Analyzing the Effect of Trip Pattern on the Mode Choice Decision of LRT in Palembang City

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Abstract: **This paper aims to analyze the potential demand of LRT in Palembang. A cluster analyses method was used to reach our research goal. A number of 1000 respondents living or working in a radius of 1000 meters from the 13 planned-LRT stations was involved as the respondents. Three scenarios were offered to the respondents related to factor of travel time, travel cost, and waiting time. Socio demographics, travel characteristics, and type of trip pattern are three main factors constructing the traveler cluster. The result shows that there are 5 cluster of travelers. Travelers who currently use public transport becomes the most potential demand by 28%. The result also predict that the demand of Palembang LRT is very low. Due to this, the government has to prepare some scenarios to increase the demand of Palembang LRT.**

Index Terms**: public transport, trip pattern, potential demand, cluster analysis**

I. Introduction

CHARACTERISTIC of trip chaining plays a vital element on mode choice decision [1]. In Indonesia, people prefer choose motorcycle mode to support their daily activities also due to the flexibility of motorcycle mode that can easily reach some destination in a trip tour [2]. By using motorcycle mode, many discretionary activities can be carried out during trip to/from work place, such as escorting children, shopping, etc. Also, traveler with many destination places in a tour has a tendency to leave public transport mode.

This paper aims to analyze the travelers' preference to use public transport mode that conditional on the characteristic of individual trip pattern especially on work based sub tour, in which Palembang city was chosen as a case study. A new light rail transit system will be operated in this city. It also becomes the first LRT in Indonesia. Understanding the characteristic of individual trip pattern becomes important to predict the travel demand of Palembang LRT, because it should be noted that the main purpose of the development of Palembang LRT is more focused to support an Asian Games 2018, rather than to support people movement. The operational sustainability of Palembang LRT becomes a question when this sport event has been completed.

This paper is grouped into six sections. The next section is the characteristic of Palembang City as a case study. Section three presents literature review. Data collection and research method will be described in Section four. Section five is discussion. Some finding will be concluded in the last section (section six).

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II. The Palembang City

In Palembang, motorcycle mode dominated the existing vehicle composition by 922,746 (79.82%), and followed by 162,055 passenger cars (14.02%), 67,374 freight vehicle (5.83%), and 3,859 bus (0.33%). There are also some type of public transport serving travelers such as Palembang Bus Rapid Transit (BRT), paratransit, rickshaw, and taxi. However, paratransit will stop operating because of its operation permit in 2018. The Palembang Government does not extend the route permit and focus on Palembang BRT (Trans Musi).

Trans Musi is a Bus Rapid Transit (BRT) transport system managed by a regional owned enterprise of Palembang. Trans Musi operates 8 corridors with 230 buses. Bus headway is 10-15 minutes. There are 275 bus stops with the distance of 300-400 meters between bus stop. The number of passenger is 7,500 passengers per day with an average of load factor is 75%. Ticket fee of using Trans Musi is 5,000 IDR (USD 0.36).

Palembang LRT is planned operating in 2018. This system has a one corridor with 24.5 km. LRT lane stretches from airport to Palembang sport center with 13 stations.

III. Literature Review

Bowman and Ben-Akiva (2000) defined that tour is a journey from home to one or more destination places and return home. A tour is broadly divided as primary tour and secondary tour. Primary tour is a tour that support the most important activity, such as to work. While, some tours excluded in primary tour then called as secondary tours [3]

Meloni et al. (2014) categorized type of activities into mandatory and discretionary activities. To fulfill the out of home mandatory activities such as working, studying, etc.,

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people conduct a trip called as primary trip. Discretionary activities are some activities with higher degree of temporal flexibility than mandatory activities [4]. In term of discretionary activities, Dharmowiyono et al. (2016) classified into maintenance and leisure activities. Maintenance activities are some activities that attempt to satisfy personal biological needs, such as: shopping, go to hospital, bank, etc., while leisure activities are related to some activities to satisfy personal physiological needs, such as: sport activities, sightseeing, or meeting families. [5]

Recently, many studies used an activity based modelling approach to forecast travel demand by considering activity based individual trip chain. In this study, we forecast the potential demand of Palembang LRT by considering travelers' trip chain. We hypothesize that when travelers' have a complex trip chain, they are less likely to use Palembang LRT. Several researches commonly used discrete choice model to analyze the potential demand of public transport or a particular transport means [6-8]. For this study, we apply a cluster analysis technique to stratify the sample to analyze the potential demand of Palembang LRT in view of detailed traveler profiles and work based sub tour. It should be noted that in this paper, we neglect work based discretionary tour.

