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Analysis of Transportation Mode Choice In The Midst of Private Vechicles, Bus Rapid Transit (BRT), And Online Transportation in Banjarbaru City

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ABSTRACT : *Banjarbakula Bus Rapid Transit (BRT) is one of the mass transportation that is being promoted by the South Kalimantan provincial government for the Banjarmasin-Banjarbaru route and the reverse route which operates every day to serve community mobility. This is possible for changes in the community's mode choice patterns regarding the current use of private vehicles and online transportation. Primary data was collected by distributing questionnaires consisting of several scenarios about complementary facilities from existing modes, after which respondents were asked to choose from the existing scenarios whether to use private vehicles, BRT or online transportation. The analysis was carried out using the choice models method or logit method with the help of Limdep software. From the research results, a model was obtained with the following equation: private vehicle mode choice utility* $U_{private\ vehicle}$ *= -0.20673629.*X_8 *,BRT mode choice utility* U_{BRT}*= 2.03684227-0.00124961*X_1*+1.47558323*X_2*+0.71055604*X_3 *; and online transportation mode choice utility* U_{online}*=0.25690278-0.00124961*X_1*+1.47558323*X_2*. It is known that the attributes that influence mode choice are: travel cost (X1), travel time/duration (X2), service (X3), and purpose of travel (X8).*
KEYWORDS : *BRT, mode choice, model logit, private vehicle, , online transportation*

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I. INTRODUCTION

The choice of transportation mode is the most important model in transportation planning [1]. Mode choice plays an important role in determining transportation policy issues, in relation to the types of modes and infrastructure available. . Choosing a mode of transportation depends on the prospective passengers. Prospective passengers have the right as consumers to choose. The characteristics of prospective passengers influence mode choice [2].

The use of private vehicles in the city of Banjarbaru needs to be reduced to reduce congestion. One way is by using public transportation to travel [3]. Currently, the majority of the population uses private vehicles to travel because public transportation offers few comfortable, practical and affordable options compared to using private vehicles. The speed of movement has increased rapidly, but has not been matched by appropriate expansion of transportation infrastructure, resulting in disruption of accessibility and mobility [4].

Choosing an online-based mode of land transportation, which can be ordered at any time via smartphone, is the most popular choice for the public, especially people who use smartphones, is the most popular choice for the public, especially people who use smartphones[5]. The decision to choose land transportation modes is starting to be influenced by the ease of digital access, where ordering a mode (Gojek) is as easy as downloading

an application on the user's Android device [6]. Online transportation is transportation that can be accessed via Android application technology and uses the Global Positioning Systems (GPS) feature on smartphones [7]

The government's efforts to reduce congestion are through the efficient operation of mass transportation to facilitate people's mobility. One of them is by providing Bus Rapid Transit (BRT), a bus system that is fast, comfortable and safe [8]. BRT is a type of public transportation whose service is faster and more efficient and offers comfort, security, safety, time and cost efficiency. BRT has its own routes and is well integrated, the fares are affordable because it uses the same fees for long and short routes, BRT is well integrated and has its own routes [9].

Banjarbaru is one of the cities included in the Banjarbakula urban area, being one of five cities in Indonesia that is developing mass transportation. The Banjarbakula BRT is managed by the South Kalimantan Provincial Transportation Service. Consists of a fleet of 5 buses serving Banjarmasin-Banjarbaru and Banjarbaru-Banjarmasin. Trials were carried out on May 8 2019 to May 22 2019 among the public free of charge. However, as of 15 August 2019 the tariff has been set by the South Kalimantan Provincial Transportation Service at IDR 5,000 for the general public and IDR 2,000 for students [8].

The problems that occur are in areas or pockets that are not filled due to feeders not being ready, and in pockets that are far from the main BRT route. Things like this cause online transportation to still play an important role in its use. This results in people still having a tendency to choose online transportation, because it goes door to door, straight to their destination. It is hoped that there will be a policy to improve feeder transportation to support BRT operations [10].

