

# Passenger's choice in responding to inter-city railway operation for Makassar - Parepare line: a conditional logit model based on stated preference method

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## Passenger's choice in responding to inter-city railway operation for Makassar – Parepare line: a conditional logit model based on stated preference method

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**Abstract.** The present paper aims to model the passenger's choice in responding to the inter-city railway operation for Makassar-Parepare line. The railway line is the first railway track in Eastern Part of Indonesia, and it is still under construction. In this regard, the study attempted to construct the passenger's preferences through a conditional logit model approach based on the stated preference method. The study considered some main attributes of transport mode services, i.e., travel cost, travel time, and frequency. In further, the study also taking account into the model two additional attributes of the mode, i.e., transfer travel time and transfer travel cost. The data collection of the study carried out an interview method using questionnaire sheet based the stated preference method. The study experimented with varying the level of service for the main attributes of the two available travel modes, i.e., railway and private car modes. The study results showed that passengers prefer to choose one of both travel modes when the mode has travel time faster than the other one, as well as for the lower travel cost. In addition, the inter-city travelers more considered the transfer travel cost attribute than the transfer travel time attribute, when they face both travel mode choice, the new railway mode, and the existing private car mode.

### 1. Introduction

In recent years, Indonesia Ministry of Transportation has been constructing a new railway track in South Sulawesi Province, as the first railway infrastructure in Eastern Part of Indonesia [1]. For the first stage, the central government constructs the railway track in Makassar City to Parepare City, namely Makassar – Parepare line [1]. The infrastructure project is significant to improve travel demand management in the region. In his regard, the transportation demand management has travel choices and links as the derived problem [2]. For example, in Malaysia, many people still use their cars at the beginning [3], as well as at Ohio State, USA [2].

To explore the problem, at least there two are factors which play an essential role, i.e., the characteristics of the inter-city travel, and the characteristics of the travel using railway mode. In this view, some previous studies have elaborated the characteristic of the inter-city travel such as in Libya



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[4, 5], in China [6, 7], and Great Britain [8]. Related to characteristics of the inter-city travel which utilize a railway mode, there are previous studies which focus on London-Paris line [9], and on Beijing – Guangzhou line [10]. Besides, psychological factors and specific attitudes also influence on the inter-city travel behavior [11-14], as well as the socioeconomic characteristics, land use, and travel time [15].

Furthermore, there were some previous studies which focused on the model development on estimating the inter-city travel demand. Majority of the previous studies applied multidimensional system and modeling such as some variation of the logit models [16-20]. Further, structural equation modeling was also applied [21]. Focused on inter-city travel by using railway mode, some previous studies have a concern about the travel mode choice [22-24]. In a case study for the choice problem of the traveler or passengers of the inter-city travel on Makassar – Parepare line, the travelers have two choice modes, i.e., the new railway mode, and the private car mode. This case is similar to traveler's problem in Kuala Lumpur [25].

Regarding the inter-city problem for operating the new railway mode in Makassar – Parepare line, the present study aims to model the passenger's choice in responding to the inter-city railway operation for the line. The study attempted to construct the passenger's preferences through a conditional logit model approach based on the stated preference method. In particular, this study provides the methodology in developing and calculating a stated preference method for determining the significant variables influencing the mode choice behavior model.

## 2. Methodology

### 2.1. The study location

The study located in Parepare City, the second biggest city in South Sulawesi Province, after Makassar City. The main reason to select the citizen of the city to become the respondent target of this study is due to the city is the final terminal for the first stage construction of the new railway mode in the province. Indonesia government has planned to operate a new railway mode in South Sulawesi Province as the first railway operation in the eastern part of Indonesia. In the first stage, the government has been constructing railway track for Makassar – Parepare line. The railway line has track length of about 142 kilometers, and through three regency area, i.e., Maros, Pangkep, and Barru regencies [1]. Figure 1 shows the map of the railway line.



**Figure 1.** The route of the railway track for Makassar – Parepare line [1].

## 2.2. Data collection

The study carried out the data collection through an interview survey using a questionnaire sheet. We randomly selected respondent participants of Parepare City citizens who are already have traveled for Makassar – Parepare line using private cars. Two hundred fifty respondents participated in the survey. The questionnaire in this study involves two categories of questions, i.e., socio-demography characteristics, and the travel attributes of the respondents. The socio-demography characteristics of the respondents include age, family size, occupation field, education, and income. Table 1 presents the categories of each character.

