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Online-Taxi Choice Model Based on Passenger Perception in Indonesia

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***Abstract*—Malang, and Surabaya are two cities in East Java Province, Indonesia with day-population more than 1 million and have experienced daily traffic congestions because of the over usage of private vehicle. This study aim is to find the modal choice model for shifting the passenger from conventional-taxi to online-taxi. To develop the modal choice model, a Stated Preference (SP) questionnaire were developed to obtain a preference of respondent, as many as 400 questionnaires were collected. Binary Logit Model was used to develop a modal choice model, based on price and waiting time, the result shows the difference in trip costs is Rp. 4.348 and waiting time is 10 minutes. If the trip cost more than Rp. 4.348 and waiting time more than 10 minutes, the passenger rather using the conventional-taxi.**

Keywords: Binary Logit Model, online-taxi, modal choice model, price, stated preference, waiting time

I. INTRODUCTION

Cities in developing country with the population more than 1 million and lack of sufficient control have caused big issues one of which is traffic congestion. Indonesia represents of developing country with serious traffic congestion. Surabaya and Malang, two cities in Indonesia have faced serious traffic congestions due to their high usage of private cars. Facing this problem, most authorities prefer to introduce a means of transportation which is similar to private cars, which known as online transportation as a solution for serious traffic problems. The phenomenon of ridesharing has become a common issue based on ridesharing thought, cab-sharing or taxi-sharing has developed [1]. The development of technology such as mobile phone and social network have enhanced and changed the traditional ridesharing. Malang and Surabaya represent big cities in Indonesia which have already had an online-taxi company such as Grab and local ride service named GO-JEK. A study about online transportation which had been held in Malang found that the citizens in Malang give significant influences regarding the use of this online transportation service which later it results in positive preference to online transportation utilization [2]. Ridesharing promise to increase reliability and reduce waiting time has affected the total travel time of point-to-point traveling.

There have been many studies conducted regarding the issue of conventional-taxi and online-taxi. The previous study regarding the use of online-taxi service has been conducted in China, on this study, personalized travel choice between the taxi and tailored taxi called Didi is the concern of the study. The personalized travel choice is determined by personal characteristic and trip characteristic. Using stated preference technique, a questionnaire is designed to acquire data on travel preference. The results indicate that the traveler with old age, high household income, or relatively low education level would prefer choosing taxi as their personalized travel mode as for the travel preference evaluation, tailored taxi is now considered as a convenient however low-security travel mode compared to a conventional taxi. [3]. Another study held in San Fransisco found that ride-sourcing wait times are dramatically shorter than typical taxi dispatch and hail times, so ridesourcing customers could expect a wait of ten minutes or less anytime and anywhere in the city, in contrast, taxi wait times varied considerably by time, day, and location and were notably longer in the city outside the neighborhood [4]. This study concerns with taxi apps and its impact on taxi markets in Canada which has come up to the conclusion that instead of restricting the growth of taxi market, the regulator should focus on reducing the likelihood of monopoly and collusion in a taxi market led by apps [5]. Another study concerns the factor affecting the adoption of on-demand ride services such as Uber and Lyft, respondents who report higher numbers of long-distance business trips and have a higher share of long-distance trips made by plane are also more likely to have used these services as they are frequent users of smartphone transportation-related apps, and those who have previously used taxi and car sharing services. From attitudinal factors that were investigated, individuals with stronger pro-environmental, technology-embracing, and variety-seeking attitudes are more inclined to use ridesharing [6]. Based on the literature mentioned before, previous studies mainly discussed the conceptual level qualitatively. Quantitative analysis of traveler's preference in mode choice is important and beneficial since a traveler's preference in the modal choice is important. However, this quantitative research aims at finding out the modal choice model and fill the gap of the previous studies. The quantitative research deals with the shifting of the passenger from conventional taxi to online taxi which is held in both Malang and Surabaya. The online-survey and offline-survey were held to collect primary data. To develop the modal

choice model, a Stated Preference (SP) questionnaire was developed to obtain a preference of respondent and it results in 400 questionnaires collected. Binary Logit Model was used to develop the modal choice model, based on price and waiting time.

