauheni in the south of Sumatera to Bandar Lampung This emerging urban area continues to grow dynamically due to the support of adequate transportation infrastructure and geographical proximity to the capital of Jakarta. The output of the mode choice model with the attributes of fare, travel time, headway, and delay shows that the greatest potential in the existing conventional mode for shifting to railways is the non-AC bus user group by almost 25%, followed by AC-bus 20%, auto user by 4% and motorcycle user by 1%.

Keywords: Attitude, Indonesia, Mode choice, Perception, Southern Sumatera

1. INTRODUCTION

Unlike the toll road usually built far apart from the railway lines, the trans-Sumatera toll road, on the third-largest island of Indonesia, which stretches from Bakauheni to Palembang, is designed with a right of way width of about 100 meters. Right of way planned, including for railway lines that are fully parallel with the toll road.

This condition allows the bargaining position of the railway mode to be more competitive because the station and bus stops/terminals allow proximity so that interchanges, especially passengers, can be designed more quickly, efficiently, and smoothly. Meanwhile, referring to the PT ASDP Indonesia Ferry data, 2017-2018, where the port of Merak - Bakauheni is one of the main contributors, the number of ship trips increased from 179,016 (2017) to 185,344 (2018); the number of passengers increased from 5,519,642 to 5,866,688 and the number of four or more wheeled vehicles to be transported increased from 2,065,421 to 2,196,808 in the same period.

As the main port connecting Java and Sumatera, the presence of the Bakauheni - Palembang toll road, which began operating in early 2019, will trigger an increase in passenger and logistic flows from Sumatera to Java and vice versa, not only because of the shorter travel times but also the addition of new infrastructure capacity on toll roads and ferry terminals.

To anticipate the use of overly dominant highway modes, the Ministry of Transportation plans to build a railway line from Bakauheni to Bandar Lampung on the right of way of the toll road that has been operated; far earlier, the railway had operated from Bandar Lampung to Palembang, so that the expansion of the new rail mode from Bakauheni Port to Bandar Lampung for 109 km, would later be connected to the existing railway lines of 387 km that PT KAI Regional IV had served as an operator since a few decades ago (Fig. 1).

This paper aims to explore changes in the travel behavior of users of various modes of transportation along the corridor when a new railway mode is offered as an alternative from Bakauheni to Bandar Lampung and to compete with conventional modes such as AC-bus, non-AC bus, auto, and motorcycle. The uniqueness of this study is to explore respondents' attitudes and perceptions with the stated preference technique for railway modes that are still missing links and will be fully aligned with the toll roads that are already operating in corridors of emerging urban areas that are dynamically growing and is closest to capital Jakarta outside the Java island. The impact of changing attitudes and perceptions on travelers has been discussed by He & Thøgersen [1] on megacity in China but is more associated with car ownership aspects. In India, research is conducted to determine changes in

respondents' attitudes and perceptions related to bike route improvement strategies [2] and the relationship between urban transport and community severance [3,4].

Research group Paleti et al., [5] emphasizes the impact of individual daily travel patterns associated with the value of time; several other researchers focus on discussing the estimation of the value of travel time for work trips and bus service configuration, real-time traffic information, individual grouping based on cluster analysis and service desired by public transport users [6,7,8,9,10], and discuss the user response to parking policy change [11].

Moreover, the attitude and responses of respondents in this study are related to the existence of the railway mode that will be connected to the existing line in the capital of Lampung province, which in total will reach a length of nearly 500 km to the capital city of South Sumatera province, competing with the dominant road-based mode with a length of toll road which is almost the same but offers the flexibility of departure time and door to door service, especially auto and motorcycle modes.

It is important to note that both Lampung and south Sumatera provinces are the two most dynamic growth provinces in the southern part of Sumatera because of the support of their natural resources and benefited from the additional capacity of the trans-Sumatera toll road where the travel time from and to capital Jakarta has decreased significantly. The findings of the research will be attractive compared to the phenomenon of commuting behavior in emerging urban areas in developed countries, such as Napoca, Romania [12], and case study cities in London [13] and Palermo [14].

