Investigating the Preference on Public Transport in a Metropolitan Area of Lampung Province, Indonesia

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Abstract

Metropolitan areas grow and develop as the region's population grows and travels to meet needs such as education, work, family matters, and business. Kotabumi and Bandar Lampung are two of the regions that have grown faster in recent years as a result of the construction of the trans-Sumatera toll road, while railway has been operating for more than two decades. The main objective of this works is to explore preference towards public transport with service quality attributes. The minibus mode or "travel" in Indonesia is defined as transportation services that pick up passengers. This study surveyed 384 commuters who used three modes of transportation: rail, bus, and minibus with relatively different service characteristics and trip purposes of school/college (35%), leisure (28%), family affairs (19%), work (14%), and business (4%) and represented predominantly an age range of 17 to 55 years (97%). The rail mode's utility value was 4.383, while the bus and minibus modes' utility values were 3.751 and 3.737, respectively. Because utility value reflects the level of user satisfaction with the overall attributes and service quality, the rail mode has a much higher probability of being chosen by respondents, with a probability level of 48.65%, compared to the bus and minibus modes, which have a probability level of 25.86% and 25.49%, respectively.

Keywords

metropolitan area, Kotabumi to Bandar Lampung, utility, probability, mode choice

1 Introduction

1.1 Research background

The city of Bandar Lampung in the southern part of Sumatera Island has a special attraction not only because of its proximity to Jakarta, but also because of the presence of the Trans Sumatera toll road in the past three years. From the south to the north of the city, there are three toll gates with direct access to the city center: Lematang, Kota Baru, and Natar. As a coastal city, the city not only has beaches, but also hills and the best educational facilities in Lampung province, making it a destination for recreation, education, business, government service centers, and health services from the province's districts and cities, as well as neighboring areas (Duadji et al., 2022; Sugiyono and Dewancker, 2021). The increase in mobility to and from Bandar Lampung city in recent years is primarily due to the toll road service and its access support, which contributes to a half-hour reduction in travel time. As is well

known, the characteristics and behavior of users in determining the choice of transportation modes, namely train, bus, and minibus services on the Kotabumi to Bandar Lampung route, are investigated in the paper (Wong et al., 2018). With a distance of approximately 100 km between the two cities – so still within the Bandar Lampung metropolitan area's reach – both cities are crossed by the main route across the middle of Sumatera and the Trans Sumatera toll road. Aspect such as public transportation preferences and the availability of bus, minibus, and train services that have been operating for several decades were the uniqueness of this research compared to previous ones (Acheampong et al. 2021; Fahlstedt and Ma, 2022). Even though the two regions do not share a geographical border, the availability of transportation services with various options has increased commuter mobility in the metropolitan area.