With the increasing development of services implemented by the government, it is hoped that BRT will be equipped with feeders. This allows for changes in the pattern of mode choice by the public regarding online transportation that is currently running. Departing from the current condition where BRT is still not equipped with feeders, this condition means that online transportation services for areas far from the main BRT route are still relatively high.

Based on previous research, where for example there were improvements to BRT services such as the availability of feeders, it was deemed necessary to conduct research on the analysis of mode choice between private vehicles, BRT and online transportation in the city of Banjarbaru. This is intended to determine the level of public tendencies in choosing modes of transportation between private vehicles, online transportation and BRT for services within the city of Banjarbaru. This research also aims to examine the reasons that form the basis for decision making on mode choice. It is hoped that the results of this research will provide an overview of the factors that influence people in choosing a mode, which can later provide input to the local government in order to improve mass transportation services, especially BRT

II. RESEARCH METHODS

The stages in this research generally consist of 4 (four) stages, consisting of the preparation stage, data collection stage, data analysis and discussion stage, and the thesis completion stage. This type of research is descriptive in nature with a combination of quantitative and qualitative data analysis approaches obtained through distributing questionnaires and direct interviews. Meanwhile, data analysis and data collection used regression

analysis and stated preference techniques. The Stated Preference Method is a technique that uses individual respondents' statements or opinions regarding their choice of a set of options. The questionnaire was created using the stated preference technique which consists of several options offered to respondents. After the data from primary data collection was collected, analysis was then carried out using the Multinomial Logit method using the LIMDEP software tool.

III. RESULT AND DISCUSSION

Respondent Data Based on Gender and Based on Age

Based on the results of the distribution of questionnaires that have been carried out, the gender distribution of respondents (Male/Female) and based on age is obtained as follows:

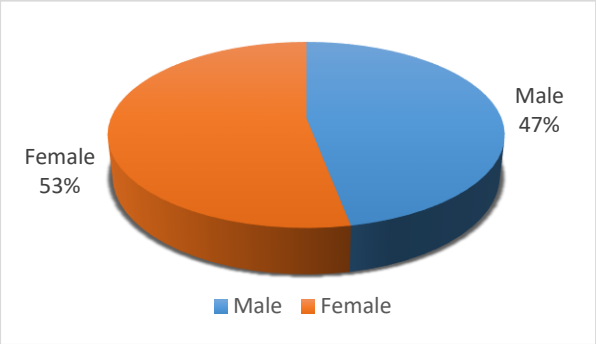

Figure 1. Number Of Respondents by Gender

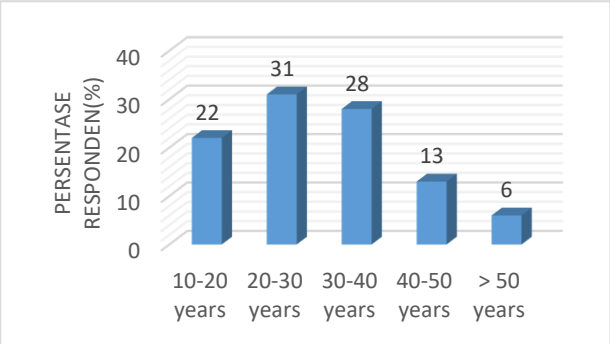

Figure 2. Number of respondents by Age

The number of male respondents was 47 respondents or 47% of the 100 respondents and the number of female respondents was 53 respondents or 53% of the 100 respondents. The distribution of the number of respondents based on gender, the dominant respondents in filling out the questionnaire were female respondents.

The number of respondents aged less than 10-20 years was 22 respondents or 22% of 100 respondents, the number of respondents aged around 20 to 30 years was 31 respondents or 31% of 100 respondents, and the number of respondents aged 30 -40 years as many as 28 respondents or 28% of 100 total respondents, the number of respondents aged around 40 years to 50 years is 13 respondents or 13% of 100 total respondents, , the number of respondents with age >50 years is 6 respondents or as large as 6% of the 100 respondents, the distribution of the number of respondents based on the age distribution of the respondents, the dominant respondents in filling out the questionnaire were respondents aged 20-30 years.

