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Integrated River Transport Development to Support Smart City

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Abstract: Light Rail Transit (LRT), integrated with river transportation as a unique city and tourist attraction, is important in supporting smart cities. This study aims to assess the possibilities of river transportation users who use LRT as an advanced mode and its supporting infrastructure. This research is quantitative research with a descriptive approach. Primary data is obtained from a survey of the movement of river transportation users from outside the city to Palembang City and has the potential to continue their journey using the LRT. Interviews were also conducted with respondents covering the respondents' travel destination, travel destination, and reasons. The study results indicate that the use of river transportation from within the city, which gets off at the pier and does not continue the journey as much as 75%, and the rest will continue the journey using the LRT mode only 16%. Meanwhile, 29.5% of river transport users from outside the city disembark at the pier. The remaining 53% continue their journey with the potential to use LRT, which is a reasonably high percentage if it can be appropriately managed. The availability of a variety of public transportation that can park near the pier at a cheaper rate is the main cause of their lack of interest in using the LRT mode. The proposed supporting infrastructure for integration between river transport and LRT is the pedestrian path.

Keywords: Light Rail Transit; Integrated River Transport; Smart City

1. Introduction

The number of vehicles has increased in line with economic growth. On the other hand, the growth of traffic infrastructure is not as high as the growth in the number of vehicles and community mobility. Traffic is a means of mobility of urban people from one place to another. If traffic flow is disrupted or congestion occurs, the community's mobility will also be disrupted. It encourages the emergence of various dynamic programs that focus on innovation, solutions, and optimal utilization of human resources and technological resources, such as in the transportation sector, to support the development of smart cities in the transportation sector. Transportation is the movement of goods or passengers from one location to another, where the product being moved or moved is needed or desired by the other location. There are five main elements in transportation: humans, those who need transportation, goods needed by humans, vehicles as means of transportation, roads as infrastructure, and organizations as transportation managers. The transportation system has always been an interesting issue and has even become a topic of sexy debate in every event in the context of direct regional head elections because the issue of mass transportation is in direct contact with the general public (Razak & Ahmad, 2020).

The safety and comfort of transportation are necessary for minimizing the waste of road use due to the increasing volume of vehicles. Transportation that allows city residents to mobilize efficiently and can provide safe and comfortable services is one part of a smart city (Rahmadiansyah & Arief, 2019). Smart city ideas are an alternative to solving urban problems and ensuring livable cities even during relatively fast urban population growth. In essence, a smart city is an effective city and the concept of efficient city management to address various city challenges by using innovative, integrated, and sustainable solutions (Wicaksono et al., 2021). The success of the government can be seen from its public services. Because of this, the smart city concept was born to solve problems in the city with a more integrated approach (Safitry et al., 2020). Public service is an important issue for the sustainability of a city. In order to create excellent service, it is necessary to develop smart cities as a new way to serve the community (Naibaho, 2021).

The government is obliged to improve good governance or commonly referred to as good governance, including improving public services (Razak & Harfiah, 2018). Public services involve very broad aspects of life and are also one that encourages the improvement of the quality of public transportation services (Fadli et al., 2014). Public transportation, also known as public transportation or mass transportation, is a passenger transportation service by a group travel system available for use by the general public, usually managed according to a schedule, operated on a defined route, and charged for each trip (Razak & Ahmad, 2020).

Planning and development of transportation facilities and infrastructure greatly influences and determines the increase in economic growth in supporting the achievement of development goals and the results that have a real impact on constructive changes in society in all aspects of life. Transportation plays an important role for individuals, the wider community, and the economic and socio-political growth of a country. Transportation can create and increase the accessibility of natural resource potentials that were initially not utilized to become affordable and processed. The progress of transportation will also lead to an increase in human mobility, where the higher the mobility, the higher the level of productivity. The increase in productivity will have an impact on economic progress. In addition, the situation and environmental conditions underwent a fundamental change towards a better and more advanced improvement to improve the standard of living of the wider community and strengthen national stability. Construction and improvement of road quality are some of the things that make it easier for the population to move, which in turn can reduce transportation costs. In addition, the availability of good roads can also facilitate the flow of trade within the region and between regions (Hamid, 2014).