2. RESEARCH SIGNIFICANCE

The survey method applied was a paper-based interview with a stated preference technique; the substance explored included socioeconomic respondents, travel characteristics, and respondents' attitudes and perceptions related to the expansion of the new railway modes along the Bakauheni - Bandar Lampung corridor.

The survey covers as many as 567 respondents, each of which is an AC bus (150), non-AC bus (154), Auto (153), and motorcycle (110) user. Commercial areas, offices, and settlements are the primary data collection points. Fig. 1 shows the route of the Bakauheni – Palembang toll road that has been operated and the development plan for the railway line connecting Bakauheni to Bandar Lampung.

Fig. 1 Bakauheni – Palembang section of Trans Sumatera toll road

3. MODELS AND ANALYSIS

3.1 Socioeconomics

The overview of the respondent socioeconomics is shown in Fig. 2 to Fig. 4, respectively expressing age range and mode of transport used, education level, and occupation.

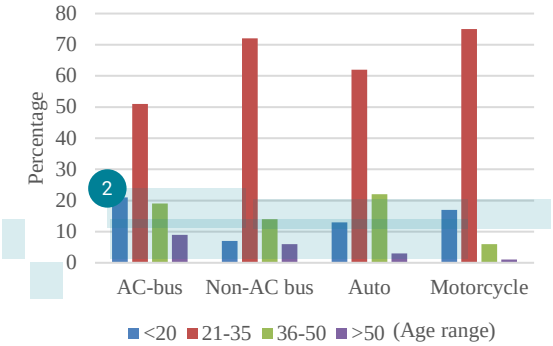

Fig. 2 Transport mode and age range

As shown in Fig. 2 above, the 21 to 35 age group dominates the journey for all modes of transportation, followed by the age group of 36 to 50 for auto and less than 20 years old and the age of 36 to 50 years for AC-bus. It is alleged that the 21 to 35 years old group dominated about 75% for the motorcycle mode, followed by a less than 20 age group with nearly 20%. The respondent education level and transport mode commonly used by respondents throughout the study corridor is shown in Fig. 3.