Respondent Data Based on Occupation and Income

Based on the results of the distribution of questionnaires that have been carried out, it was obtained that respondents filled out questionnaires based on the distribution of respondents' occupations (Entrepreneur, Civil Servant, TNI/POLRI, Private Employees, Students, Not Working, others) and income, namely as follows:

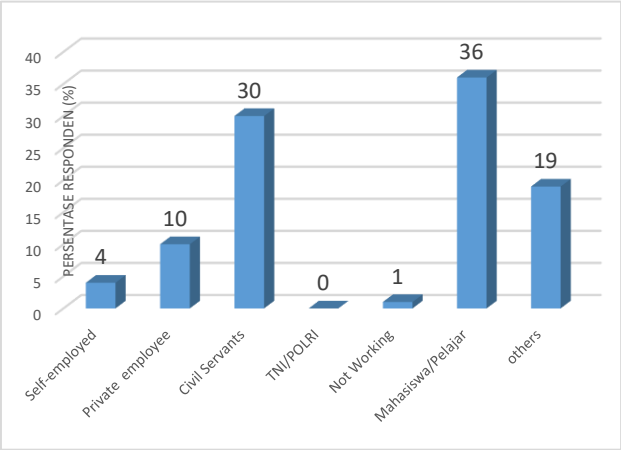

Figure 3. Number of Respondents Based on Occupation

Figure 4. Number of Respondents Based on Income

There were no respondents with TNI/POLRI employment status, 30 respondents with PNS employment status, 10 respondents with Private Employee employment status, 36 respondents with Student/Student employment status, 1 respondent with Unemployed employment status respondents, and for respondents with other employment status there were 19 respondents, for respondents with self-employed jobs there were 4 respondents. The distribution of the number of respondents is based on the distribution of occupations. The dominant respondents in filling out the questionnaire are respondents with the status of students.

Number of respondents with income < IDR 1.000.000 as many as 30 respondents, respondents with an income of IDR. 2.00.,000- IDR 3,500,000 as many as 15 respondents, respondents with an income of IDR 1.000.000- IDR 2.000.000 as many as 14 respondents, respondents with an income of IDR 3.000,000- IDR 5.000.000 as many as 20 respondents, respondents with income ≥ IDR 5.000.000 as many as 21 respondents, the distribution of the number of respondents was based on the distribution of the average income of the dominant respondents in filling out the questionnaire were respondents with income < IDR 1.00.,000.

Respondent Data Based on Travel Purpose and Common Modes Used

Based on the results of the distribution of questionnaires that have been carried out, it was obtained that respondents filled out questionnaires based on the purpose of travel and the modes commonly used, namely as follows :