The river is the lifeblood of the community's economy that affects the pattern of life, namely placing the river as a livelihood area and transportation infrastructure (Hamidah et al., 2014). The Musi River has long been an icon or symbol for the city of Palembang, and this river is still an alternative means of transportation for the local community. Palembang City as the capital city of South Sumatra Province is the second largest city on Sumatra Island, after Medan City whose economy continues to increase from year to year with the source of economic growth coming from the trade sector (Hidayat et al., 2021). The Musi River separates Palembang into two parts, the downstream area functions as the city and government center while the upstream part is an upstream and downstream settlement, which is united by the Ampera bridge. The Musi River area is more strategically located because it is the center of human activity and offers tourism potential and a shopping center (Saksono et al., 2022). River transportation grows and develops naturally due to natural geographical conditions that have many rivers. The river has a distinctive contribution to the history of Palembang City. For the people of Palembang City, the river in the past was very functional, namely as a source of drinking water, a place to bathe and wash clothes, as a water transportation infrastructure that was highly reliable, such as for trading activities (starting from clothing, food to boards), to find fish. In the river as a livelihood and others. Palembang city is one of the metropolitan cities in Indonesia. The development of river transportation is also one of the steps taken by the city government in providing better transportation services. However, the existing development has not given optimal results because it has not been well mapped from the origin of the trip and the demand for passengers using river transportation or other modes of transportation. Water transportation is an important transportation and liaison infrastructure to facilitate social, economic, cultural, educational and health activities. The increasing development effort demands water transportation or water transportation segments to facilitate population mobility and traffic from one area to another, both between sub-districts and sub-districts to the district capital.

Law Number 21 of 1992 concerning Shipping Article 80 (1): The operation of river and lake transportation is arranged in an integrated manner, intra and intermodal, which is an integral part of the national transportation system. Article 80 (2): Transportation of rivers and lakes is carried out using fixed and regular routes equipped with irregular and irregular routes. In 2015 the city of Palembang started the construction of the Light Rail Transit (LRT) mass transportation mode as a solution to solving transportation problems within the city. 13 stations were built at the same time as the LRT, one of which is Ampera Station which will serve the movement in the area of its construction. The uniqueness of this station is that it is located right next to the Musi River, which is expected to be integrated with river transportation modes and increase the use of river transportation modes in Palembang City.

Light Rail Transit is an electric rail network system that can be run using one carriage along a special line, multistorey with a hanging structure, subway, or usually integrated with the road. One thing that distinguishes LRT from other types is that it often runs without an exclusively dedicated lane mixing with traffic. In addition, the development of the LRT mode, which is integrated with river transportation modes as a unique city and as one of the tourist attractions of Palembang City, is important. Development of River Transportation to Support Movement in LRT Mode at Ampera Bridge Station. In connection with the congestion problem and the integration of river transportation into the national transportation system, a plan for developing river transportation and infrastructure that is compatible with the LRT movement in Palembang City is required to increase the city community's comfort, time efficiency, and interest in using integrated LRT river transportation.

2. Methods

This research is quantitative research with a descriptive approach. Primary data collection includes respondents who use river transportation and inventory and condition of river transportation facilities and infrastructure. The survey was conducted on 228 respondents who use river transportation during peak hours, namely when going to work and coming home. In addition, the collection of data regarding the potential users of river transportation using LRT as a follow-up mode was carried out using a survey to find out the travel pattern, the origin of destination, and use of the intermodal river transportation mode with LRT in Palembang City. Thus, the respondents surveyed are passengers using river transportation and potentially intermodal with LRT.

Passengers who will intermodal with the LRT are expected to board or disembark at Ampera Pier and Pasar 16 so that an interview survey will be conducted at these two jetties. The information collected includes the trip's origin, the mode used before and after the river mode, the willingness to use the LRT. The survey was conducted using the interview method with respondents. The information collected covered the characteristics of correspondents, the origin of travel destinations, the purpose of travel, and modes used before and after river transportation. In this interview survey, information will be obtained regarding respondents' expectations for the development of river transportation connected to the LRT. Data collection regarding the need for infrastructure to support the integration of river transportation with LRT mode is carried out by field observations regarding the condition of infrastructure and the need for dock facilities or integration facilities with LRT modes.

In order to determine the percentage and analysis of river or other modes of transportation used by the community surrounding the river, a multinomial logit model is used. This is applicable to all modes of transportation, including river transportation, motorcycles, automobiles, buses, and city transportation. The goal of modeling many modes of transportation is to determine which are the most in-demand by residents in terms of journey time, waiting time, other charges, and parking fees.

3. Results and Discussion

Respondents in this study amounted to 228 people who are users of river transportation consisting of 184 respondents using river transportation from within the city and 34 respondents using river transportation from outside the city. The place of origin and destination is useful for studying the pattern of origin and destination trips or the pattern of travel distribution. The concept of transportation is based on a journey between the place of origin and destination. In a journey, there is a journey which is a movement that starts from home, and there is also a journey whose origin or destination is not home, for example, from work to the market, from the bus terminal to campus, and so on. The data displayed in a matrix is no longer respondent's data but has been multiplied by the population multiplier for each urban village. The origin-destination relationship matrix for river transportation users describes the travel destinations of respondents who use river transportation as a means of transportation to the destination of the trip. The relationship matrix for the origin of the use of river transportation is attached.