1.2 Literature review

The benefits of integrating public transportation system services with autonomous services is a modern preferred approach today (Manivasakan et al., 2021). The previous studies have been conducted by several researchers and scholars. One of them; Davidson (1973) pioneered transportation research using stated preference techniques, experimentally exploring respondents' preferences for the presence of a fifth transport mode over four existing modes: car, bus, train, and plane on the Montreal-Ottawa (Canada) route. A recent study by De Vos et al. (2022) attempts to investigate and demonstrate that the mode of transportation used has a greater influence on the level of travel satisfaction and support by multi-modal public transport services and new ones will be familiar with all modes of transport (Ho et al. 2020; Othman, 2021). Previously, De Vos and Witlox (2017) investigated travel satisfaction with several focuses, including income level, mode of transportation preference, travel-related habits, and residence location. The findings revealed that the level of satisfaction with daily travel influences residential location. Kroesen et al. (2017) conducted additional micro research and concluded that attitude and behavior (in the context of travel behavior) influence each other and change over time. Another finding of the studies is that the effect of behavior on attitude is greater than the effect of attitude on behavior (Hilgarter and Granig, 2020). In terms of transportation modes, the study found that regular use of public transportation is required to develop a positive attitude toward these modes (Dong et al., 2021). Decision-makers' presence and assertiveness are critical to ensuring this. Lin et al. (2017) investigated the relationship between built environment, attitude, and behavior using data from a household-based daily travel survey conducted in Beijing, China, between 2011 and 2012. The findings suggest that the built location of residence is a significant predictor of travel preferences. Travelers in Beijing, like those in developing countries, prefer private cars to support daily activities when residences and workplaces are relatively far away, even when rail or bus-based public transportation is available with adequate service levels. However, in areas where public transportation is easily accessible, the use of private cars is drastically reduced. Farinloye et al. (2019) studied travelers in London and discovered a slightly different phenomenon from the habits of the community in Beijing, where several groups of respondents interviewed by the research team confirmed that they have not or do not intend to try other modes of transportation because the modes they usually use to support mobility (private cars and trains) are claimed to be more comfortable and familiar. While car ownership is not cheap, and train tickets in London are not cheap, this group of respondents stated that convenience is more important than cost. Meanwhile, Faber et al. (2021) found that the distance to bus stops, metro/tram stops, and living close to the city center had no effect on the level of car use in the Netherlands, which is known to be very friendly to cyclists and public transportation users. On the other hand, Guidon et al. (2020) noted that offering low-share transportation modes i.e. bike-sharing and taxi services, which may not be perceived directly as complementary to public transportation, may not be effective due to its valuated which is lower compared to stand-alone services. However, as is common in developed cities, the findings suggest that policies aimed at making public transportation more welcoming can increase community interest in using these modes to support daily activities to avoid the long wait and crowding (Erdoğdu and Watson, 2022). According to the study of Olde Kalter et al. (2021), when targeting young adults, the use of car, public transportation, and bicycle modes was relatively stable over time and above the average level. The study, on the other hand, shows that young adults who later become parents prefer to use cars and have a higher preference for cars as a daily mode of transportation over time. In contrast, people use public transportation and bicycles less after having children. Clark et al. (2016), using data from the UK Household Longitudinal Study (Department for Communities and Local Government, 2024), concluded that changes in commuting mode are primarily driven by changes in travel distance to work that occur as a result of residential relocation and job transfers. Previous studies in developed cities consistently show that cost factors have little effect on changes or shifts in transportation modes. According to Saleh et al. (2022), the most important consideration for travelers in the northern tip of the island of Sumatera is travel cost. Although transportation conditions, community norms, and the environment differ between developing and developed countries, Ye and Titheridge, (2017) found some similarities based on previous findings. Active commuters are the most satisfied with public transportation services; travel attitude is significantly related to travel satisfaction; overcrowding on trains or buses and the need to change modes indicate lower levels of travel satisfaction; and road congestion has a strong and negative relationship with travel satisfaction.

2 Data and methods

2.1 Data

The survey was conducted in and around Kotabumi, the capital of North Lampung district in Lampung province, and the modes of transportation that became the subject of the study were train, bus, and minibus, in that order. The minibus mode or "travel" in Indonesia is defined as transportation services that pick up passengers. It provides passenger pick-up services from in front of the house and transport to the address. Table 1 shows a brief profile of the cities of Bandar Lampung and Kotabumi, while Table 2 shows the service characteristics of the train, bus, and minibus modes. Respondents in the study refer to the Kotabumi population source from the Badan Pusat Statistik Kabupaten Lampung Utara/Statistics of Lampung Utara Regency (Badan Pusat Statistik Kabupaten Lampung Utara/Statistics of Lampung Utara Regency, 2021) as shown in Table 1, and 384 people were selected using the Isaac and Michael, (1995) formula. Bandar Lampung and Kotabumi can be seen on a map of Lampung province (Tirto.

id, 2024) in Fig. 1. The province of Lampung is located on the southern tip of the island of Sumatera. Lampung province has a railway line with forty stations along 387 km between Bandar Lampung-Palembang, which is part of a railway network in south Sumatera operated by Kereta Api Indonesia. Tanjungkarang station is a large railway station and located at the heart of Bandar Lampung as the capital city of Lampung province. The station served as starting point for passenger trains heading for Kertapati station in Palembang. The Bakauheni-Terbanggi Besar toll road spanning from Bakauheni in south Lampung to Terbanggi Besar in central Lampung along 141 km was completed in March 2019. The Rajabasa bus terminal is the main public road based transportation center of the city.