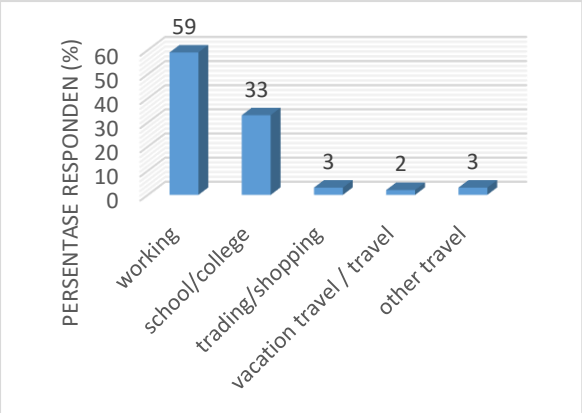

Figure 5. Number of respondents based on travel purpose

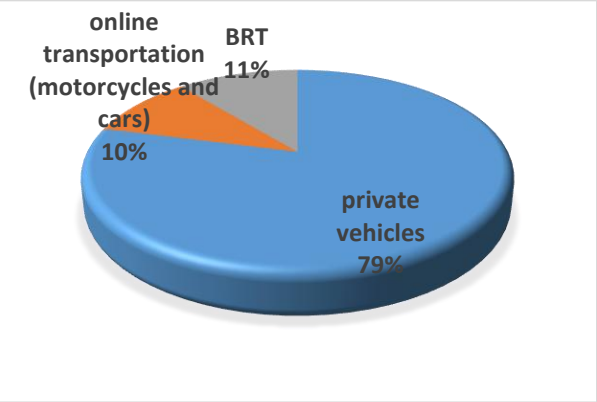

Figure 6. Number of Respondents Based on Modes Usually Used

The number of respondents with the intention of traveling to work was 59 respondents, the number of respondents with the intention of traveling to school/college was 33 respondents, the number of respondents with the intention of traveling to trade/shopping was 3 respondents, the number of respondents with the intention of traveling for holidays/sightseeing was 2 respondents, the number of respondents with other travel intentions as many as 3 respondents. The distribution of the number of respondents was based on the distribution of respondents' travel intentions. The dominant respondents in filling out the questionnaire were respondents with the intention of working.

The number of respondents who use private vehicles is 79%, the number of respondents who use online transportation (motorbikes and cars) is 10%, and the number of respondents who use Bus Rapid Transit (BRT) is 11%. The distribution of the number of respondents was based on the distribution of mode choices. The dominant mode in filling out the questionnaire was respondents using private motorbikes.

Respondent Data Based on Reasons for Choice of Mode

Based on the results of the distribution of questionnaires that have been carried out, it was obtained that respondents filled out the questionnaire based on the reasons for choosing the mode, namely as follows :

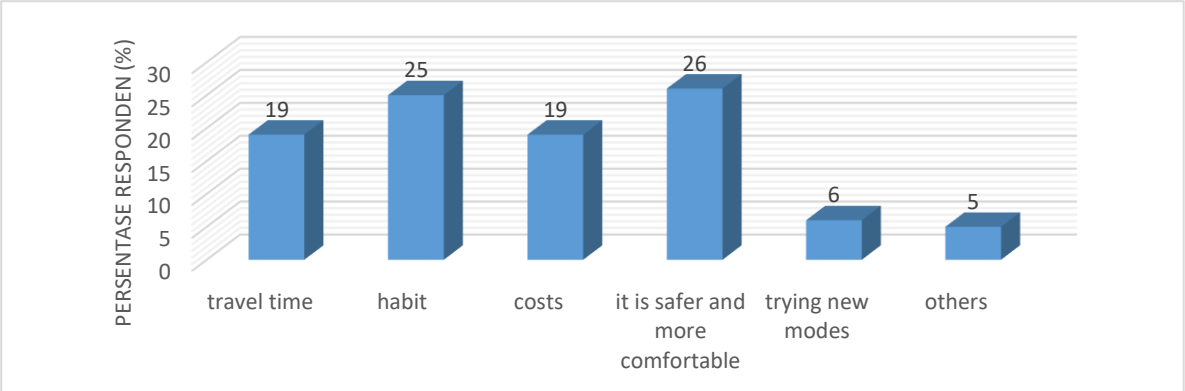

Figure 7. Number of Respondents Based on Reasons for Choice of Mode

The number of respondents with the reason for choosing because of travel time was 19 respondents or 19%, the number of respondents with the reason for choosing because of habit was 25%, the number of respondents with the reason for choosing because of cost was 19%, the number of respondents with the reason for choosing because it was safer and more comfortable was 19%. 26%, the number of respondents with the reason for choosing because they tried a new mode was 6%, the number of respondents with the reason for choosing because of other things was 5%. The number of respondents based on the dominant reason for choosing the mode in filling out the questionnaire were respondents whose reason for choosing the mode was because it was safer and more comfortable.