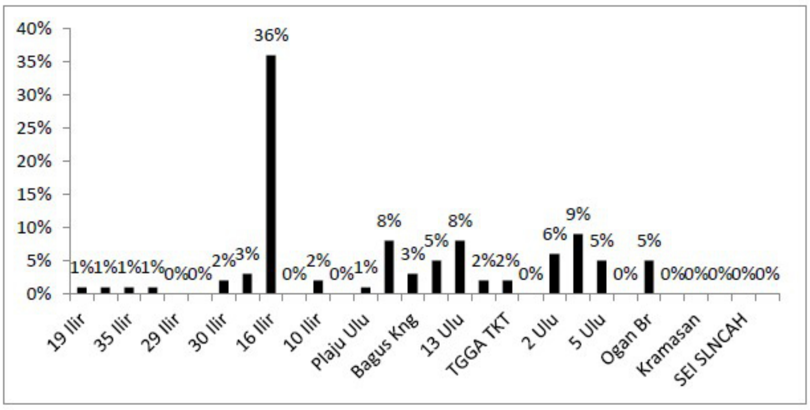

Figure 1. Percentage of Use of River Transport Used in Areas Along the Musi River

The use of river transportation used in areas along the Musi River Based on the above curve (Figure 1), it is known that almost 40% of river transportation users go to the 16 downstream villages. Kelurahan 16 downstream is the main destination for river transportation users because this urban village is a business center and shopping. This area generates great attraction and generation for people who shop for various goods and workers in large quantities. In addition, there are various public facilities around this area, such as docks, river mode parking, integration with other modes, and other quite good facilities. The use of technology in various routine activities carried out by public organizations, namely providing public services, effectiveness, efficiency, and the quality of basic services provided by the government. Government provision is made to provide welfare and services for the community. Service effectiveness and efficiency to accelerate development (Gunartin, 2018). Innovative solutions are needed, and that is where Smart Transportation Systems should play a role in contributing to tangible results quickly and efficiently (Alam et al., 2018).

Survey data from the origin of the trip and field observations show that respondents with the intention of shopping, work, and social culture use river transportation as a vehicle for crossing from upstream to downstream or vice versa. Information from river transport users uses this transportation to cross from upstream to downstream of the Musi River. Then the journey continues by using other modes. This information shows that river transportation generally has to be between modes with other transportation. The potential for river transportation users to continue their journey using the LRT mode is quite high considering the LRT route through the center of business and commercial activities in Palembang City.

In contrast to river transportation, which is widely used as a means of crossing to Kelurahan 16 Downstream and between modes with other transportation to continue the journey, traveling to Kemaro Island for recreation, river transportation is the main means of transportation. For travel purposes other than to Kelurahan 16 Downstream, it is very rare for people to travel using river transportation. People choose land transportation because it is more efficient than river transportation, especially door-to-door private vehicles.

Kelurahan 16 Downstream produces the most trips for both origin and destination movements. The movement of origin of the largest river transportation besides the 16 downstream village is 12 upper course of a river (8.3%), while the destination 9—10 upper course of a river (11.9%). The survey was conducted on several respondents who got on and off at Pier 16 Downstream to see the opportunities for passengers to travel using the LRT mode. Intelligent transportation systems require creating interconnected transit systems to ensure flexibility and efficiency (Abbas et al., 2021). The survey results are shown in Table 1.

Table 1. River Transport Users Who Stop at Pier 16 Downstream and Ampera

Pier	Destination	Total	Description
16 Downstream	1 Downstream	1	Potential
16 Downstream	9 Downstream	1	Potential
16 Downstream	13 Downstream	1	-
16 Downstream	16 Downstream	125	-
16 Downstream	18 Downstream	1	-
16 Downstream	20 Downstream	2	Potential
16 Downstream	22 Downstream	2	Potential
16 Downstream	24 Downstream	4	Potential
16 Downstream	2 Downstream	2	Potential
16 Downstream	28 Downstream	1	-
16 Downstream	7 Upper course of a river	1	-