II. Literature Review

Modal choice selection is one of the basic and important issues in transportation. Nowadays modal choice selection has been influenced not only by the facility service availability and policy, but it is also influenced by the passenger's perception. The adoption of technology-has enabled transportation alternatives, such as online-taxi. Therefore, people are more open to using information and communication technologies (ICT). This is also considered as variable influencing in modal choice selection. Modern technologies increase the success rate and the potential market for emerging transportation services by improving the convenience of arranging travel or making a reservation, providing online pay-for-service methods, collecting and disseminating online customer feedback, and offering better platforms for the efficient and dynamic management of resources [7].

The Stated Preference approach has been widely used in transportation, as well as in modal choice selection. The Stated Preference, originated from mathematical psychology can measure how people choose not-yet-existing travel modes or how people take actions in case of introducing new policies. This approach examines the individual response to a series of experimentally designed choice alternatives, which are typically described in terms of combinations of attributes with several predefined levels. Hensher used Stated Preference (SP) in his study to determine the value of time [8].

The Stated Preference approach offering the modal choice at once to the respondent, then the respondent make a sort based on their choice that shows the level of the preference of their choice. [9] Three types of questionnaires that can be used in stated preference studies namely ranking, choice, and rating. In a ranking questionnaire, respondents must order the hypothetical situations to state their preference, meanwhile, in the choice questionnaire the respondents simply choose the hypothetical combination of attributes that is more favourable according to them and the researcher has an actual prediction of the respondent's choice in a hypothetical situation. In rating questionnaire, the respondents must be able to not only order their responses in order of preference but they also must be able to indicate how much they prefer one alternative over the other. There was a study examines the perception and preferences of passengers on bus and rail routes modes, the preferences and perception of the passenger are collected using both stated preference and revealed preference techniques, this study found that the passengers choose their modes based predominantly on the time and cost associated with traveling. The frequency and reliability are less necessary for passengers [10].

To build a model of the modal choice there are numbers of formula that can be utilized. One of them is the logit model which is used to forecast the probability of an event by fitting data. Binary Logit Model, as a kind of discrete choice model, is widely used in transportation for prediction and it is an important traffic behaviour model. In this study, we determine the occurrence of an event as traveling by Online-Taxi. The result of personalized travel mode prediction is either traveling by Online-Taxi or Conventional-Taxi. The Xi refers to *i* th traveler. A total prediction is the probability of the event (Online-Taxi or Conventional-Taxi). Assume that *n* variable exists, namely x_1, x_2,…,x_n, the logit value of the unknown binomial probability is defined as a linear function as follows:

$$logit\ (probability) = ln\ [probability\ /\ (1 - probability)] \quad (1)$$

$$= \beta_0 + \beta_1 x_1^i + \beta_2 x_2^i + \ldots + \beta_n x_n^i$$

The unknown parameter β_k is estimated through maximum likelihood estimation, which characterizes the contribution that *k* th variable making to the logit probability value (k= 1,2, …, n) and β_0 refers to an intercept. From the (2) we get the (3)

$$Probability_i = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1^i + \beta_2 x_2^i + \ldots + \beta_n x_n^i)}} \quad (2)$$

Assuming that the utility function could be written as,

$$Z = \beta_0 + \beta_1 x_1^i + \beta_2 x_2^i + \ldots + \beta_n x_n^i \quad (3)$$

The (2) could be formulated as logistic regression

$$f\ (Z) = 1\ /\ (1+e^{-Z}) \quad (4)$$

Where the f(z) Є (0,1) refers to the probability of an event. Zhang et al. [10] used the binary logit model which is proposed to describe the preferences of traveler's personalized travel behavior in their study in China. This study found that the estimated logit model can describe the personalized travel mode choice well.