MODELING ANALYSIS

From the data above, "trial and error" was carried out to get the best equation results using the LIMDEP program. Estimation is carried out by removing the attribute with the largest P-value and which does not meet the requirements (P-value <0.05). Estimation is carried out repeatedly by reviewing the P-value of the resulting attributes until a combination of attributes that meets the requirements is obtained (trial & error). The final result of the parameter estimation for each utility is as follows:

$U_{personal\ vehicle} = -0.20673629.X_8$

$U_{BRT} = 2{,}03684227-0{,}00124961X_1+1{,}47558323X_2+0{,}71055604X_3$

$U_{online} = 0{,}25690278-0.00124961X_1+1{,}47558323X_2$

The Probability Equation of the 3 (three) modes is:

$$P_{personal\ vehicle} = \frac{\exp(Upersonal\ vehicle)}{\exp(U\text{personal vehicle})+\exp(UBRT)+\exp(Uonline\ transportation)}$$

$$P_{BRT} = \frac{\exp(UBRT)}{\exp(Uk\text{personal vehicle})+\exp(UBRT)+\exp(Uonline\ transportation)}$$

$$P_{online\ transportation} = \frac{\exp(Uonline\ transportation)}{\exp(U\text{personal vehicle})+\exp(UBRT)+\exp(Uonline\ transportation)}$$

Attributes That Influence the Mode Choice Model

Based on the results of the data analysis carried out, the attributes that influence the transportation mode selection model are the attributes of cost, time, service and purpose of travel. influences the model, because it determines a person's choice in choosing the mode that will be used to travel within the city of Banjarbaru.

Sensitivity of Fare and Trip Duration Attributes

The time sensitivity/trip duration calculation is used to determine the extent of influence of travel time on the probability of the traveler choosing the mode of transportation. This can describe the ideal travel time/duration for the mode of transportation concerned in providing services for travelers.

Table 1. Sensitivity of Travel Costs/Tariffs to BRT Trip Duration, Faster Than Private Vehicles

Travel Cost			Utilitas		Probability		
BRT (IDR/road)	Online Transportation(IDR/Km)	Privete Vehicles	BRT	Online Transportation	Private Vehicles	BRT	Online Transportation
9000	3000	-0,21	-4,07	-2,02	0,84	0,02	0,14
8000	3000	-0,21	-2,82	-2,02	0,81	0,06	0,13
7000	3000	-0,21	-1,57	-2,02	0,70	0,18	0,12
6000	3000	-0,21	-0,32	-2,02	0,49	0,43	0,08
5000	3000	-0,21	0,93	-2,02	0,23	0,73	0,04
4000	3000	-0,21	2,18	-2,02	0,08	0,90	0,01
3000	3000	-0,21	3,43	-2,02	0,03	0,97	0,00

The results of the above sensitivity calculations are distributed into the graph shown in Figure 8.

