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# **A CHOICE MODEL ON TRIP MODE CHAIN FOR INTER-ISLANDS COMMUTERS IN NORTH MOLUCCA-INDONESIA: A CASE STUDY OF THE TERNATE ISLAND – HALMAHERA ISLAND TRIP**

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## **ABSTRACT**

*The present paper focused on the choice model of trip mode chain for inter-island commuters in a case on the commuter's travel in North Maluku Province, Indonesia. The study conducted an interview survey using a questionnaire sheet instrument for civil servant commuters which have trip route for Ternate Island to Halmahera Island. The condition logit model approach was utilized in order to construct the choice model of the trip mode chain for the commuters. There were four alternative choice of the trip mode chain from origin to destination place which faced by the commuters. The four trip mode chains consist of firstly, private car – crossing mode – taxi motorcycle; secondly, private motorcycle – crossing mode – taxi motorcycle, thirdly, public transit – crossing mode – taxi motorcycle; and fourthly, taxi motorcycle – crossing mode – taxi motorcycle. In this regard, the crossing modes consist of three modes such as ferry, speed boat, and fast ship. The attributes of the choices which taking account into the model were travel time and travel cost. The modelling results showed that the second choice was largest chosen by the commuters than the others choices. However, the fourth and the first choices were a little bit smaller chosen by the commuters than the favorite choice. **Additionally, the commuters more considered travel time than travel cost in choosing their trip mode chain.***

**Key words:** Trip mode chain, inter-island commuters, and North Maluku

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## 1. INTRODUCTION

The commuter trip is a major trip in a daily activity-travel of people from an origin place to a destination place. According to the place of the occurred trip, the commuter trip is occurring not only in urban and or sub-urban area, but also the trip is occurring in inter-island trip. One of the important travel behavior aspects in urban commuter travel is the commuter's behavior on their mode choice. Many previous studies have focused on travel model choice model for commuters in urban area, particularly in developing countries such in Indonesia. In this regard, Ramli et al (2010) have described the mode travel choice model of commuters in Makassar City, Indonesia for a daily household logistic trip purpose, as well as, the choice behavior of a commuter trip for shopping trip in the city (Ramli et al, 2011; 2013). In addition, Nur et al (2016) has constructed for travel behavior of commuters in using public transit mode in Makassar City. These previous studies spent attention on mode choice for a single travel mode assumption.

