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The Modelling of Transportation choice for Students and Workers at School in Malang

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ABSTRACT :*Modes of transport student and workers in schools in the city evenbecome part of the traffic'sproblemsthat have persisted. This isrelated to the conditions their in the city and availability of transportation related to the place wherethey are live. In thisstudy, wetry to use nestedlogit model. The motives are expanding the scope research and also to capture the actual condition for student and labor in the city. This studyconducted in Malang City as a growing city and becomecity of education. The data used in thisstudyis the secondary data obtainedfromrespondentresponse to the statedpreferencemethodis by providingeightdifferent scenarios.*
KEYWORDS: *Modes of transport, nested logit model, stated preference.*

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I. INTRODUCTION

Transportation mode is one of the major components of the transportation systems that estimates the level usage for different transportation modes (e.g., walking, public, private transportation, bicycle, and vehicle) and given the performance characteristics of each available mode and characteristics of the individual user. As we know, in developing countries, especially Indonesia appears transportation that is becoming a trending topic, namely transportation online. Transportation online is one of the newest service innovation in m-commerce. Online transportation service is an individual transportation service where a customer can order a ride (car and motorcycle) through mobile application and the driver can respond the order the order through the apps. [1]Transportation problems that often occur include traffic jams, air pollution, and accidents. [2]These problems are not only caused by the limited transportation infrastructure system, but also with other problems. [3]Travel mode choice has received the most attention among discrete choice problems in travel behavior literature. Mode choice analysis and prediction are closely related to transportation system policies and congestion mitigation strategies. The most of mode choice models are based on random utilty maximization principle derived from econometric theory. The multinomial logit (MNL) model and the nested logit (NL) model are two commonly used models.

Adinirekso [4] said that using the the multinomial logit model approach, it can be obtained a model of the characteristics of travelers who can influence the selection of worker transportation modes. [5]To form a MNL it takes an assumption that between choices are mutually independent and between individuals are mutually independent. If there is a correlation between choices, then MNL will produced an estimator that is biased. One model that can be used is the NL model. The modechoice is used in this study to determine the proportion of people who are willing to use each mode by knowing each of the factors that influence it. The nested logit (NL) model is the preferred specification of a discrete choice model when analysts move beyond the multinomial logit (MNL) model [6]. Despite the increasing availability of other less restrictive models such as mixed logit, random parameter logit, and multinomial probit [7] there remain reasons why the NL model will continue to be estimated. For example, the NL model is relatively easy to estimate and with its closed form structure, it is to implement in the simulation of market shares before and after a policy change[8]. Nugraha [9] said that the NL model is more accurate than MNL. Hensher [10] analyzed to seek clarify the issue about alternative normalisations. Danaher [11] used a NL model to forecast television ratings with into effects random program. HuanmeiQin,et.al [12] analyzed airport parking behavior based on stated preferences survey studies. Soltani [13] explored individuals travel behavior and its relationship with observed built environment in three

different patterns of urban development of Shiraz metropolitan area. Palma [14] presented of an empirical analysis of the mode choice for work trips in the city of Geneva by means of a nested logit approach.

II. METHOD

The standard logit model imposes the restriction of the independence from irrelevant alternatives (IIA) property, which implies proportional substitution across alternatives. When the IIA assumption does not hold, models with more flexibility are needed. One of the the most widely used models is called the nested logit. In a nested logit model, all the alternatives in a choice set can be partitioned into nests in such a way that the following conditions are true. The ratio of any two alternatives that are in the same nest is independent of the existence of all other alternatives. Hence, the IIA assumption holds within each nest. The ratio of any two alternatives that are in different nests is not independent of the existence of other alternatives. Hence, the IIA assumption does not hold between different nests. [15] The models supported are based on variations of four level tree structure such as the following (see fig.1)

The choice probability under the assumption of the nested logit model is defined to be the conditional probability of alternative j in branch b, limb l, and trunk r, $j|b,l,r$[15]

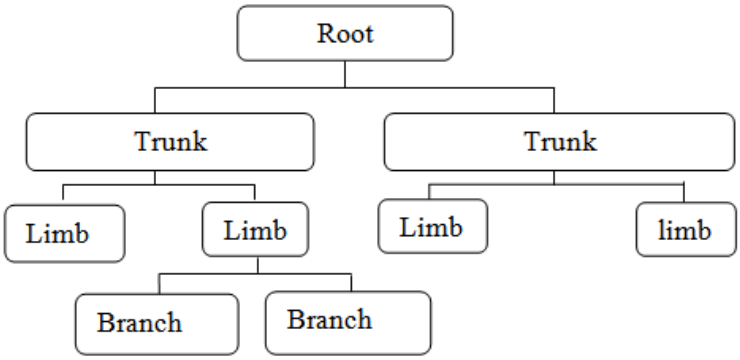

Fig1. Nested Logit Model

$$P(j|b,l,r) = \frac{e^{(\beta' x_j|b,l,r)}}{\sum_{q|b,l,r} e^{(\beta' x_j|b,l,r)}} = \frac{e^{(\beta' x_j|b,l,r)}}{e^{(J_{b|l,r})}} \quad (1)$$