2.2 Methods

It is undeniable that the situation in developing countries is more complicated and influenced by many variables because the available transportation modes are more diverse. As shown in the following Eq. (1), mode selection is typically based on the maximum utility value obtained by users from each alternative available option.

$$U = c + a_1 x_1 + a_2 x_2 + \dots a_n x_n, \tag{1}$$

where:
- U = utility value
- c = constant
- $a_1 \dots a_n$ = regression coefficient
- $x_1 \dots x_n$ = variable.

Furthermore, because there are more than two modes of transportation available, namely rail, bus, and minibus with relatively different service characteristics, as shown in Table 2 above, a multinomial model is used for mode selection. The train only makes two trips per day but has a seating capacity of nearly 400 people, whereas buses and minibus modes with a capacity of less than 10% have a much higher number of trips with a 30-minute headway.

$$P(i) = \frac{e^{ui}}{e^{ui} + \sum e^{ujn}}, \tag{2}$$

where:
- $P(i)$ = probability of mode i being chosen by the respondent
- u = utility value
- e = exponential
- $\sum e^{ujn}$ = sum of utility values of all modes.

Table 1 Brief profile of Bandar Lampung and Kotabumi

Bandar Lampung	City Comparison	Kotabumi
Lampung province	Capital	District of Lampung Utara
197	Area (km²)	2,725
1,184,949 (2021)	Population	634,117 (2021)
6,008	Density (persons per square kilometer)	234
Airport, port, rail, bus, minibus	Transport facility	Rail, bus, minibus
Government, education, business, tourism	Driving force of the city's economy	Local government, agriculture, plantation
Center of national activity (PKN)	National city's statute	Center of regional activity (PKW)

Table 2 Service characteristics of transportation modes

	Rail	Bus	Minibus
Capacity (seat)	384	30	15
Daily passenger	180 – 200	130 – 150	250 – 270
Number of trips	2 (9am and 5pm)	30 mins (headway)	30 mins (headway)
Travel time (hour)	1.5 – 2	2.5 – 3	1.5 – 2
Fare (IDR)	10,000	23,000	35,000
No. of fleet	-	24	18
Type of service	station to station	terminal to terminal	point to point

Fig. 1 Map of Lampung province, Tirto.id (2024)

Figs. 2–6 depict an overview of respondents' socioeconomic status. Fig. 2 depicts the age group, Fig. 3 illustrates the occupation, Fig. 4 shows the education level, Fig. 5 displays the travel destination, and Fig. 6 reveals the travel purpose. As shown in Fig. 2, the productive age group includes 366 people between the ages of 17 and 55. Members of this age group work as a student/at college (229 people), at a private company (53 people), as a civil servant (41 people), as a teacher/lecturer (16 people), or as an entrepreneur (11 people), which represents 91% of commuter passengers on the Kotabumi-Bandar Lampung route (Fig. 3). Most respondents' education level is high school or below with 229 people (59%), followed by undergraduate with 96 people (25%). Although there are several travel destinations, it appears that Bandar Lampung is the destination of 348 people, or nearly 91% (Fig. 5), where the provincial capital is indeed

the center of government, education, business, and tourism. While the majority of respondents (241) or 63% travel for school/at college and leisure activities (Fig. 6).

The last chart shows travel purposes of all interviewed respondents. As expressed by Fig. 6 the school or college, leisure, family affairs and work are the most common travel purposes of respondents within the metropolitan area.