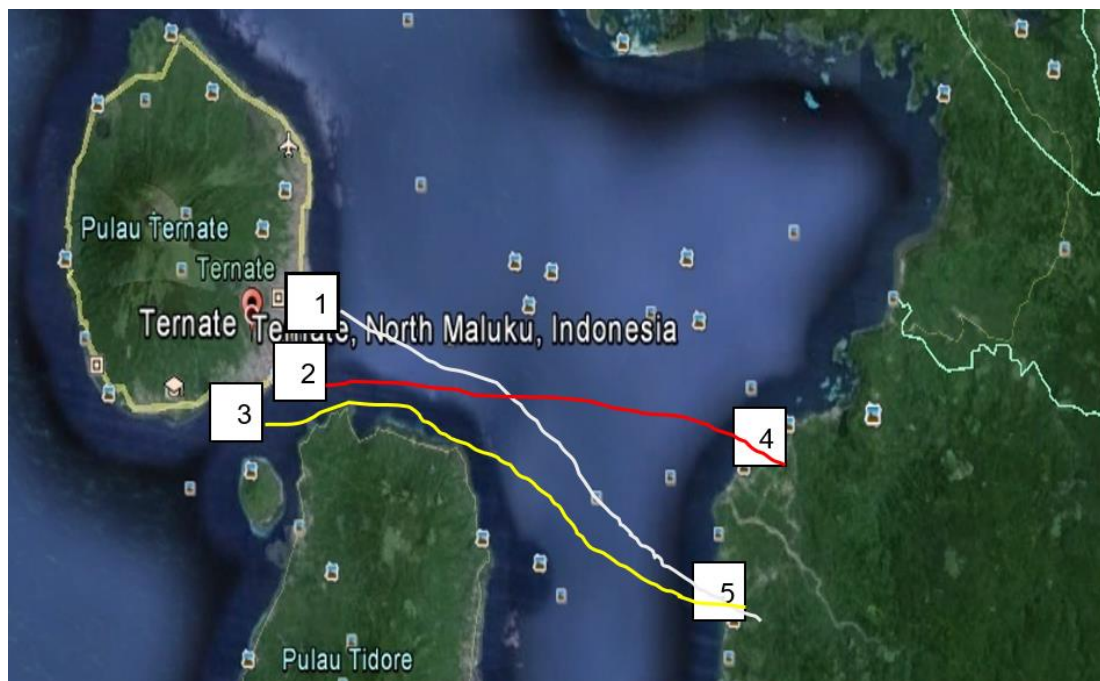
A little bit different with inter-island travel characteristics, where the commuters are facing multi-mode choices. In this regard, the commuters are more facing trip mode chain choices than facing trip mode choices. However, only a few previous studies have been conducted for the inter-island trip. One previous study (Oeda et al, 2012) have studied the travel behavior of commuters which conducted an inter-island trip in Japan for trip purposes as daily combined activities of regular medical treatment and shopping. The commuters faced multi-mode choices such as a public transit mode in hinterland and foreland, also faced cross mode choices for cross trip additionally. However, there is a slightly different case for inter-island commuter trip in developing countries such in Indonesia. As an archipelago and maritime country, many Indonesian have to have inter-island trip for their travel, for example the civil servant commuters in North Maluku Province, Indonesia. The commuters in conducting their travel form Ternate Island to Halmahera Island have been facing some trip mode chains, such as: private car – crossing mode – taxi motorcycle; private motorcycle – crossing mode – taxi motorcycle; public transit – crossing mode – taxi motorcycle; and taxi motorcycle – crossing mode – taxi motorcycle (Hakim et al, 2016).

Regarding the inter-island trip phenomena in the province, the present study attempted to grasp the travel behavior of the civil servant commuters for inter-island trip in choosing their trip mode chain. A case study for civil servant commuter trip in North Maluku Province in Indonesia has been explored to model the trip mode chain of the commuters for their travel. The present paper is organized as follows. Section 2 describes the study methods such the survey location and the construction of choice model of the trip mode chain. Section 3 presents the results of the survey and the model estimation. The final section provides conclusions related to the results.

## 2. STUDY METHODS

### 2.1. Location of the Study

The present study located in North Maluku Province in Indonesia. The study captured the commuter behaviors for work trip of civil servant in the province with route Ternate Island to Halmahera Island. Figure 1 shows the map of the commuter trip in the province.



- 1: Fast ship port in Ternate Island
- 2: Speedboat port in Ternate Island
- 3: Ferry port in Ternate Island
- 4: Speedboat port in Halmahera Island
- 5: Fast ship port and Ferry port in Halmahera Island

**Figure 1** The map of study location for inter-island trip in North Maluku

Figure 1 show that there are three ports in Ternate Island side, and two ports in Halmahera Island which used by the commuters in across between both islands, Ternate Island and Halmahera Island. In this regard, the commuter’s trips face three crossing modes from Ternate Island to Halmahera Island or the opposite way. The three crossing modes consist of ferry, speedboat, and fast ship. In addition, the commuters have to have additional trip modes for their trip from origin place to across port, and from the across port to destination place. In the side of the origin place to across port in Ternate Island, the commuters have three alternative modes, such as private cars, public transit, and taxi motorcycle. In the other side, for the across port in Halmahera Island to destination place, the commuters have only two alternative modes, such as public transit, and taxi motorcycle.

Regarding the various of the transportation modes which ride by the commuters, the study simply the trip mode chain of the commuters from origin place or home to destination place or office using four alternatives of the trip mode chain. The four trip mode chains are showed in Table 1.