III. Research Method

A. Location of Study

This research was conducted in Malang and Surabaya, Indonesia. Malang city is the second biggest and densest city in East Java. The City area is 110.06 Km^2 and consists of five sub-districts. Meanwhile, Surabaya city is the densest city in East Java which its area covers 326.36 km and it is divided into 31 districts. The selection of Malang as the research location is based on its unique characteristics as an education and tourism city in which the need for transportation is highly growth-demanding. Furthermore, Surabaya city is also chosen as the location of study because Surabaya city is central government city for East Java and Surabaya is also known as a business city. The same as

Malang city the need for transportation in Surabaya is highly growth-demanding. The study location can be seen in Fig. 1 Map of Indonesia and East Java.

Fig. 1. Map of Indonesia and East Java.

B. Research Variable and Data Collection

Travel expenses and waiting time are the variables of the study. To achieve the objective, literature study about online-taxi performance has been held first. It was then continued by developing the modal choice model while a Stated Preference (SP) questionnaire was developed to obtain a preference of respondent which results in 400 questionnaires collected. Binary Logit Model was used to develop the modal choice model based on price and waiting time.

C. Method of Data Analysis

At first, the descriptive statistic was used to analyze the demographic characteristic of the respondent and to understand the user of online-taxi in Malang city. Meanwhile to understand the user preference about mode choice between conventional-taxi and online-taxi, stated preference approach has been used by utilizing a stated preference questionnaire. The option of modal choice is offered at once and the respondents give the response based on their preference. Regression linear was used to form mathematical equation and Binary Logit Model was used to develop the modal choice model, based on price/travel expense and waiting time.

IV. Result and Analysis

A. Respondent Characteristic

The respondent for this study is Indonesian people aged between 15 – 65 years old, who stay in Malang city and Surabaya city and who have experience in using both conventional-taxi and online-taxi. They also must have the mobile application for online-taxi in their mobile-phone they have experienced using online-taxi application, TABLE I show the detail of respondent characteristic.

TABLE I. Respondent Characteristics

Demographic Variable		Number	Percentage
Gender	Male	162	40,5%
	Female	238	59,5%
Age	15 – 22 year	218	54,5%
	23 – 45 year	145	36%
	46 – 54 year	23	6%
	55 – 64 year	14	3,5%
Residence	Permanent	295	74%
	Temporal	105	26%
Occupa-Tion	High-school student	112	28%
	University student	132	33%
	Private employees	69	17%
	Civil servant	5	1%
	Entrepreneur	27	7%
	Teacher/lecturer/others	17	4%
	Housewife	38	10%
Education Level	Elementary/Junior High School	107	27%
	Senior High School	165	41%
	Diploma/Bachelor Degree	104	26%
	Master/Doctoral Degree	24	6%
Income/ Pocket Money	< Rp.1.000.000	171	43%
	Rp.1.000.000-Rp.2.999.999	119	30%
	Rp.3.000.000-Rp.4.999.999	80	20%
	>Rp.5.000.000	30	7%
Average Expenditure/ Trip	Rp.10.000-Rp29.999	214	53,5%
	Rp.30.000-Rp49.999	114	28,5%
	Rp.50.000-Rp.69.000	50	12,5%
	>Rp.70.000	22	5,5%
Main Purpose of Traveling	Work	48	12%
	Study	135	34%
	Shopping	39	10%
	Family	97	24%
	Recreational	62	15%
	Health	19	5%