IV. METHODOLOGY

A. Data Collection

A face to face interview survey was conducted by involving 1000 respondents in Palembang. Since this paper aims to understand the travelers' preference to use Palembang LRT, we conduct the interview survey at some locations within a radius 1000 meters of the thirteen planned-LRT stations. Our survey was conducted from June to August 2017. The questionnaire form was divided into three different parts: (1) individual characteristics, (2) panel time-use and activity diary during 24 hours, and (3) stated preference survey related to their probability to use Palembang LRT. On the stated preference survey, we ask to the respondent whether or not they will use Palembang LRT into three scenarios as shown in Table 1. While, Table 2 shows the respondents' characteristics.

B. Research Method

There are two step in our cluster method. The first step is pre-clustering. This step aims to reduce the size of the matrix that contains distances between all possible pairs of cases. The second step is hierarchical clustering of pre-clusters

TABLE 1
QUESTIONS ON STATED PREFERENCE SURVEY

No.	Ticket price	Travel time	Waiting time
1	< IDR 8.000 (0.56 USD)	1.5 times faster than existing travel mode	>15 minutes
2	> IDR 8.000 (0.56 USD)	Same with existing travel mode	<10 minutes
3	> IDR 8.000 (0.56 USD)	2 times faster than existing travel mode	>15 minutes

TABLE 2
RESPONDENTS' CHARACTERISTICS

Variable	Percentage	
Socio-demographic characteristics		
Gender	Male	56.70
	Female	43.30
Work	Workers	96.20
	Non-workers	3.80
	Less than 21 years old	12.10
	Aged 21-30 years old	69.20
	Aged 31-40 years old	11.60
	Aged 41-50 years old	5.50
	More than 50 years old	1.60
Income	low-income (less than IDR 3 Million)	5.72
	lower-middle income (IDR 1.5-3 Million)	60.71
	medium-income workers (IDR 3-6 Million)	27.75
	high-income (More than IDR 6 Million)	5.82
Household Characteristics		
Status	Single	62.40
	Married	37.60
Child	Having children	18.20
	Having dependent children household	17.10
Vehicle Ownership	Household with motorcycle ownership	98.10
	Household with car ownership	38.00
Travel Characteristics		
Travel Mode Choice	car users	15.30
	motorcycle users	77.00
	public transport users	7.70
Single/ Joint Travel	Alone	67.83
	Joint – by picked up by family members	15.65
	Joint – with escorting family members	16.52
Discretionary Activities	Before depart to work	62.10
	At work	63.70
	After work	66.90

V. DISCUSSION

From the two step cluster method, five groups were resulted as shown in Table 2. The variables considered in the clustering process consist of factor of age, income, work based sub tour, mode choice, marital status, the number of dependent children, the number of discretionary trips, and travel time duration of discretionary activities in a day.

Cluster 1 is a group that does not travel during work, relatively young age people, single, lower-middle income, motorcyclists, three discrete trips with a long travel time duration (40-80 minutes). It indicates that travelers in this group travel with a lot of time with independent discretionary activities. We indicated that they are not hampered by the family constraint.

Cluster 2 is a group that also does not travel during work. They are more mature people. They tend to have a family and dependent children. They are upper-middle income. They also tend to have two trips for discretionary activities in a day with a short travel time (less than 40 minutes). Due to the effect of intra-household interaction, their discretionary activities only need a short activity time.

Cluster 3 is a group with work based sub tour, using public transport, home-work-home trip pattern, and has no discretionary activities.

Cluster 4 is a group with a work based trip pattern is work-leisure-work. travel. Leisure activities undertaken at work include eating in places far away from work locations, visiting friends or family members, etc. Characteristics from travelers categorized in Cluster 4 are a young worker, single, lower-middle income (1.5-3 million rupiah), motorcyclist, have five discrete trips with a 40-80 minutes

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of travel time duration.

Cluster 5 is a group that doing maintenance and/or mandatory activities at work, for example: shopping, escorting children/family members, and travel for the benefit of work. Characteristics of travelers in this group are workers aged 30-40 years old, married and have children, car users, five discretionary trips in a day, duration of discretionary trips is 40-80 minutes.

Then, considering the potential demand of Palembang LRT, five clusters generated from the cluster analysis process were checked their responses related to the three scenarios offered as shown from Table 3 to Table 7. The result of each group is shown in Fig. 1.