Pier	Destination	Total	Description
16 Downstream	15 Upper course of a river	1	Potential
16 Downstream	Pakjo	1	Potential
16 Downstream	Kertapati	1	Potential
16 Downstream	Lawang Kidul	2	Potential
16 Downstream	Ario Kemuning	1	Potential
16 Downstream	Bukit Lama	1	-
16 Downstream	Banyuasin	1	Potential
Ampera	3 Downstream	1	Potential
Ampera	8 Downstream	1	Potential
Ampera	16 Downstream	13	-
Ampera	18 Downstream	1	-
Ampera	22 Downstream	1	Potential
Ampera	24 Downstream	1	Potential
Ampera	27 Downstream	2	-
Ampera	30 Downstream	1	-
Ampera	Bukit Lama	6	-
Ampera	Kertapati	1	Potential
Ampera	Sukarami	2	Potential
Ampera	Pahlawan	1	Potential
Ampera	Banyuasin	4	Potential

From Table 1, it can be seen that most of the destinations of river transport users who stop at Pier 16 Downstream and Ampera are urban village 16 Downstream, as many as 138 of 184 respondents or 75%. The rest of the 46 continuous respondents only 30 people who can continue their journey using the LRT mode. Public transport has become an important issue for urban development: more people plan LRT (light rail transport system) and village transit as part of integrated transportation (Furlan & Sipe, 2017). Based on the purpose of the trip, the potential for a movement that continues the journey using the LRT mode is the movement from the origin zone to the destination zone that crosses the LRT route. Thus, the potential for movement using the LRT mode is 16.5%. Extra zone movement, namely movement from outside the city of Palembang using river transportation where the potential for passengers getting on or off at Pier 16 Downstream and Ampera and continuing their journey by LRT mode is shown in Table 2.

Table 2. River Transport Movements Outside the City of Palembang Up/Down at Pier 16 Downstream and Ampera

Pier	Destination	Total	Description
16 Downstream	16 Downstream	2	-
16 Downstream	17 Downstream	1	-
16 Downstream	26 Downstream	1	Potential
16 Downstream	Kertapati	1	Potential
Ampera	3 Downstream	1	Potential
Ampera	8 Downstream	1	Potential
Ampera	16 Downstream	8	-
Ampera	20 Downstream	1	Potential
Ampera	22 Downstream	1	Potential

Pier	Destination	Total	Description
Ampera	24 Downstream	1	Potential
Ampera	27 Downstream	2	-
Ampera	30 Downstream	1	-
Ampera	Bukit Lama	2	-
Ampera	Pakjo	1	Potential
Ampera	Kertapati	1	Potential
Ampera	Sukarami	3	Potential
Ampera	15 Upper course of a river	1	Potential
Ampera	Banyuasin	5	Potential

Table 2 shows users of river transportation from outside the city who get off at Pier 16 Downstream and Ampera as many as ten respondents from 34 respondents or 29.5% with the ultimate goal of Kelurahan 16 Downstream. The rest of the respondents who continued or continued the trip were 24 people, and only 18 respondents had the potential to use the LRT or 53%. This percentage is quite high if it can be managed properly. Stronger influence is found on customization, new customer value proposition, competitive advantage, and reduced transportation and storage costs as potential mechanisms to help revolutionize the transportation industry towards increasing traffic congestion and pollution (Akbari & Ha, 2020). The empirical analysis provides evidence that light rail has positive effects on transit use (Dziauddin et al., 2015). Knowing the behavior of passengers to use transit services can be useful support for transit managers and marketers who can determine the most convenient strategy to satisfy existing passengers and attract new passengers (de Oña et al., 2016).

The multinomial logit model is applied to all types of modes used in urban villages located on the banks of the river, including river transportation, motorbikes, cars, buses, and public transportation. The purpose of modeling on several types of transportation is to get a model of each that is most in demand by residents based on travel time, waiting time, other costs, and parking costs cause factors that are considered in determining the type of transportation chosen are the purpose of the trip, distance traveled, cost and level of comfort. The following comparison of mode users based on the results of the analysis is shown in Table 3.

Table 3. Number of Users of Various Types of Transportation What Riverside Communities Use

Origin	Destination	Number of Users				
		River Transport	Motorcycle	Car	Bus	Public Transport
35 Downstream	35 Downstream	40	560	40	80	200
35 Downstream	32 Downstream	20	120	80	40	40
30 Downstream	2 Upper course of a river	26	360	40	80	40
30 Downstream	9–10 Upper course of a river	13	80	160	40	40
9–10 Upper course of a river	30 Downstream	25	80	160	40	40
13 Downstream	14 Upper course of a river	13	80	40	40	40
14 Upper course of a river	13 Downstream	15	80	40	40	40
16 Downstream	14 Upper course of a river	18	280	200	80	160
2 Upper course of a river	16 Downstream	25	80	40	40	40
16 Downstream	2 Upper course of a river	45	80	120	40	40