**Table 1** The mode chain trip of the civil servant commuters in North Maluku

Trip mode chain (TMC)	Cross transportation mode	
	Ternate island side (Home – Port)	Halmahera island side (Port – Office)
TMC – 1	Private car	Taxi motorcycle
TMC – 2	Private motorcycle	Taxi motorcycle

TMC – 3	Public transit	Taxi motorcycle
TMC – 4	Taxi motorcycle	Taxi motorcycle

## 2.2. Data Collection

The interview survey was carried out to the civil servant commuters in North Maluku Province, particularly the civil servants which have trip from Ternate Island to Halmahera Island. There were 341 respondents which selected randomly from three across ports in Ternate Island side.

The interview survey utilized a questionnaire sheet which contains questions related to individual characteristics of the respondent, and characteristics of the commuter's travel. The individual characteristics involve sex, age, education, income, car ownership, and driving license. The trip characteristics of the commuters consist of the used mode from origin place to the crossing port, the used crossing mode, total travel distance, total travel cost, and total travel time.

## 2.3. The Construction of the Choice Model for the Trip Mode Chain

The present study has adopted the conditional logit model approach in constructing the choice model phenomenon of the trip mode chain for the commuters which conducted inter-island trip. In this regard, the outcome of the model has four trip mode choices as shown in Table 1, and the exogeneous variables of the model were constraint by two primary attributes of the choices, i.e., travel cost and travel time.

The construction of the choice model for trip mode chain available was formulated as the following equation:

$$P_{TMCi} = \frac{e^{\beta_0 + \beta_1 X_{tci} + b\beta_2 X_{tti}}}{e^{\beta_{0i} + \beta_1 X_{tci} + b\beta_2 X_{tti}} + \dots + e^{\beta_{0n} + \beta_1 X_{tcn} + b\beta_2 X_{ttn}}} \quad (1)$$

Where:  $\beta_0$  is constant for choices  $i$  to  $n$ ;  $\beta_1$  and  $\beta_0$  are parameters of travel cost ( $X_{tci-n}$ ) and travel time ( $X_{tti-n}$ ), respectively; and  $i$  or  $n$  is index of the trip mode choice available.

The estimation method to calculate the parameters values of the model applied the Maximum Likelihood optimizing. In this regard, the study utilized *STATA* software which calculated the conditional logit model.

## 3. THE RESULTS

### 3.1. Individual Characteristics of the Commuters

The individual characteristics of the inter-island commuters in the North Maluku, particularly for Ternate Island – Halmahera Island trip of the civil servants are summarized in Table 2. The individual characteristics involve sex, age, education, income, car ownership, and driving license ownership.

Table 2 show that the civil servant commuters in the North Maluku Province is dominated by male. The major age category of the commuters is 31 – 40 years old category, and 41 – 50 years old category. The commuters have dominant education as undergraduate. Their income is averagely three until four million rupiahs. Majority of the commuter in the province have motorcycle. However, the commuters are dominant having driving license for motorcycle and car.

**Table 2** The individual characteristics of the inter-island commuter

Variables & Attributes		Survey results	
Variables	Parameter	Frequency	Percentage (%)
Sex	Male	207	61
	Female	134	39
Age (Years old)	20 – 30	95	19.6
	31 – 40	160	39.4
	41 – 50	155	37.5
	> 50	20	3.5
Education	Senior High School	78	21.7
	Bachelor	94	28.7
	Undergraduate	152	44.6
	Graduate	17	5
Income per-month (1 x 10 <sup>6</sup> IDR)	< 1.0	0	0
	1.0 – 2.0	73	21.4
	3.0 – 4.0	184	54
	> 4.0	84	24.6
Car ownership	Auto-car	62	18.2
	Motorcycle	237	69.5
	Car & Motorcycle	42	12.3
Driving license	DL-A	117	34.3
	DL-A & DL-C	164	48.1
	DL-C	60	17.6