where $J_{b|l,r}$ is the inclusive value for branch b in limb l, trunkr,

$$J_{b|l,r} = \log \sum_{q|b,l,r} e^{(\beta' x_{q|b,l,r})} \quad (2)$$

At the next level up the tree, we define the conditional probability of choosing a particular branch in limb l, trunk r,

$$P(b|l,r) = \frac{e^{\left((\alpha' y_b|l,r)+\tau_{b|l,r} J_b|l,r\right)}}{\sum_{s|l,r} e^{\left((\alpha' y_b|l,r)+\tau_{b|l,r} J_b|l,r\right)}} = \frac{e^{\left((\alpha' y_b|l,r)+\tau_{b|l,r} J_b|l,r\right)}}{e^{(I_{l|r})}} \quad (3)$$

where $I_{l|r}$ is the inclusive value for limb l in trunk r,

$$I_{l|r} = \log \sum_{s|l,r} e^{(\alpha' y_{s|l,r}+\tau_{s|l,r} J_{s|l,r})} \quad (4)$$

The probability of choosing limb l in trunk r is

$$P(l|r) = \frac{e^{\left((\delta' z_{l|r})+\sigma_{l|r} I_{l|r}\right)}}{\sum_{s|l,r} e^{\left((\delta' z_{l|r})+\sigma_{l|r} I_{l|r}\right)}} = \frac{e^{\left((\delta' z_{l|r})+\sigma_{l|r} I_{l|r}\right)}}{e^{(H_r)}} \quad (5)$$

where H_r is the inclusive value for trunk r,

$$H_r = \log e^{\left((\delta' z_{l|r})+\sigma_{l|r} I_{l|r}\right)} \quad (6)$$

Finally, the probability of choosing a particular limb is

$$P_r = \frac{e^{\left((\theta' h_r)+\kappa_r H_r\right)}}{\sum_s e^{\left((\theta' h_r)+\kappa_r H_r\right)}} \quad (7)$$

By the laws of probability, the unconditional probability of the observed choice made by an individual is

$$P(j,l,b,r) = P(j|b,l,r) \times P(b|l,r) \times P(l|r) \times P(r) \quad (8)$$

This study use nested logit model with two levels where the choice transportation includes public transportation, motorcycles and cars. Motorcycle and car will be grouped into alternative private transportation and online transportation. Thus, alternatives choices in different nests will be free from each other. We will se fig.2.

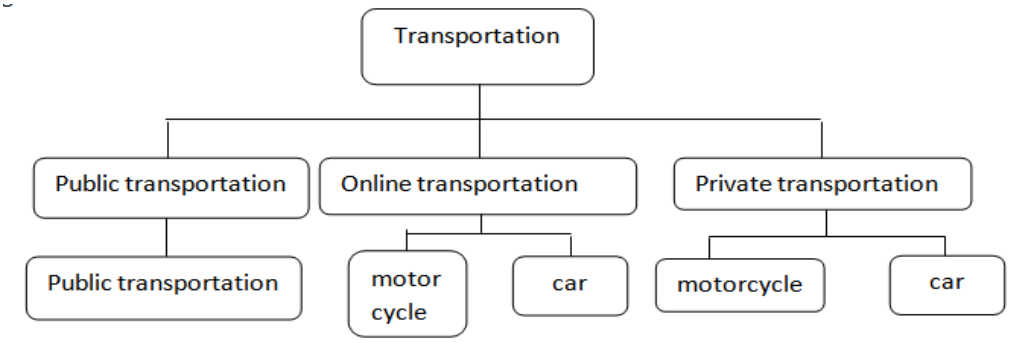

Fig.2 Stucture diagram of NL model

III. RESULT

This study is based on a personal survey of senior high school student, teachers, and workers who to start activities in the morning and often experience traffic jam. To obtain representatives data a total of 11 senior high schools were contacted. The sample was drawn from school who experiencing a congested traffic jam. This study based on stated preference survey. The survey questionnaire mainly covers various questions regarding traveler attributes, trip characteristics, and socio demographics characters. The detailed questionnaire contents are illustrated follows.

1. The first part of the questionnaire is composed of questions designed to collect information about attributes for the trips; such as travel costs, frequency of use transportation mode, travel time, and percentage of the transportation mode.
2. The second part of the questionnaire is designed to collect socio demographic information of travelers such as; gender, age, occupation, and income.
3. The last part is about traveler preferences for transportation choices. Attributes for the trips are assumed to have two levels which are each transportation researched. The respondent were given a choice to select between public, private, and online transportation in each scenario.

Sampling is used because it is impossible to use the population. With slovin method,

$$n = \frac{N}{1 + Ne^2}. \quad (10)$$

sample obtained is 200. The obtained samples were enough to meets the requirements of NL modelling.