B. The Utility Model on the Difference of Travel Expense and Waiting Time

The respondents fill in the questionnaire regarding their preference in using either conventional-taxi or online-taxi. Their answers were transformed into quantitative data and transformed again by used Berkson-Theil Transformation. Based on model construction of linear regression, the difference of travel expense and waiting time of mode selection, the result found that the equation of the difference in travel expense and gaining time is as follows:

$$(UTK - UTO) = 0.0000738\,\Delta X1 + 0.0618803\,\Delta X3 - 0{,}219,$$

with F = 0,000 and R-square = 0,334, show that simultaneous travel expense and waiting time significantly influence and contribute to 33,4 % in the difference of utility between online-taxi and conventional-taxi. From the equation by using Binary Logit model, the probability of mode selection for Online-Taxi and Conventional-Taxi is:

$$P_{CT} = \frac{e^{U_{CT}-U_{OT}}}{1+e^{U_{CT}-U_{OT}}} = \frac{e^{0.0000738\Delta X1 + 0.0618803\Delta X3 - 0{,}219}}{1+e^{0.0000738\Delta X1 + 0.0618803\Delta X3 - 0{,}219}}$$

$$P_{OT} = 1 - P_{CT}$$

Here it can be analyzed that with the difference in trip costs which is Rp. 4.348, so if the difference in trip costs increased beyond Rp. 4.348, then the probability of users selecting for an online taxi will decrease, and they will use a conventional taxi. For waiting time, the difference is for 10 minutes, so if they have to wait more than 10 minutes they will use a conventional taxi. As the result, the policy implication for Online-Taxi is for the price, Online-Taxi price must be Rp 4.348 cheaper than Conventional-Taxi and for the waiting time the Online-Taxi must be less than 10 minutes, so the expected number of Online Taxi user will be about 65%.

V. Discussion of Online-Taxi Choice Model based on Passenger Perception

The aim of this study is analysing the influence of travel expense and waiting time on the choice of conventional-taxi or online-taxi. The sensitive analysis is performed using the proposed model. These analyses below are important to understand the traveller's personalized travel mode choice.

A. The Effect of Travel Expense and Waiting Time

Travel expense and waiting time are evaluated simultaneously. The evaluation of travel expense and waiting time plays an important role in the decision of using either conventional-taxi or online-taxi. To see the influence of the travel expense and waiting for time evaluation in this study, the researchers used selection ratios of taxi and tailored taxi which is evaluated by the binary logit model and the results are shown in Fig. 2 The graph of travel expense and wait time in optional condition.

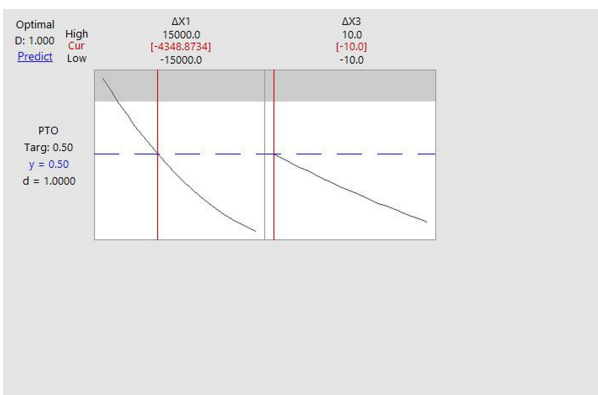

Fig. 2. The graph of travel expense and wait time in optional condition.S

B. Finding and Development Strategy of Online-Taxi

Based on the coefficient estimation and sensitive analysis, some differential development strategies for taxi and tailored taxi are proposed as follows:

- As for the demographic characters, the target market for emerging online-taxi is the people who are willing to try new things and prefer more comfort and convenient service. In this study, it shows that around 54,5 % passenger is young people, aged between 15 – 22 years old, a university student and the reason using online-taxi because with online-taxi more reliable in getting the vehicle (33%), short-distance trip with the average expenditure/ trip Rp 10.000 – Rp. 30.000 (53,5%).
- During the rush hours when most trips are commuting travel, it is time for online-taxi to take advantage of its online order feature. In this period, conventional-taxi is more inefficient as the congestion in the road and in uncertainty waiting time/pick up time.
- To increase the number of user of online-taxi, the stakeholder must pay more attention to the travel expenses because the price is a sensitive variable to the passenger. The stakeholder must provide affordable price since the user of the online-taxi is young people with no private vehicle or restricted to use the private vehicle.