TABLE 3
TRAVELERS' CHARACTERISTICS IN CLUSTER 1

Cluster label	Group 1
Number of traveler involved	335
Work Based Activity Tour Chain	No trip
Age	20-30 years old
Number of Dependent Children	0
Income	1.5-3 million
Mode	Motorcycle
Type of Traveler	Alone
Duration of travel at work	0
Status	Single
Number of Travel per day	5
Total Duration of discretionary travel per day	40-80 minutes

TABLE 4
TRAVELERS' CHARACTERISTICS IN CLUSTER 2

Cluster label	Group 2
Number of traveler involved	247
Work Based Activity Tour Chain	No trip
Age	30-40 years old
Number of Dependent Children	1
Income	3-6 million
Mode	Motorcycle
Type of Traveler	Joint – Escorting
Duration of travel at work	0
Status	Married
Number of Travel per day	4
Total Duration of discretionary travel per day	< 40 minutes

TABLE 5
TRAVELERS' CHARACTERISTICS IN CLUSTER 3

Cluster label	Group 3
Number of traveler involved	204
Work Based Activity Tour Chain	No trip
Age	20-30 years old
Number of Dependent Children	0
Income	< 2juta
Mode	Public transport
Type of Traveler	Joint – Picked Up
Duration of travel at work	0
Status	Single
Number of Travel per day	2
Total Duration of discretionary travel per day	0

TABLE 6
TRAVELERS' CHARACTERISTICS IN CLUSTER 4

Cluster label	Group 4
Number of traveler involved	113
Work Based Activity Tour Chain	Work-Leisure-Work
Age	20-30 years old
Number of Dependent Children	0
Income	1.5-3 million
Mode	Motorcycle
Type of Traveler	Alone
Duration of travel at work	< 20 minutes
Status	Single
Number of Travel per day	7
Total Duration of discretionary travel per day	40-80 minutes

TABLE 7
TRAVELERS' CHARACTERISTICS IN CLUSTER 5

Cluster label	Group 5
Number of traveler involved	101
Work Based Activity Tour Chain	Work-Maintenance-Work and Work-Mandatory-Work
Age	30-40 years old
Dependent Children	1
Income	3-6 million
Mode	Car
Type of Traveler	Joint – Escorting
Duration of travel at work	< 20 minutes
Status	Married
Number of Travel per day	7
Total Duration of discretionary travel per day	40-80 minutes

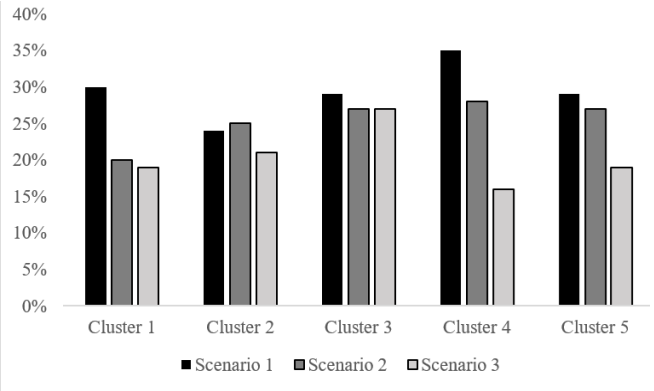

Fig. 1. Potential demand of Palembang LRT in each cluster of traveler

From Fig. 1, It can be seen that cost has significant influence on the mode choice decision. Travelers in all clusters preferred to use Palembang LRT because of a cheap tariff of LRT even though with a long waiting time (more than 15 minutes). The result also shows that travelers in Cluster 3 (public transport users) could be said as a group that is very enthusiastic with the existence of Palembang LRT. In the last scenario, where the potential demand of LRT decrease caused by high tariff, travelers in this cluster persist to use LRT. However, it also should be noted that only 28% of travelers in Cluster 3 will shift to LRT. Clusters 4 and 5 are travelers with travel to work. Cluster 4 is travelers with leisure activities, while Cluster 5 is travelers with maintenance and/or mandatory activities. Since travel to fulfill the leisure activities could be abandoned and can be changed at the other times, travelers grouped in Cluster 4 is more potential to move to Palembang LRT compared to travelers in Cluster 5.

VI. Conclusion

The clustering process divides the travelers into five categories. Considering the work based sub tour, Cluster 1 to 3 are travelers who do not travel at work, Cluster 4 is travelers who have leisure activities at work, and Cluster 5 is travelers who have mandatory or maintenance activities at work.

The five divided clusters show different potential demand of Palembang LRT. Tariff of Palembang LRT has a significant effect on mode choice decision. Travelers in Cluster 3 shows the highest interest to shift to LRT. This result is related to the public transport as their existing travel

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mode. The second most interested group to use LRT is travelers in Cluster 4. Travelers in Cluster 4 are people who have leisure activities during work with motorcycle as their main travel mode. Perhaps, by using Palembang LRT they will change their discretionary activities in the other times since they have no intra household relationship (singe) and their time duration to do discretionary activities is between 40-80 minutes.

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