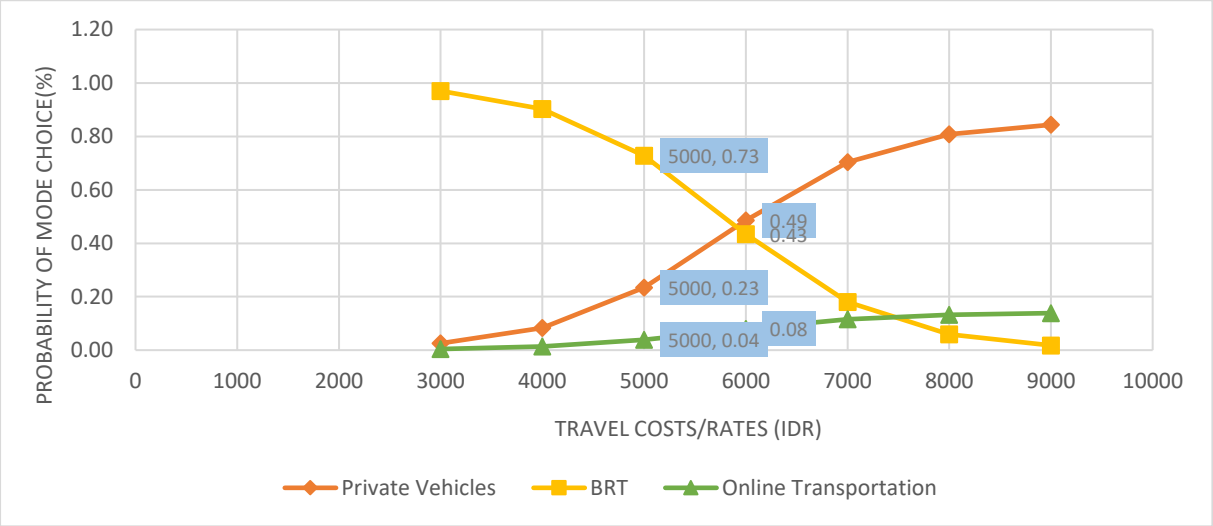

Figure 8. Sensitivity Graphvity Mode Choice to Cost/Fare with BRT Travel Duration Faster Than Personal Vehicle

In BRT transportation modes, to achieve conditions that can compete with existing transportation modes, a trial of using tariffs is carried out, by constantly reducing the highest fare (IDR 9.000) until it reaches the lowest fare (IDR 3.000). In the condition of BRT fares of IDR 5.000, and online transportation of IDR 3.000/km there is a balanced probability, namely private vehicles by 23%, BRT by 73%, and *online* transportation by 4%. This illustrates that the ideal fare applied to BRT modes with a faster trip duration than *online* transportation is IDR 5.000.

The sensitivity value of the effect of travel costs on the selection of three types of transportation modes with BRT trip duration assumed to be the same as private vehicles can be seen in Table 2.

Table 2. Cost/fare sensitivity of trips with BRT trip duration is the same as private vehicles

Travel Cost			Utilitas		Probability		
BRT (IDR/road)	Online Transportation(IDR/Km)	Privat Vehicles	BRT	Online Transportation	Private Vehicle	BRT	Online Transportation
9000	3000	-0,21	-5,55	-2,02	0,86	0,00	0,14
8000	3000	-0,21	-4,30	-2,02	0,85	0,01	0,14
7000	3000	-0,21	-3,05	-2,02	0,82	0,05	0,13
6000	3000	-0,21	-1,80	-2,02	0,73	0,15	0,12
5000	3000	-0,21	-0,55	-2,02	0,53	0,38	0,09
4000	3000	-0,21	0,70	-2,02	0,27	0,68	0,05
3000	3000	-0,21	1,95	-2,02	0,10	0,88	0,02

The results of the above sensitivity calculations are distributed into the graph shown in Figure 9.