3 Results and discussion
3.1 Factors influencing mode choice
People choosing a mode of transportation are frequently confronted with a number of service characteristic factors, which provide valuable input to stakeholders. According to Guirao et al. (2016), after conducting face-to-face surveys of 520 respondents in Madrid (Spain), the perceived service quality of certain service attributes, for example, can
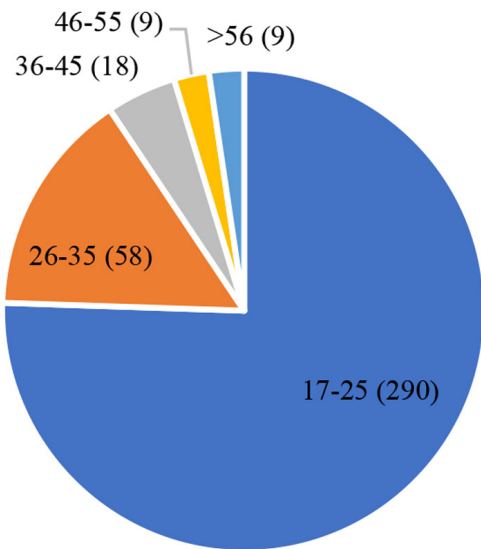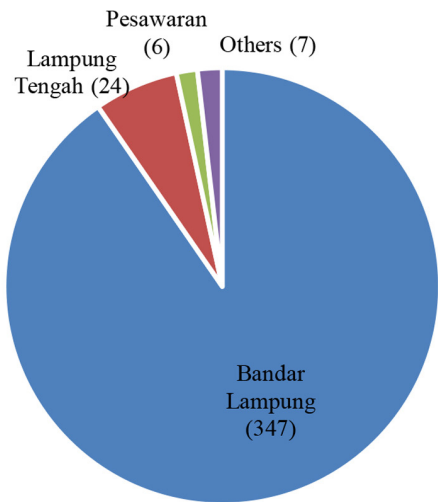
Fig. 2 Age group

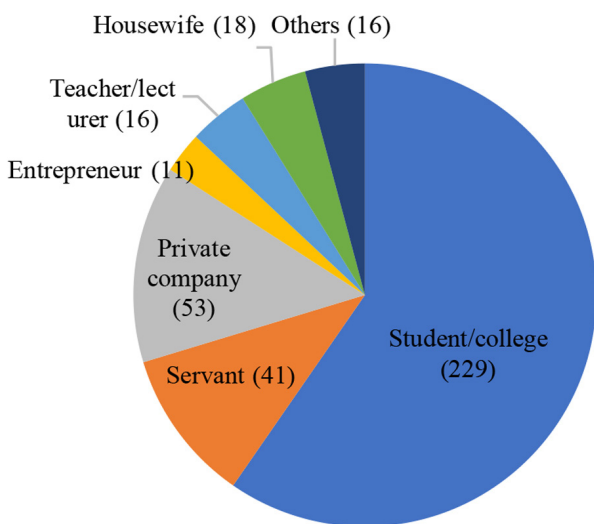**Fig. 5** Travel destination
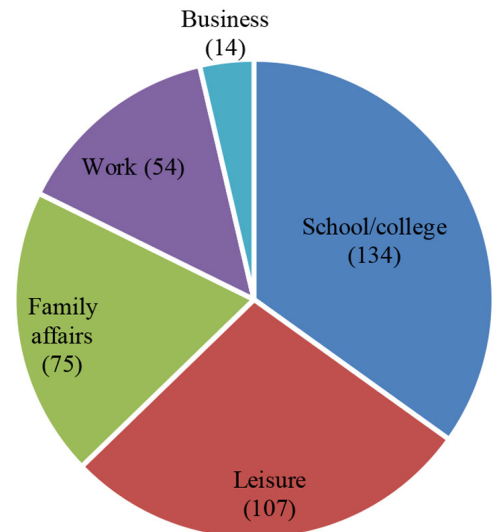