Origin	Destination	Number of Users				
		River Transport	Motorcycle	Car	Bus	Public Transport
5 Upper course of a river	16 Downstream	143	640	160	80	320
16 Downstream	5 Upper course of a river	99	600	160	40	200
10 Downstream	10 Downstream	30	160	120	40	40
10 Downstream	11 Downstream	13	280	40	40	200
11 Downstream	10 Downstream	15	320	40	40	200
10 Downstream	14 Upper course of a river	13	80	40	40	320
14 Upper course of a river	10 Downstream	15	80	120	40	320
Plaju Upper course of a river	Plaju Upper course of a river	15	2600	440	160	800
12 Upper course of a river	13 Downstream	15	40	160	40	40
12 Upper course of a river	12 Upper course of a river	52	320	80	40	360
Bagus Kuning	Bagus Kuning	78	480	40	40	480
13 Upper course of a river	13 Upper course of a river	13	400	40	40	320
Tangga Takat	16 Downstream	36	280	160	80	200
16 Downstream	Tangga Takat	65	320	120	40	40
2 Upper course of a river	13 Downstream	30	320	240	120	360
2 Upper course of a river	2 Upper course of a river	78	320	40	40	200
Kemang Agung	16 Downstream	18	120	240	120	320
Ogan Baru	13 Downstream	15	40	320	120	360
Ogan Baru	Ogan Baru	80	2720	440	40	400

Based on the survey results, the average income of residents who use public transportation is River transportation: Rp1,700,000/month, Bus: Rp2,500,000/month, City transportation: 2,350,000/month. The value of time is distinguished by the purpose of the trip—the value of work trips (business) and the value of other trips (non-business). The road transportation system contributes to the overall transportation system (Supratikta, 2014). The following is the result of calculating the travel time value of the five modes of transportation.

Table 4. Value of Travel Time for the Five Modes of Transportation

Description	Unit	River transport	Motorcycle	Car	Bus	Public transport
Income per month	Rp/Month	1,700,000	-	-	2,500,000	2,350,000
Net income	Rp/Month	1,445,000	-	-	2,125,000	1,997,500
Average wage	Rp/Month	5,418.75	10,837.50	27,093.75	7,968.75	7,490.62
Business trip value	Rp/Month	5,418.75	10,837.50	27,093.75	7,968.75	7,490.62
Value of non-business trip	Rp/Month	1,806.25	3,612.50	9,031.25	2,656.25	2,496.87
Business time value	Rp/Hour	541.87	2,709.37	6,773.43	796.87	749.06
Non-Business time value	Rp/Hour	1,625.61	2,709.37	6,773.43	2,390.61	2,247.18
Total time value	Rp/Hour	2,167.48	5,418.74	13,546.86	3,187.48	2,996.24

The data that has been collected is analyzed using simple calculations. First, the time unit value is obtained by adding up the total time value of the five modes divided by the number of modes so that the total average time value is 5,463 rupiah/hour. Then the unit of time value is changed to rupiah/minute; thus, the unit value of travel time is 91 rupees/minute, and waiting time is 182 rupiah/minute (waiting time value is assumed to be two times the value of time while in the vehicle. It is hoped that by merging and synchronizing public transport modes, the time for changing modes can be saved, and changing modes can be more comfortable and easier (Buchari, 2018).

This research focuses on river transportation, which can use LRT as a continuation mode. As is known from previous research, most of the movement through the river is carried out by residents who live in areas that are relatively close to the riverbank, while the potential to continue the journey using the LRT is carried out by passengers who get on and off at the piers of 16 Downstream and Ampera villages. The following is the river transport operation data.

Table 5. River Transport Operation Data

Origin	Destination	River Transport			
		X1	X2	X3	Y1
		Traveling Time	Waiting Time	Cost	Passenger
35 Downstream	35 Downstream	8	2	5	40
35 Downstream	32 Downstream	10	2	7	20
30 Downstream	2 Upper course of a river	26	2	5	26
30 Downstream	9-10 Upper course of a river	14	3	5	13
9-10 Upper course of a river	30 Downstream	14	3	5	25
13 Downstream	14 Upper course of a river	13	5	5	13
14 Upper course of a river	13 Downstream	13	3	7	15
14 Upper course of a river	16 Downstream	14	6	5	26
16 Downstream	14 Upper course of a river	14	3	5	18
2 Upper course of a river	16 Downstream	27	7	7	25
16 Downstream	2 Upper course of a river	27	6	7	45
5 Upper course of a river	16 Downstream	8	7	5	143
16 Downstream	5 Upper course of a river	11	7	7	99
10 Downstream	10 Downstream	6	6	5	30
10 Downstream	11 Downstream	18	2	5	13
11 Downstream	10 Downstream	18	2	5	15
10 Downstream	14 Upper course of a river	19	2	5	13
14 Upper course of a river	10 Downstream	19	2	5	15
Plaju Upper course of a river	Plaju Upper course of a river	8	2	5	15
12 Upper course of a river	13 Downstream	13	2	7	15
12 Upper course of a river	12 Upper course of a river	12	6	5	52
Bagus Kuning	Bagus Kuning	13	4	5	78
13 Upper course of a river	13 Upper course of a river	6	2	5	13
Tangga Takat	16 Downstream	14	5	5	36
16 Downstream	Tangga Takat	25	4	7	65
2 Upper course of a river	13 Downstream	14	2	5	30
2 Upper course of a river	2 Upper course of a river	6	7	7	78
Kemang Agung	16 Downstream	23	1	5	18
Ogan Baru	13 Downstream	22	4	5	15
Ogan Baru	Ogan Baru	6	2	5	80