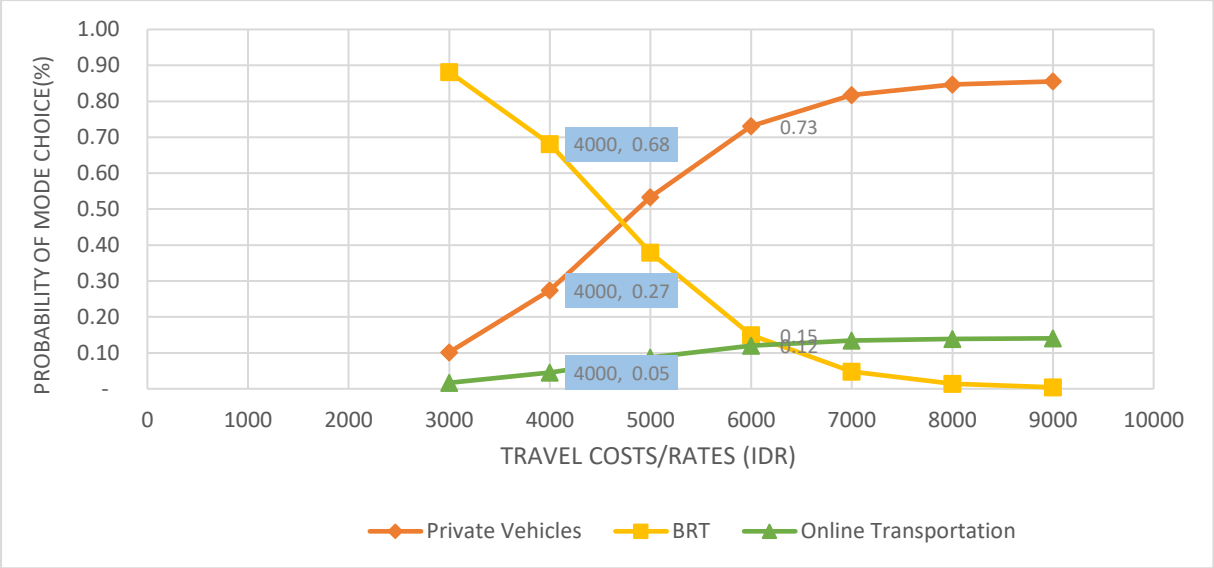

Figure 9. Sensitivity Graphvity Mode Choice to Cost/Fare with BRT Travel Duration Equal to Personal Vehicle

In BRT transportation modes, to achieve conditions that can compete with existing transportation modes, a trial of using tariffs is carried out, by constantly reducing the highest fare (IDR 9.000) until it reaches the lowest fare (IDR 3.000). In the condition of BRT tariffs of IDR 4.000, and online transportation of IDR 3.000 / km there is a balanced probability, namely private vehicles by 27%, BRT by 68%, and online transportation by 5%. This illustrates that the ideal fare applied to the BRT mode with the same trip duration as *online* transportation is IDR 4.000.

The sensitivity value of the effect of travel costs on the selection of three types of transportation modes with BRT trip duration assumed to be slower than private vehicles can be seen in Table 3.

Table 3. Cost/fare sensitivity of trips with BRT trip duration slower than private vehicles

Travel Cost			Utilitas			Probability	
BRT (IDR/road)	Online Transportation (IDR/Km)	Privete Vehicles	BRT (IDR/road)	Online Transportation (IDR/Km)	Privete Vehicles	BRT (IDR/road)	Online Transportation(IDR/Km)
9000	3000	-0,21	-7,02	-2,02	0,86	0,00	0,14
8000	3000	-0,21	-5,77	-2,02	0,86	0,00	0,14
7000	3000	-0,21	-4,52	-2,02	0,85	0,01	0,14
6000	3000	-0,21	-3,27	-2,02	0,83	0,04	0,14
5000	3000	-0,21	-2,03	-2,02	0,75	0,12	0,12
4000	3000	-0,21	-0,78	-2,02	0,58	0,33	0,09
3000	3000	-0,21	0,47	-2,02	0,32	0,63	0,05

The results of the above sensitivity calculations are distributed into the graph shown in Figure 10.