After data processing respondents were conducted, using N-Logit software can be seen the proportion of respondents in each alternative. Table 1. shows that the proportion of branches from transportation is 0,08375 to public transportation. The proportion from private transportation is 0,80812 and online transportation is 0,10813. This shows that the largest proportion is in the selection of private transportation which is equal to 0,80812 . We can conclude that respondents have a tendency to be more selective in using private transportation namely private motorcycle because the proportion shows 0,5618. In addition, private cars (SP) also have the second largest proportion is 0,24625. Although online transportation is still relatively new transportation, online transportation is preferred by respondents than public transportation. It is seen that the proportion of online transportation is greater than public transportation. And online motorcycle more chosen than online cars.

Table 1. Tree Structure Specified for the Nested Logit Model

JenisTransportasi	Proporsi	Nama Transportasi	Proporsi
Public Transportation	0,02500	Public transportation	0,02500
Private Transportation	0,82937	Motorcycle	0,61500
		Cars	0,21438
Online Transportation	0,14563	Motorcycle	0,13688
		Cars	0,00875

Probability is done by using nested logit models. The selection of model is obtained as follows:

1. $P(Angkutan\ Umum|Umum, Transportasi) =$
$\left(\frac{e^P}{e^P}\right)\left(\frac{0{,}58420652\ \times ln(e^P)}{(0{,}58420652\ \times ln(e^P)+3{,}88547820\ \times ln(e^R+e^S)+5{,}14589292\times ln(e^U+e^V))}\right)$
2. $P(Sepeda\ Motor|Pribadi, Transportasi) =$
$\left(\frac{e^R}{e^R+e^S}\right)\left(\frac{3{,}88547820\ \times ln(e^R+e^S)}{(00{,}58420652\ \times ln(e^P)+3{,}88547820\ \times ln(e^R+e^S)+5{,}14589292\times ln(e^U+e^V))}\right)$
3. $P(Mobil|Pribadi, Transportasi) =$
$\left(\frac{e^S}{e^R+e^S}\right)\left(\frac{3{,}88547820\ \times ln(e^R+e^S)}{(0{,}58420652\ \times ln(e^P)+3{,}88547820\ \times ln(e^R+e^S)+5{,}14589292\times ln(e^U+e^V))}\right)$
4. $P(Sepeda\ Motor|Online, Transportasi) =$
$\left(\frac{e^U}{e^U+e^V}\right)\left(\frac{5{,}14589292\times ln(e^U+e^V)}{(0{,}58420652\ \times ln(e^P)+3{,}88547820\ \times ln(e^R+e^S)+5{,}14589292\times ln(e^U+e^V))}\right)$
5. $P(Mobil|Online, Transportasi) =$
$\left(\frac{e^V}{e^U+e^V}\right)\left(\frac{5{,}14589292\times ln(e^U+e^V)}{(0{,}58420652\ \times ln(e^P)+3{,}88547820\ \times ln(e^R+e^S)+5{,}14589292\times ln(e^U+e^V))}\right)$

where:

P =utility function of public transportation

$$P = -1{,}812X_3 - 1{,}314\ X_4 + 0{,}5715$$

R =utility function of motorcycle private

$R = 3{,}069X_1 - 4{,}607\ X_2 + 5{,}452\ X_4 + 0{,}5924$

S =utility function of cars private

$S = 0{,}664X_2 - 1{,}0488\ X_3 - 0{,}929\ X_4 + 2{,}288$

U =utility function of motorcycle online

$U = -1{,}564\ X_1 - 0{,}9662$

V =utility function of cars online

$V = -1{,}3574$

If we have to situation in this scenario (Table 2), so probability respondent to choice mode transportation is can be seen Table 3. If the respondent is asked to choose an alternative with the same frequency that is 1 to 2 times a week then the probability of the respondent choosing an online motorcycle is greater than public transportation and online car which is 0.0400. if the respondent is asked to choose alternative transportation with a frequency of use 3 to 6 times a week then the probability of the respondent choosing a private motorcycle is greater than the private car which is 0.8127.

Table 3. Probability alternatives

Alternatives	**Probability**
Public transportation	0,0304
motorcycle private	0,8127
cars private	0,1142
motorcycle online	0,0400
cars online	0,0026

Table. 2 Scenario alternatives modes of transportation

Transportation	Public	Private		Online	
JenisTransportasi	Public	motorcyles	Cars	motorcyles	Cars
Cost (one week)	12.000-24.000rp	10.000-25.000rp	75.000-100.000rp	20.000-35.000rp	40.000 – 65.000rp
Frequency of use(one week)	1 – 2	3 – 6	3 – 6	1 – 2	1 – 2
Percentage of comfort	50 – 65%	55 – 75%	75 – 90%	55 – 75%	75 – 90%
Travelling time	10-20 minutes	10-25 minutes	>35 minutes	>25 minutes	>35 minutes

IV. CONCLUSION

In order to analyze the choice preference for transportation, two NL models were established for the joint choices of transportation. The survey result show that private transportation more preferred as a mode of transportation for motorcycles and cars. However it is undeniable online transportation more preferred than public transportation. NL model created in this study is a good enough model to describe the actual situation.

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