VI. Conclusions

This paper examines the personalized travel mode choice with the consideration of a traveller's characteristic and perception. Information is obtained through a questionnaire survey in Surabaya city and Malang city, Indonesia. A binary logit model is used to describe the choice of traveling by conventional-taxi or online-taxi. How the influential factors have an impact on the personalized travel mode choice is revealed by sensitivity analysis. The following conclusions are drawn based on the result: This paper examines the personalized travel mode choice with the consideration of a traveller's characteristic and perception. Information is obtained through a questionnaire survey in Surabaya city and Malang city, Indonesia. A binary logit model is used to describe the choice of traveling by conventional-taxi or online-taxi. How the influential factors have an impact on the personalized travel mode choice is revealed by sensitivity analysis. The following conclusions are drawn based on the result.

1. The estimated logit model can describe the personalized travel mode choice well.
2. The results indicate that travellers with young age, a university student who does not have a private vehicle or relatively low education level would prefer to choose online-taxi as their personalized travel mode.
3. The service improvement online-tax, especially in travel expense needs to be given more attention by the stakeholder because travel expenses are sensitive attribute to passenger/customer in Surabaya and Malang.
4. The stakeholder must provide an incentive or price policy like promotion price to attract the user to use online-taxi, without reducing the performance of online-taxi, both in facility and driver performance.
5. Online-taxi wait times are shorter than conventional-taxi so online-taxi customers could expect a wait of ten minutes or less anytime and anywhere in the city. However, if the wait time more is than ten minutes the

driver will give the customer an option either to keep use the online-taxi or not.

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REFERENCES

[1] Zhang, Yujie, Hongwei Goo, Cheng Li, Wuhong Wang, Xiaobei Jiang, Yang Liu. Which One Is More Attractive to Traveler, Taxi or Tailored Taxi? An Empirical Study in China. Procedia Engineering 137 (2016) 867-875.

[2] Rayle, Lisa., Danielle Dai., Nelson Chan., Robert Cervero., Susan Shaheen. Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in SanFrancisco. Transp. Policy 45 (2016) 168–178.

[3] Ahern, Aoife A., and Nigel Tapley. The Use Of Stated Preference Techniques To Model Modal Choices On Interurban Trips in Ireland. Transp. Research Part A 42 (2008) 15 – 27.

[4] Hensher, D.A. (2003) Revealing Differences in Willingness to Pay Due To The Dimensionality of Stated Choice Designs; an Initial Assessment. Design of Design Report#1, Institute of Transport Studies, The University of Sidney.

[5] Harding, Simon, Millind Kandlikar, Sumeet Gulati. Taxi App, Regulation, and The Market for Taxi Journeys. Transp. Research Part A 88 (2016) 15-25.

[6] Hardaningtyas, Ratna Tri. Citizen Perception about Online Transportation Utilizing in Malang. Journal of Student Majoring in Civil Engineering vol 1 no 2 (2019) Brawijaya University Malang.

[7] Hensher, D.A. (1994) Stated Preference Analysis of Travel Choice: The State of Practice. Transp. 21, 107-133.

[8] Taylor, Brian D., Chin, Ryan, Crotty, Melanie, Dill, Jennifeer, Hole, Lester A, Meanville, Michael, Polzin, Steve et al. (2015) Between Public and Private Mobility: Examining The Rise of Technology-Enabled Transportation Services. Special Report 319. Transportation Research Board. Committee for Review of Innovative Urban Mobility Services.

[9] Alemi, Farzad, Giovanni Circella, Susan Handy and Patricia Mokhtarian. What Influences Travelers To Use Uber? Exploring The Factor Affecting The Adoption of On-Demand Ride Services in California. Travel Behavior and Society, 13 (2018) 88-104.

[10] Gidovalvi, G., Pederson, T.B. (2007) Cab-Sharing: An effective, door-to-door, On-Demand Transportation Service. Proceeding of the 6th European Congress on Intelligent Transportation Systems and services.