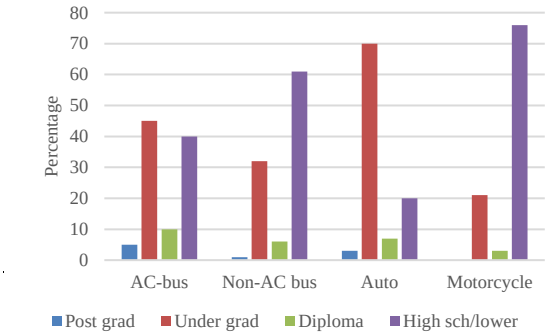

Fig. 3 Transport mode and education level

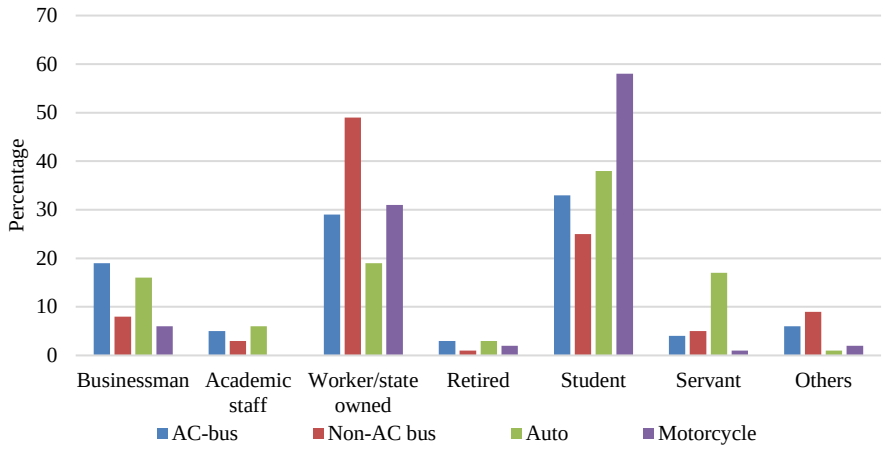

Fig. 4 Transport mode and occupation

As shown in Fig. 3, the level of education equivalent to high school or lower dominates trips using motorcycle and non-AC bus modes. In contrast, undergraduate education levels dominate trips for auto and AC-bus modes. Postgraduate and diploma education levels only contribute less than 10% of all modes of transportation in the Bandar Lampung - Bakauheni corridor. The current occupation of the respondent and the modes of transportation used to support the activities are shown in Fig. 4.

As previously thought it turns out that motorcycle mode is the foremost choice of students when traveling in the corridor with a percentage of almost 60% followed by auto and AC-bus, while the workers are more inclined to choose a non-AC bus with a percentage of almost 50%; motorcycle and AC-bus users show almost the exact figures of 31% and 29% respectively for groups of worker/state-owned company. One surprising finding shows that businessman and servant groups were recorded using auto and AC-bus modes with only 16% to 19% of the total trips in the study area.

3.2 Utility Function

Data analysis using the stated preference in this study estimates the probability that respondents will choose the railway compared to existing modes

such as AC-bus, non-AC bus, auto, and motorcycle with the attributes offered by each mode. Assuming the utility function to be quasi-linear, consisting of the attributes of the fare, travel time, delay, and headway, the difference in utility values in the two modes can be expressed in the form of the difference in these attributes.

Table 1a Mode choice competition model (AC-bus and non-AC bus)

	AC bus			Non-AC bus		
	Coeff.	SE	t-Stat	Coeff.	SE	t-Stat
A constant	-1.822	1.8072	-1.0082	-1.347	1.4644	1.6025
Fare	-1.05E-05	-1.78E-05	-1.18E+00	-1.18E-05	-1.69E-05	1.39E+00
TT	-0.0491	-0.3348	-1.4670	-0.0035	-0.3181	1.1023
Headway	-0.0053	-0.0367	-0.1454	-0.0032	-0.0348	0.0932
Delay	-4.44E-05	1.22E-03	-0.0364	-1.52E-04	1.16E-03	-0.1304
R^2		0.62			0.65	

Table 1b Mode choice competition model (auto and motorcycle)

	Auto			Motorcycle		
	Coeff.	SE	t-Stat	Coeff.	SE	t-Stat
A constant	-3.212	1.3606	0.7439	-4.413	0.0810	-2.6362
Fare	-3.05E-06	-9.38E-06	6.51E-01	-1.05E-07	-4.00E-07	2.63E-01
TT	-0.2288	-0.2651	0.1726	-0.1734	-0.0210	-8.2593
Headway	-0.0386	-0.0290	-1.3281	-0.0064	-0.0380	-0.1675
Delay	-5.45E-04	9.68E-04	0.5628	-9.09E-05	1.27E-03	-0.0718
R^2		0.68			0.71	

SE: standard error t-Stat: t statistic

For example, for auto user respondents as the existing mode, the difference between the utility function value between choosing railway and auto is as shown in Equation (1):

$$U_{rail} - U_{auto} = a_0 + a_1(Fare_{rail} - Fare_{auto}) + a_2(TT_{rail} - TT_{auto}) + a_3(Delay_{rail} - Delay_{auto}) + a_4(Headway_{rail} - Headway_{auto}) \quad (1)$$

In the equation, the a_0 is a constant a nd a_1, a_2, a_3, and a_4 are the coefficients of the fare, travel time, delay, and headway attributes obtained using the multiple linear regression method. The multiple linear regression analysis results are shown in Table 1a and Table 1b above. Table 1a expresses the mode choice competition model AC-bus and non-AC bus, and Table 1b represents the mode choice competition model between auto and motorcycle, respectively.