Fig. 3 Respondent's occupation
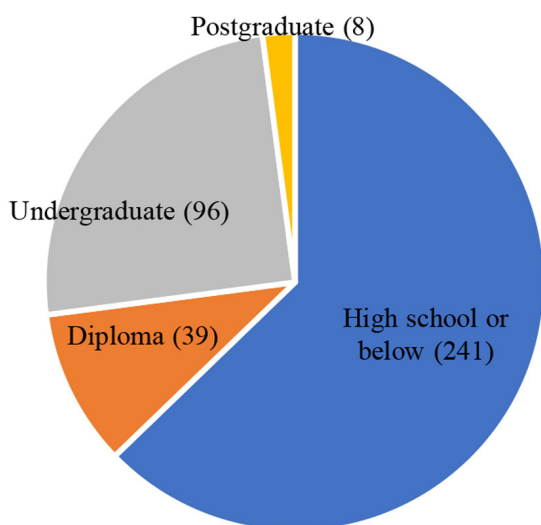

Fig 6 Travel purpose

Fig. 4 Education level

encourage increased use of public transportation. In the Kotabumi to Bandar Lampung case study, the research team attempted to explore previous studies related to factors that are considered the most influential when choosing public transportation, i.e. fare, waiting time, services provided, safety, comfort, and travel time. All of the 384 respondents were asked to choose the factors that influence their choice of mode of transportation, and the results are shown in Table 3. Based on the interview that authors have conducted fare, waiting time, services, safety, comfort and travel time, respectively, are the most factors influencing mode choice.

The main reason given by 94 people (27%) who chose the train as their mode of transportation was comfort, followed by waiting time (23%), safety factor (14%), and fare (14%). The influencing factors are not far from the researcher's prediction in terms of the characteristics of

Table 3 Factors influencing mode choice

Factors	Rail respondent		Bus respondent		Travel respondent	
	No. of pass	%	No. of pass	%	No. of pass	%
Fare	49	14	109	33	91	26
Waiting time	82	23	70	21	61	17
Services provided	32	9	42	13	42	12
Safety	50	14	31	9	39	11
Comfort	94	27	58	18	74	21
Travel time	42	12	21	6	50	14

rail services, which are safer in terms of operation and provide more spacious seating space, allowing for work while traveling. Furthermore, the fare factor influences the mode choice, because traveling by train is less expensive than traveling by road. Waiting time (23%) is an important consideration for rail travelers because this mode is more adaptable to weather changes and uses centralized control to strictly regulate train arrival and departure. Surprisingly, the fare factor is the most important consideration for bus travelers (33%) and minibus respondents (26%), followed by waiting time and comfort. This finding suggests that respondents for the two road-based modes are willing to pay more for better service, particularly in the case of the minibus mode with a fare that is 3.5 times higher than rail fare and 1.5 times higher than bus fare. However, when compared to the private vehicle mode, the minibus fare of 35,000 IDR and the bus fare of 23,000 IDR (Table 2) are significantly less expensive because the toll alone costs 46,000 IDR plus the cost of fuel.

Since it is assumed that bus and minibus passengers on the Kotabumi to Bandar Lampung route were previously commuters using private vehicles, fares ranging from 23,000 IDR to 35,000 IDR are deemed adequate. The flexibility of departure times with 30-minute headways is the allure of bus and minibus transportation modes, even if they are deemed insufficient in terms of safety (Table 3). Chocholac et al. (2020) emphasized the importance of maintaining the quality of public transportation services for specific age groups. According to research conducted in the Hradec-Pardubice agglomeration (Czech Republic) with a population of over 335,000 people, public transportation service providers should focus primarily on potential users aged 35–44. The findings of the research team do not differ significantly from the age group in the Kotabumi to Bandar Lampung case study, where the 17 to 45 age group accounts for 95% of all respondents (Fig. 2).

Another research conducted by de Oña et al. (2020) investigated the quality of public transportation from the perspective of private car users and identified three key factors for stakeholders to consider: frequency, speed, and intermodality. When compared to public transportation modes, the flexibility of private vehicle modes allows users to obtain the three attributes to the greatest extent possible, even though the fare factor is generally lower for rail or bus-based public transportation.