### 3.2. Inter-island trip characteristics of the commuters

The characteristics of the inter-island trip of the commuters such as travel modes, travel distance, travel time, and travel cost are summarized in Table 3. Table 3 show that private and taxi motorcycle are major travel modes which using by the commuters from their home to the cross port in Ternate Island. Cross mode which become favorite in using by the commuters are speedboat and fast ship. However, the ferry ship has also a large demand. The dominant travel attributes such as travel distance, travel cost, and travel time are 36 – 40 km, 76 – 80 thousand rupiahs, 76 – 80 minutes, respectively.

Furthermore, the attributes of the three cross modes such as ferry, speedboat, and fast ship are presented in Table 4. The speedboat and fast ship have similarity in travel time and travel cost, i.e. 50,000 rupiahs, and 45 minutes, respectively. The other one has travel cost smaller than both travel modes, however, its travel time is larger than both travel modes.

**Table 3** The inter-island trip characteristics of the commuters

Variables & Attributes		Survey results	
Variables	Parameter	Frequency	Percentage (%)
Travel mode from home to port	Private car	43	12.6
	Private motorcycle	123	36
	Public transit	27	8
	Taxi motorcycle	148	43.4
Across mode	Ferry ship	69	20

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	Fast ship	112	33
	Speedboat	160	47
Travel distance (Km)	30 – 35	114	33.5
	36 – 40	139	40.8
	> 40	88	25.7
	<70	6	1.6
Total Travel cost (1 x 10 <sup>3</sup> IDR)	71 – 75	42	12.2
	76 – 80	173	51
	>80	120	35.2
Total travel time (Minutes)	70 – 75	52	15.2
	76 – 80	124	36.5
	81 – 85	103	30.1
	> 85	62	18.2

**Table 4** The inter-island trip characteristics of the commuters

Cross mode	Travel cost (IDR)	Travel time (Minutes)
Ferry	24,000	105
Speed boat	50,000	45
Fast ship	50,000	45

### 3.3. The choice model of trip mode chain on the inter-island trip

The estimation results of the parameters values for the choice model of the trip mode chain of the commuters are presented in Table 5. Table 5 shows that the model has good acceptance level which indicated by Likelihood ratio ( $\rho^2$ ) more than 0,2. In further, the  $P_{value}$  indicators implied that travel time variable was more significant than the travel cost variable in influencing the commuter's choice. In addition, the sign of both variables followed the rational sign which expected.

Table 6 shows the result of validation model, where a set data, around 50% from the number of the survey data which used to develop the model, was selected randomly. The validation result show that the model has validation level averagely around 97% significance level. Overall, the choice model could be utilized in predicting the chosen probability of each trip mode chain.

**Table 5** The estimation results of the choice model parameters

Variables/Parameters		Model estimation results*	
Variables	Parameter	Parameters values	Significant values ( $P_{value}$ )
Constant of TMC-2	$\beta_{TMC-2}$	-2.1321	0.279
Constant of TMC-3	$\beta_{TMC-3}$	-3.1715	0.253
Constant of TMC-4	$\beta_{TMC-4}$	-2.8105	0.245
Travel cost	$\beta_{TC}$	-0.1057	0.212
Travel time	$\beta_{TT}$	-0.0441	0.044
Likelihood ratio	$\rho^2$		0.441
Number of data	$N$		341

\*The based alternative choice is TMC-1

**Table 6** The validation results for the choice model of trip mode chain

Trip mode chain (TMC)	Chosen probability (%)		Validation level (%)	
	Model	Observed	Deviation	Significance Level

TMC – 1	24	22	2	98
TMC – 2	29	34	5	95
TMC – 3	21	16	5	95
TMC – 4	26	28	2	98
The average of the validation level (%)			3	97

Regarding the results, travel time variable becomes important variable which was considered by the commuters in choosing their trip mode chain for the inter-island trip. This phenomenon is in line with the characteristics of the inter-island trip which has transportation multi-mode. The travel cost variable has a small sensitivity for the commuters in choosing their trip mode chain, due to the commuters have allocated monthly transportation cost constantly. In addition, as civil servant, the commuters have considered travel time more premier than the travel cost due to the commuters have to have time discipline in arriving at their origin destination place or office.