The data that has been collected is analyzed using a multinomial logit model, which is applied to all types of modes, including river transportation, motorbikes, cars, buses, and city transportation. The purpose of modeling various kinds of transportation is to get a model of each that is most in demand by residents based on travel time, waiting time, other costs, and parking costs. Furthermore, the available data were analyzed using the SPSS program to obtain the best model selection utility model for river transportation with R^2 = 0.892, and F-count (71.569) < F-table (2.98), namely:

Y_{angsu} = -32,976 + 0.005 X_1 + 0.022 X_2 + 4.802 X_3
Y_{angsu} = users of river transportation modes
X_1 = travel time (minutes)
X_2 = waiting time (minutes)
X_3 = other costs (Rp)

The R^2 value of 0.892 indicates that the percentage contribution of the influence of the independent variable (travel time, waiting time, and other costs) to the dependent variable (mode users) of 89.2% can be explained by 89.2% by the variation of these independent variables. While the remaining 10.8% is explained by other variables not included in the model, the value is still considered and accommodated in constants. F-count (71.569) value is greater than F-table (2.98), indicating that all independent variables simultaneously have a significant effect on the dependent variable.

The utility model for the other modes is calculated the same way as for the river transport utility model—differences in utility equation variables between public and private transportation on the second independent variable (X_2). In public transportation, X_2 is determined by the waiting time, while the parking fee is determined for private transportation. The following are the results of the calculation of the other mode selection utility models:

- Y_{motor} = 88,952 – 0.043 X_1 – 5,612 X_2 + 39,092 X_3
- Y_{mobil} = 33.010 + 0.036 X_1 – 9.731 X_2 – 5.623 X_3
- Y_{bus} = 0.007 X_1 + 0.055 X_2 – 1.553 X_3
- Y_{angkot} = 50.109 – 0.011 X_1 + 0.031 X_2 – 4.840 X_3

This utility model equation will be used in the mode selection model to determine the probability or percentage of using a mode for residents around the riverbank, which is reviewed based on travel time, waiting time, other costs, and parking costs. The value of the utility equation variable is the average value for each surveyed mode of transportation. Table 6 is the average value of the independent variable in various modes.

Table 6. Average Value of Independent Variables for Various Modes

Independent Variable (X)	River Transport	Motorcycle	Car	Bus	Public transport
Traveling Time (X1)	1337.7	1352.9	1504.5	1631.9	1613.7
Waiting Time (X2)	673.4	-	-	1079.9	612.7
Other Costs (X3)	5.5	0.591	2.4	5.8	5.7
Parking Free (X4)	-	3.2	5.8	-	-

To determine the probability of each mode of transportation used the multinomial logit equation by entering the utility value of the transportation mode that has been obtained above. The results of the above calculation show that the population of 30 urban villages around the outskirts of the Musi River choose river transportation as a means of movement as much as 18%, motorbikes as much as 26%, 19% choose cars, 17% choose buses and the remaining 20% choose to use city transportation.

Pier 16 downstream is the highest number of departures and arrivals. Various business and commercial activities are found in the 16 downstream villages, so this pier is very busy compared to other piers. This pier is also close to the LRT station so that passengers can continue their journey using the LRT to other major business and commercial centers in the center of Palembang City. These two modes can complement the needs of the people of Palembang City in carrying out movements, especially for people who live in villages near rivers. With an integrated and coordinated approach to ports and other entities in the logistics chain, traffic from road traffic to rail traffic and inland air routes is an energy-efficient and environmentally friendly form of transportation (Krčum et al., 2015). Based on data from the origin of the trip destination at the time of departure at the 16 downstream piers, it is shown in Table 7.