3.3 Mode Choice Elasticity

In principle, the value of elasticity indicates sensitivity changes in the magnitude of the utility due to changing the value of attributes of fare, travel time, headway, and delay; the specified mode selected by the respondent indicates the utility value of the mode is higher compared to others. Further direct elasticity means a change of elasticity function related to changing the value of fare, travel time, headway, and delay attributes in the corresponding mode. In contrast, indirect elasticity (cross elasticity) reflects the change of the elasticity function for changing the value of the fare, travel time, headway, and delay attributes between one mode and its competitors' modes. The following Table 2a and Table 2b show the results of the mode choice elasticity model expressing direct elasticity and indirect elasticity, respectively.

Table 2a Direct elasticity

	Fare	Travel Time	Headway	Delay
Rail-AC bus	-5.27E-02	-1.79E-02	-6.42E-03	-4.46E-05
Rail-Non AC bus	-7.72E-02	-1.67E-03	-5.11E-03	-1.99E-04
Rail-Auto	-2.80E-03	-1.53E-02	-8.48E-03	-9.99E-05
Rail-Motorcycle	-3.37E-05	-4.05E-03	-4.90E-04	-5.83E-06

Table 2b Indirect elasticity

	Fare	Travel Time	Headway	Delay
Rail-AC bus	-2.10E-01	-7.14E-02	-2.56E-02	-1.78E-04
Rail-Non AC bus	-2.17E-01	-4.70E-03	-1.44E-02	-5.59E-04
Rail-Auto	-7.35E-02	-4.01E-01	-2.23E-01	-2.62E-03
Rail-Motorcycle	-2.59E-03	-3.11E-01	-3.77E-02	-4.49E-04

As shown in the tables above, the respondents of AC-bus and non-AC bus users show that the fare attribute is the most influential in changing utility values to shift to railway mode (direct and indirect elasticity). If railway travel costs are cheaper, the respondent group may shift from AC-bus and non-AC buses to the railway. Conversely, the group of respondents using auto and motorcycles considered travel time as the most crucial attribute in terms of shifting to the railway, followed by headway (direct and indirect elasticity). The faster railway, the more auto and motorcycle users will shift to the railway.

3.4 Rail Mode Share

The following analysis estimates the proportion of users who will shift using the rail mode from previous modes of AC-bus, non-AC bus, auto, and motorcycle along the corridor of Bandar Lampung – Bakauheni. The proportions are calculated by entering the coefficient values of each attribute contained in Table 1a and Table 1b, including the rail mode and attributes proposed in the mode choice elasticity model.

Table 3 Attributes data of the rail and other modes (distance 100 km)

	Fare (Rp)	TT (hr)	Headway (hr)	Delay (min)
Rail	25,000	1.8	3.0	5.0
AC-bus	66,940	2.4	0.3	30.0
Non-AC bus	52,542	3.0	0.3	30.0
Auto	68,742	1.9	0.0	30.0
Motorcycle	28,600	2.4	0.0	5.0

TT: travel time in an hour

Service attribute values of each existing mode based on field observations are shown in Table 3, except the value of rail mode attribute based on assumptions referring to service parameters of the Bandar Lampung – Palembang railway line, which has been operated.

Based on the attribute values listed in Table 3, the output of the mode choice model results in the proportion of users of the existing modes that shift potentially to rail mode, shown in Fig. 5. As shown in Fig. 5, the most significant proportion of existing modes that have the potential to shift if a new railway is developed is the non-AC bus user group at nearly 25%, followed by the AC-bus user group with potential shifting of 20%.

Surprisingly, auto users with the potential to shift less than 5%, while motorcycle users have the potential to shift to rail mode only 1%. However, the findings in this study did not differ significantly compared to the results of previous studies, especially regarding the attitude and perception of the auto user group, which does offer the flexibility of departure, more private, and door-to-door service compared to railway mode.

Findings of this research show an overview of the community in Indonesia and, in particular, the study area of Bakauheni - Bandar Lampung, which expresses attitudes and perceptions relatively differ compared to the habits in developed countries such as Romania, the UK, and Italy [12,13,14] which more consider service quality such as travel time while choosing transport mode even though the purpose of a trip sometimes also influences the choice.