3.2 Utility equations

Furthermore, a series of statistical tests were performed until the best coefficient of determination and maximum utility (Eq. 1) were obtained for each mode of transportation, as follows:

$$U_{\text{rail}} = -0.142 + 0.071_{\text{fare}} + 0.203_{\text{waiting time}}$$
$$+0.114_{\text{frequency}} + 0.204_{\text{availability}} + 0.144_{\text{travel time}} \quad (3)$$
$$+0.190_{\text{on-time depart}} + 0.162_{\text{on-time arrival}},$$

$$U_{\text{bus}} = 0.148 + 0.127_{\text{fare}} + 0.159_{\text{waiting time}}$$
$$+0.203_{\text{frequency}} + 0.114_{\text{availability}} + 0.055_{\text{travel time}} \quad (4)$$
$$+0.111_{\text{on-time depart}} + 0.180_{\text{on-time arrival}},$$

$$U_{\text{minibus}} = 0.122 + 0.110_{\text{fare}} + 0.140_{\text{waiting time}}$$
$$+0.175_{\text{frequency}} + 0.135_{\text{availability}} + 0.149_{\text{travel time}} \quad (5)$$
$$+0.133_{\text{on-time depart}} + 0.109_{\text{on-time arrival}}.$$

The railway appears to be superior for the waiting time and availability attributes, with values of 0.203 and 0.204, respectively, as the oldest mode of transportation and having served the Kotabumi to Bandar Lampung route for the past decade. The values for the bus mode are 0.159 and 0.114, respectively, while the values for the minibus mode are 0.140 (waiting time) and 0.135 (availability). The advantage of rail-based modes over bus and minibus modes is a definite train departure schedule, which is sometimes influenced by the level of passenger demand. Another advantage of the rail mode over the other two modes is that it has a better on-time departure attribute than the minibus mode. The fare attribute of the rail mode, which is actually smaller than the other two modes despite offering lower travel costs, is quite interesting in this study. Since the fare amount is controlled by the government, the main advantage and attraction of rail mode is a more competitive fare. Travel costs for buses and minibus modes, on the other hand, are more determined by market mechanisms because they are completely controlled by private operators. However, bus and minibus

modes outperform rail modes in terms of frequency. The rail mode received a score of 0.114 for this attribute, while the bus and minibus modes obtained 0.203 and 0.175, respectively. According to Avenali et al. (2020), stakeholders should persuade local governments to allocate more efficient public funds and reprogram current services to take into account the opportunity to switch to socially cheaper transport modes while maintaining passenger mobility and service quality. According to a study of local level services in Italy, buses can meet demand at a much lower social cost while maintaining service quality continuity comparable to rail. While Suman et al. (2017) focused on direct interventions such as providing more buses by local governments, including executive services and the construction of bus-only lanes in Delhi and Mumbai. Simultaneously, policies discouraging the use of private vehicles were implemented. The investigations by Bajada and Titheridge, (2016) in Malta, where a 40 years bus service reform was attempted, emphasize the importance of the authority, as well as the regulator and bus operators, adhering to the service contract and using it as a guideline to enforce the regularity of bus services and operations.

3.3 Mode choice probabilities

The probability of choosing a particular mode of transportation is calculated using Eq. 2 and the following results are obtained:

$$P_{(\text{rail})} = \frac{e^{4.383}}{e^{4.383} + e^{3.751} + e^{3.737}} = 0.4865, \tag{6}$$

$$P_{(\text{bus})} = \frac{e^{3.751}}{e^{3.751} + e^{4.383} + e^{3.737}} = 0.2586, \tag{7}$$

$$P_{(\text{minibus})} = \frac{e^{3.737}}{e^{3.737} + e^{4.383} + e^{3.751}} = 0.2549. \tag{8}$$

With different service characteristics, even with only two trips per day from Kotabumi to Bandar Lampung, rail mode has a probability level of 48.65% of being chosen by respondents while bus and minibus modes share the remaining 24.86% and 25.49%, respectively. Although the fare attribute has no significant effect on the utility value of the rail mode, it is relatively superior to other service attributes when compared to the other two modes, so that as the first and pioneering mode on the Bakauheni-Bandar Lampung route, rail is chosen by nearly half of commuters. This also clarifies the user's desire for the government's continued presence in ensuring the operation of transportation modes through the state-owned company PT Kereta Api Indonesia.