Table 7. Number of Passengers Departing from 16 Downstream

Time	Passenger	Time	Passenger	Time	Passenger	Time	Passenger
06.00–06.30	–	09.30–10.00	30	13.00–13.30	40	16.30–17.00	50
06.30–07.00	–	10.00–10.30	90	13.30–14.00	10	17.00–17.30	90
07.00–07.30	–	10.30–11.00	–	14.00–14.30	50	17.30–18.00	40
07.30–08.00	10	11.00–11.30	70	14.30–15.00	–	18.00–18.30	50
08.00–08.30	30	11.30–12.00	10	15.00–15.30	80	18.30–19.00	30
08.30–09.00	10	12.00–12.30	–	15.30–16.00	–	19.00–19.30	10
09.00–09.30	30	12.30–13.00	–	16.00–16.30	160	19.30–20.00	–

Table 7 shows the number of passengers departing from the 16 downstream piers, most departing at 16.00–16.30 at 160 people. Then at 10.00–10.30 and 17.00–17.30 with the number of passengers departing 90 people. The time of movement depends on when a person performs his daily activities. Overall, the daily travel pattern in a city is a combination of travel patterns with work, education, shopping, and other social activities. This combined travel pattern is the daily variation pattern, with three peak times (morning, afternoon, and evening peak times).

Table 8. Number of Passengers Arriving at Pier 16 Downstream

Time	Passenger	Time	Passenger	Time	Passenger	Time	Passenger
06.00–06.30	60	09.30–10.00	20	13.00–13.30	50	16.30–17.00	–
06.30–07.00	40	10.00–10.30	180	13.30–14.00	10	17.00–17.30	–
07.00–07.30	140	10.30–11.00	–	14.00–14.30	70	17.30–18.00	–
07.30–08.00	–	11.00–11.30	10	14.30–15.00	10	18.00–18.30	10
08.00–08.30	60	11.30–12.00	–	15.00–15.30	10	18.30–19.00	–
08.30–09.00	10	12.00–12.30	30	15.30–16.00	20	19.00–19.30	–
09.00–09.30	20	12.30–13.00	–	16.00–16.30	–	19.30–20.00	–

Table 8 shows the peak hours for the arrival of river transport passengers at the 16 downstream pier and the maximum number of passengers arriving at the 16 downstream pier at 10.00–10.30 is 180 people, then at 07.00–07.30 around 140 people and 14.00–14.30 of 70 people. The main market for LRT facilities in each catchment area is employees in the city center (Bolger et al., 1992). The location of the 16 Downstream pier is quite close to the Ampera LRT station, passengers are quite comfortable walking from the pier to the LRT station or vice versa. Basically the smart city concept is not only about applying technology to solve urban problems, but also how to manage urban areas that are able to provide a sense of security, comfort, and sustainability (Pratiwi et al., 2015). In developed countries, which already have 75% of the urban population, designing a sustainable transportation system is considered one of the most pressing problems faced by modern cities (Wahyudin, 2018).

Ampera Station is one of 5 stations proposed for Transit Oriented Development area based on public transport modes and intermodal integration. Transit Oriented Development (TOD) is a collection of buildings that have diverse/mixed land uses which are expected to trigger people to live and work in areas close to public transportation facilities as a way to reduce and avoid the tendency of people to use private vehicles. The development of the transit area (TOD) is based on the poor quality of urban life which is characterized by congestion problems, urban sprawl, and unintegrated land use planning. The development of this transit-based area aims to create an area that is safe, comfortable and pleasant and sufficient for pedestrians. The functions of the area within the TOD area include the center of commercial areas, offices, high density settlements and public open spaces.

The development in the Transit Oriented Development area will attract people to come to do activities so that the traffic will be more crowded. This can attract the interest of people who travel from origin to destination where the movement can be carried out using river transportation and LRT considering that these two modes are not hindered by congestion. The development of the area around the station designated as village transit will make the surrounding area develop and provide its own attraction for the community (Astutik & Gunartin, 2019). However, supporting facilities for river transportation and connecting roads between LRT stations and river jetties should also be considered for development. Subjective observations of train passengers regarding discomfort from various elements such as vehicle conditions, track area conditions and working conditions can cause poor driving comfort (Munawir et al., 2017).

As an initial consideration, it will be proposed to improve the pedestrian path connecting the Ampera LRT Station with Pier 16 Downstream in accordance with the basic concept of village transit. Its concept is defined as a development pattern that maximizes the benefits of public transport and returns the focus of development to the users. Transit Oriented Development is the process of planning and designing spatial and regional patterns to support, facilitate, and prioritize not only the use of public transport, but also the most basic modes of transportation, namely walking and cycling. The area developed around the station has a radius of about 0–800 meters, namely the core area 0–400 meters and the sub-core area 400–800 meters. Transit Oriented Development planning around existing transit stations helps achieve better transit options and promotes local economic development (Teklemariam & Shen, 2020). Transit Oriented Development and its land value along the respective LRT routes must be designed and adequate, to maximize internally generated revenue, which increases revenue from tariff fees and government funding commitments, to cover operating and maintenance costs (Alade et al., 2019).