Interestingly some findings of this research are in line with the previous research that there are six additional functions of the trans-Sumatera toll project which can generate additional revenue, namely rest area development, tourism park development, railways integration, dry port integration, motorcycle lane integration, and optic fiber networking [15].

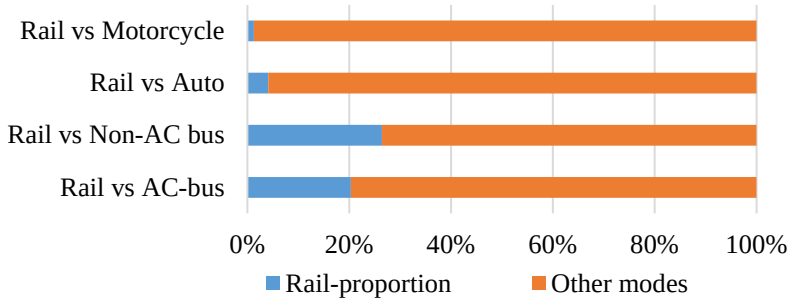

Fig. 5 Potential rail proportion

4. RESULTS AND DISCUSSION

As a newcomer mode in the Bakauheni - Bandar Lampung corridor, railways are still considered less financially feasible by investors than the toll road project, even in the trans-Sumatera toll road corridor that already exists provides right of way so that it does not require fees for land acquisition. This kind of land acquisition model for competing and fully aligned modes is the first project in Indonesia. However, the railway project has not yet ensured its realization after almost a year of operating toll roads.

On the other hand, the central government's alignment with rail mode development in the study corridor is not as strong as the commitment to realize the toll road project, which was built relatively quickly through a national strategic project scheme. If the railways and toll road infrastructure is built together, theoretically, it will be able to reduce investment costs, especially since land-sharing and land acquisition are only made once by the central government and local government along the corridor. The tendency of the government to prioritize the operation of toll roads ahead of railways may have influenced the attitude and perception of respondents, as shown in Fig. 5, which only provides a 4% shifting chance by auto users even though railways offer faster travel time and 36% cheaper fare compared to an auto.

Another uniqueness of the results of this study which rarely occurs in developed countries, is the attitude and perception of motorcycle user groups that are not affected by the presence of new modes of railways, although travel time across the 109 km route on the Bakauheni - Bandar Lampung corridor requires 2.4 hours with a high risk of accidents using a motorcycle compared to 1.8 hours travel time using railways with minimal accident risk. The AC-bus and non-AC bus user groups in the study area were detected as the two groups with the highest flexibility for shifting to railways gradually as the service attributes increased, especially headway which at the beginning of operation was assumed every three hours. Based on observations at the Bakauheni bus terminal, bus departures to Bandar Lampung vary between 1 to 3 hours, depending on the volume of passengers moving from Java to Sumatera. The shorter headway offered by the railway will potentially attract more passengers since the corridor is proliferating because it supports adequate infrastructure capacity.

5. CONCLUSION

This study has succeeded in measuring the impact of attitudes and perceptions on travel mode choice in dynamically growing corridors Bakauheni - Bandar Lampung in southern Sumatera, Indonesia, regarding the presence of railway modes that will compete with conventional road-based modes. The AC-bus and non-AC bus user groups show that the fare attribute is crucial for choosing railway mode. In contrast, the auto and motorcycle user groups consider the travel time attribute the most important followed by the headway attribute.

Hence, the proportion of passengers who have the potential to shift to railway mode is the non-AC bus user group by nearly 25%, followed by the AC-bus user group by 20%. The auto users with a potential shifting group are 4%, and motorcycle users are only 1%. The last two groups seem to be challenging to shift to railway mode since auto and motorcycle offer flexibility and more private and door-to-door service for their users, as revealed by previous research results in other cities and countries.

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