Furthermore, the central government controls the amount of tariff by establishing an upper limit tariff. As a result, the community or rail mode users believe the regulator is concerned about them. However, despite the fact that bus and minibus modes provide better service flexibility with headways of around 30 minutes and travel times that are nearly the same as rail modes due to the availability of toll roads, the findings of this study show that the service attributes provided have not been successful in attracting users. The role of regulators at the provincial and district levels regarding tariffs and service standards is not as evident as in the rail mode. Road-based modes, on the other hand, have complete control over their operations and service standards, including tariffs that are 2.5 to 3 times higher than rail modes.

Regarding fare levels, there is the possibility of government intervention through subsidies aimed at reducing fares, which has long been identified as a high priority to address (dos Santos and Lima, 2021). However, experience in many countries has shown that ensuring that such subsidies are well-targeted is difficult. The case study in Brazil emphasizes that the decision-making process for allocating additional resources, including subsidies, should prioritize improving the quality of public transportation services. Public authorities have even been involved in relocating bus stops so that certain high-priority communities can easily access them. As detected in the metropolitan case study in Lampung province, Indonesia, experience in developing countries such as Brazil has shown that fare and service characteristics such as bus stop location cannot be fully controlled by the operator.

Meanwhile, studies in Italy by Avenali et al. (2020); Ingvardson and Nielsen, (2018) who investigated 41 BRT and metro systems in a number of countries highlight the importance of ensuring adequate accessibility to station areas as a critical and strategic element showing positive effects in shaping modern urban development as well as increasing regional property values. When it comes to the long-term impact of competition between rail and road-based modes, international experience shows that it is more dependent on how much the system improves the existing situation, competition with traffic or private car users, and how the system is implemented in the local context and situation.

4 Conclusion

This paper expresses the service characteristics of three modes of transportation – rail, bus, and minibus – in a metropolitan area in Lampung province, specifically the 114 km Kotabumi to Bandar Lampung route, which has

an estimated 1,000 daily commuters. The work presented a direct survey approach to investigate preference towards public transport. Users naturally select a mode of transportation based on numerous considerations and influences, including the purpose of travel and the destination of the trip. Bandar Lampung, the province's capital, is the most popular destination for trips from Kotabumi, with trip purposes including school/college (35%), leisure (28%), family affairs (19%), work (14%), and business (4%), as shown in Fig. 6. It is worth noting that the age group of respondents is dominated by the 17–to–55–year age range, 97%, which is the productive age group and exemplifies the demographic advantage enjoyed by developing countries such as Indonesia. The number of daily trips of this age group has the potential to increase in the coming years as people get older and advance in their careers and management levels, as well as the existence of the trans Sumatera toll road since early 2019, which allows for shorter travel times on road-based modes.

With only two trips per day for the rail mode and headways of around 30 minutes for the bus and minibus modes, the utility value of the rail mode is confirmed at 4.383 compared to the utility values of the bus and minibus modes of 3.751 and 3.737, respectively. Because utility value reflects user satisfaction with overall attributes and service quality, it is not surprising that the rail mode has a much higher probability of being chosen (48.65%) than the bus and minibus modes, which have probability levels of 25.86% and 25.49%, respectively. Results indicate that rail commuters have more satisfaction preference than those using bus and minibus modes. The study's findings show that while service attributes such as frequency and fare are superior in road-based modes, they do not necessarily attract more users. Road-based modes that exist and are developed at the initiative of private operators necessitate government or regulatory intervention and, drawing on experiences in other countries, should be run on the basis of contracts that regulate the operators' rights and obligations. The regulator's representation of users' interests becomes more certain, including a reasonable tariff level to obtain a certain quality of service that is detailed in the contract. The presence of the government in the rail mode through the state-owned company PT Kereta Api Indonesia has the potential to have positive effects and encourage a higher level of probability of rail mode compared to road-based modes on the Kotabumi to Bandar Lampung route.

5 Acknowledgment

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