#### 4. CONCLUSIONS

The choice behavior of the commuters which have inter-island trip has been explored in this study. Through a case study for the civil servant commuters in North Maluku Province Indonesia, a conditional logit model approach has been applied for the commuter's choice model on the trip mode chain.

The modelling results showed that the set trip mode chain of private motorcycle – crossing mode – taxi motorcycle was largest chosen by the civil servant commuters than the others choices. However, the choice of the private car – crossing mode – taxi motorcycle, and the choice of taxi motorcycle – crossing mode – taxi motorcycle, were a little bit smaller chosen by the commuters than the favorite choice. In addition, the characteristics of the inter-island trip which having multi-mode for the commuter's travel from their home to office lead to the commuters more consider the travel time of the trip mode chain than its travel cost. In other words, the civil servant commuters which conducting inter-island trip from Ternate Island to Halmahera Island in North Maluku, have been influenced significantly by travel time attribute in choosing their trip mode chain.

#### REFERENCES

- [1] Hakim, R., Ramli, M. I., Aly, S. H. and Rahim, R. A Study on The Travel Cost Characteristic of Commuter in Region of Inter-island Cluster in North Maluku province-Indonesia. Proceedings of the 3<sup>rd</sup> International Seminar on Infrastructure Development (ISID), Makassar. 2016.
- [2] Nur, K. N., Samang, L., Ramli, M. I. and Aly, S. H. Study of Modes Transformation Preferences of Private Transport Based on Travel Characteristics and user Behavior. International Journal of Applied Engineering Research 11, (22), 2016, pp. 10766-10771.
- [3] Ramli, M.I., Oeda, Y., Sumi, T. and Matsunaga, C. Accommodating Flexible Daily Temporal Constraint on a Continuous Choice Model of Departure Time for Urban DoppingTravel, International Journal of Urban Sciences, 15(3), 2011, pp. 215-233.
- [4] Ramli, M.I., Oeda, Y., Sumi, T. and Matsunaga, C. A Simultaneous Choice Model of Departure Time and Travel Mode on One-Day Shopping Travel Based on Disutility Minimizing Model Approach. Proceeding of the Eastern Asia Society for Transportation Studies, Vol. 9, 2013.
- [5] Ramli, M.I., Oeda, Y. and Sumi, T. Study on Mode Choice Model of Trip for Daily Household Logistic Based on Binomial Logit Model, Proceeding of T-LOG Conference, 2010.

A Choice Model on Trip Mode Chain for Inter-Islands Commuters in North Molucca-Indonesia: A Case Study of the Ternate Island – Halmahera Island Trip

- [6] Oeda, Y., Asada, K. and Sumi, T. The Study on Daily Combined Activities of Regular Medical Treatment and Shopping for People Who Live in Depopulated Area, *Procedia - Social and Behavioral Sciences* 43, 2012, pp. 277-283.
- [7] Dr.S.Ramachandran and S.Aravindan An Analysis of Traffic, Transportation And Operations of Nargolport, India–A Case Study. *International Journal of Civil Engineering and Technology*, 8(6), 2017, pp. 465–476.
- [8] A. Asokan and Dr. N. Balasundaram, Development of Sustainable Urban Transport Strategies for Salem City. *International Journal of Civil Engineering and Technology*, 8(1), 2017, pp. 519–531.
- [9] Debalina Banerjee, P. Jagadeesh and Ramamohan Rao.P, Risk Analysis and Decision Support in Transportation Megaprojects, *International Journal of Civil Engineering and Technology*, 8(7), 2017, pp. 836–845.