In addition to the basic concept of village transit, interviews were conducted to obtain information on what other infrastructure needs to be improved or built so that people will switch to using the LRT. From the survey results on the improvement of integration facilities, it is then seen again the increase in the willingness of people who want to switch from various transportations to LRT modes based on the tariff set by the government, namely Rp10,000 for one trip. Interviews were conducted with respondents at Pier 16 Downstream and Ampera regarding their willingness to continue their journey using the LRT mode. The results of the interview show that the number of respondents who are willing to use the LRT mode is still very small, namely 4.75%. The availability of a variety of public transportation that can park near the pier at a cheaper rate is the main reason for their lack of interest in using the LRT mode. In addition, passengers who do not go to the business and commercial centers that are traversed by the LRT line even though on their way to their final destination must cross this route, they prefer public transportation on the grounds that they can stop closer to their homes or offices (Okada et al., 2003).

Most of the respondents strongly agree if the pedestrian from the pier to the LRT route is repaired and improved. The need for pedestrian paths that are safe from traffic accidents and protected from rain and heat is information obtained through interviews with river transport users, proposed pedestrian paths that connect the pier with the LRT station. Transport infrastructure has an important role in ensuring citizens' living, safety, security and health in urban environments (Albuquerque et al., 2021). However, the analysis of the interview results shows that if the pedestrian path is improved, the increase in the willingness of people to continue their journey using the LRT is still very small, namely 9%. The small increase was mainly due to the ticket price of Rp10,000 one way is still too expensive for potential passengers. For the record, only a few respondents were dissatisfied with the condition of Pier 16 Downstream and Ampera, most of the respondents did not mind the existing conditions. Some of the respondents stated that it was hot or rainy when walking from the pier to 16 Downstream village which made the atmosphere uncomfortable. Ampera LRT station needs repairs and improvements to intermodal physical integration facilities, in the form of facilities, namely sky bridge, non-elevated, closed, safe, comfortable, fast, and able to accommodate disability (Wiratman et al., 2020). To encourage better use of public transportation, LRT connectivity to other modes of transportation should be improved by establishing or diverting other transportation routes to LRT routes or airport terminals within 2–5 minutes walking distance of LRT stops or stations (Alade et al., 2019).

4. Conclusion

The urban village of 16 downstream produces the most trips for both origin and destination movements. The origin movement of the largest river transportation other than the 16 downstream was the 12 upper course of a river (8.3%), while the destination 9–10 upper course of a river (11.9%). The urban village of 16 downstream was the main destination for river transportation users because the urban village area is a business and shopping center. This area generates great attraction and generation for people who shop for various goods and workers in large quantities. In addition, there are various river transportation facilities around this area, such as docks, river mode parking, integration with other modes, and other facilities that are quite good. Most of the destinations of river transport users who stop at Pier 16 downstream and Ampera were an urban village of 16 downstream, as many as 138 of 184 respondents or 75%. Of the rest of the 46 respondents who will continue their journey, only 30 can continue their journey using the LRT mode.

Users of river transportation from outside the city who got off at Pier 16 Downstream and Ampera were ten respondents out of 34 respondents or 29.5% (final destination for Kelurahan 16 Downstream). The rest of the respondents who continued or continued the trip were 24 people, and only 18 respondents had the potential to use the LRT or 53%. This percentage is quite high if it can be managed properly. The results of the analysis for the probability of using various modes in people who live close to the river show that the probability of choosing river transportation is 18%, the probability of choosing a motorbike is 26%, the probability of choosing a car is 19%, the probability of choosing a bus is 17%, the probability of choosing a city transportation = 20%.

The interview results show that the number of respondents who are willing to use the LRT mode is still very small, namely 4.75%. The availability of a variety of public transportation that can park near the pier at a cheaper rate is the main reason for their lack of interest in using the LRT mode. The proposed supporting infrastructure for integration between river transport and LRT is pedestrian paths. Most respondents strongly agree if the pedestrian from the pier to the LRT route is repaired and improved. The need for pedestrian paths that are safe from traffic accidents and protected from rain and heat is information obtained through interviews with river transport users. Only a few respondents were dissatisfied with the condition of Pier 16 Downstream and Ampera. Most of the respondents did not mind the existing conditions.

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