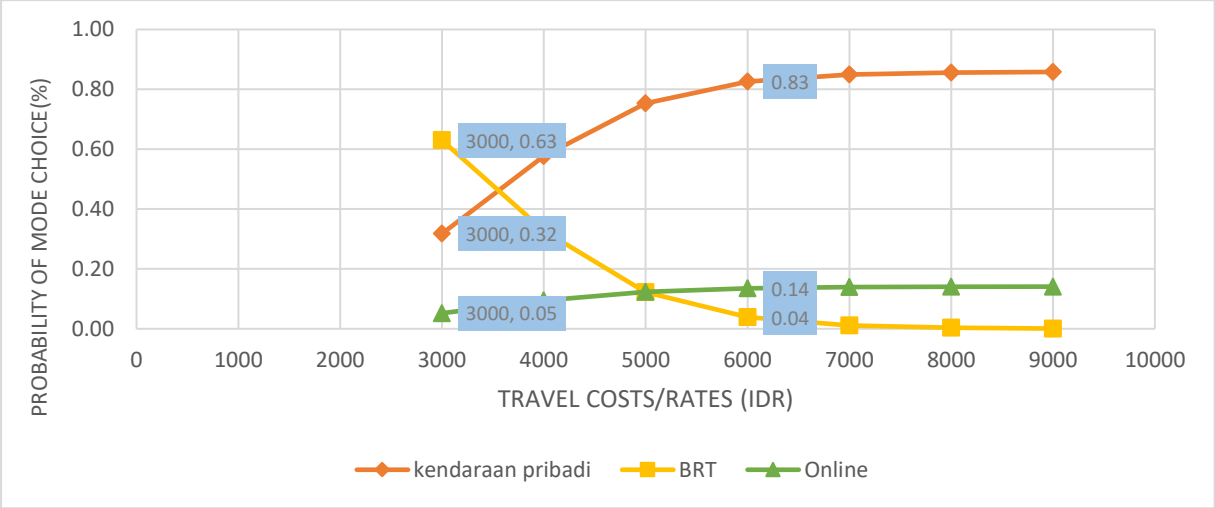

Figure 10. Sensitivity Graphvity Mode Choice to Cost/Fare with BRT Travel Duration Slower than Personal Vehicle.

In BRT transportation modes, to achieve conditions that can compete with existing transportation modes, a trial of the use of tariffs is carried out, by constantly reducing the highest fare (IDR 9.000) until it reaches the lowest fare (IDR 3.000). In the condition of BRT fares of IDR 3.000 , and online transportation of IDR 3.000 / km there is a balanced probability, namely private vehicles by 32%, BRT by 63%, and *online* transportation by 5%. This illustrates that the ideal fare applied to BRT modes with a slower travel duration than online transportation is IDR 3.000.

IV. CONCLUSION

Based on the research that has been done, the following conclusions can be drawn:

1. In this research, the attributes used as data analysis material are 10 attributes, namely: fare/cost, travel time/duration, service, gender, age, occupation, income, purpose of travel, modes frequently used, and reasons for choosing the mode . Furthermore, the attributes that have a dominant influence in modeling the

choice of transportation modes between private vehicles, BRT and online transportation are obtained, namely: the fare/travel cost attribute for BRT and online transportation, the travel time/duration attribute for BRT and online transportation, the service attribute for BRT and vehicles. personal, and travel intent attributes for private vehicles.

2. The transportation mode choice model obtained is as follows:

$$P_{\text{Private vehicles}} = \frac{\exp(UPrivate\ vehicles)}{\exp(UkPrivate\ vehicles)+\exp(UBRT)+\exp(Utransportasi\ online)}$$

$$P_{BRT} = \frac{\exp(UBRT)}{\exp(UPrivate\ vehicles)+\exp(UBRT)+\exp(Utransportasi\ Online)}$$

$$P_{\text{transportasi online}} = \frac{\exp(UTransportasi\ online)}{\exp(UPrivate\ vehicles)+\exp(UBRT)+\exp(Utransportasi\ Online)}$$

Explanation:

$U_{\text{private vehicles}}$ = -0,20673629.X_8

U_{BRT} =2,03684227-,00124961X_1+1,47558323X_2+0,71055604X_3

$U_{\text{online transportation}}$ =0,25690278-0,00124961X_1+1,47558323X_2

Which :

X1 = travel expense

X2 = time/travel duration

X3 = service

X8 = reason for travel

From the equation above, it shows that the utility of personal vehicles is influenced by the attribute of the intent of the respondent's travel destination. Meanwhile, BRT Utility is influenced by travel rates/costs, trip duration, and service attributes of BRT. For *online* transportation utility is influenced by the fare/cost of the trip, and the duration of the trip.

3. Based on sensitivity analysis of tariff/cost attributes to trip duration in mode choice, the following results were obtained:
   a. Based on the sensitivity of tariffs/costs in choosing transportation modes between private vehicles, BRT and online transportation in the city of Banjarbaru, the higher the tariff applied to BRT, the lower the probability that BRT will be chosen, and the smaller the tariff on BRT, the higher it will be. the probability that the BRT will be selected. This is due to the tendency of travelers to choose cheaper modes of transportation among the existing modes of transportation.
   b. Based on the sensitivity of time or trip duration to the probability of choosing a transportation mode, especially the BRT mode, it can be seen that the slower the duration of the BRT trip, the lower the probability value (the smaller the possibility of being chosen by the traveler). And conversely, the faster the duration of the BRT trip, the greater the probability value of BRT being chosen by the traveler. This is also due to the tendency of travelers to choose modes of transportation that have shorter (faster) travel times.

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