**Table 1.** The traveler's characteristics and their categories.

Socio-Demography Characteristics	Categories of the characteristics		
Age (Years old)	a. 18-23	b. 24-29	c. 30-35
	d. 36-41	e. 42-47	f. 48-53
	g. 54-59	h. 60-65	i. 66-71
Family Size (Person)	a. 1	b. 2	c. 3
	d. 4	e. 5	f. 6
	g. > 6		
Occupation Field	a. Industry/Manufacture	b. Construction	
	c. Communication/Transportation	d. Bank/Finance/Insurance	
	e. Business	f. Electrical/Gas/Water	
	g. Central Government	h. Local Government	
	i. Service Industry	j. Military/Police	
	k. Teacher/Lecturer	l. Others	
Education	a. Elementary School	b. Junior High School	
	c. Senior High School	d. Diploma (D3)	
	e. Bachelor	f. Master/Doctor	
Income (IDR)	a. < 2,000,000	b. 2,000,001- 3,000,000	
	c. 3,000,001 – 5,000,000	d. 5,000,001- 7,500,000	
	e. 7,500,001- 10,000,000	f. 10,000,001 – 15,000,000	
	g. > 15,000,000		

In the second category, the study considers three main attributes of inter-city travel commonly, i.e., travel time, travel cost, and trip frequency. Due to the study focused on the traveler's preference when a new railway mode operated, we added two additional attributes, i.e., transfer cost, and transfer travel time from origin place to railway station, or on the contrary. All attributes will become the main variables considered in the experiment choice situation based on the stated preference method. The next subsection will present this experiment choice situation.

## 2.3. The model's variables, and choice experiment situation

Regarding the primary purpose of this study, we attempted to generate some choice situation or scenarios based on the stated preference method [26]. By applying the five attributes as the variables in a conditional logit model approach, the study developed eight choice scenarios through varied the values of the variables. Table 2 provides eight experimental choice situations.

## 2.4. The model construction and the calculation method

The study adopted the random utility maximization approach in constructing and calculating the parameters of the individual preference [27-30]. In this regard, a conditional logit model of choice

probability was applied. The concept assumes that a decision-maker which has a set alternative to be chosen, obtain a certain level of utility from each alternative. Then, the individual decides to choose the alternative that has the highest utility. In the context of mode choice in travel behavior, the utility of each alternative is decomposed as follows [29, 30]:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{1}$$

Where:

- $V_{nj}$  is observed aspect as the deterministic portion, and
- $\varepsilon_{nj}$  is unobserved aspect as a stochastic portion.

**Table 2.** The experimental choice situation of the mode travel choice model.

Choice Condition Scenarios	Travel Cost/Fare (IDR)		Travel time (Hours)		Trip Frequency (Times/Hours)		Transfer cost (IDR)		Travel time from origin place to the railway station (minutes)	
	Railway Mode	Private Car	Railway Mode	Private Car	Railway Mode	Private Car	Railway Mode	Private Car	Railway Mode	Private Car
A	100,000	150,000	2	3	4	Every time	0	0	45	0
B	100,000	150,000	2	3	2	Every time	50,000	0	45	0
C	100,000	150,000	3.5	3	4	Every time	50,000	0	20	0
D	100,000	150,000	3.5	3	2	Every time	0	0	20	0
E	175,000	150,000	2	3	4	Every time	50,000	0	20	0
F	175,000	150,000	2	3	2	Every time	0	0	20	0
G	175,000	150,000	3.5	3	4	Every time	0	0	45	0
H	175,000	150,000	3.5	3	2	Every time	50,000	0	45	0

Therefore, the probability that decision-maker  $n$  chooses alternative  $i$  is stated below [29, 30]:

$$P_{ni} = \frac{e^{-V_{ni}}}{\sum_j e^{-V_{nj}}} \tag{2}$$

The logit probabilities become:

$$P_{ni} = \frac{e^{-\beta_1 x_{ni} + \beta_0}}{\sum_j e^{-\beta_1 x_{nj} + \beta_0}} \tag{3}$$

Where:

- $x_{nj}$  is a vector of observed variables that represent attributes relevant to the  $j^{th}$  travel mode.
- $\beta_1$  is the parameter of  $x_{nj}$  that should be estimated, and
- $\beta_0$  is a specific constant of the model for mode  $j$ .

Due to the experimental of the choice condition of the inter-city travel passengers by using stated preference method, this study only considered the attributes of the public transport mode in constructing the travel mode choice model of the passenger's preference. Then, the study applied a conditional logit model for the choice model construct in case travelers have two choice modes, the new railway mode, and auto cars as the existing mode. In this regard, we generated two choice models, model-1 and model-2, which considered the three main attributes, and the five main attributes, respectively, from table 1. The three main attributes for Model-1 involves travel time ( $x_1$ ), travel cost ( $x_2$ ), and service frequency ( $x_3$ ) of the travel mode. We extended model-1 to generate Model-2 through added both additional

attributes, additional travel time ( $x_4$ ), and additional travel cost ( $x_5$ ). Therefore, the hypothetical model of Model-1 and Model-2 by applying equation (3) is expressed in equation (4) and equation (5) as follows, respectively.

Table 3. The respondent's characteristics.

Variables	Categories	Frequency	Percentage (%)
Age (Years old)	18-23	29	11.6
	24-29	24	9.6
	30-35	48	19.2
	36-41	56	22.4
	42-47	44	17.6
	48-53	28	11.2
	54-59	11	4.4
	60-65	6	2.4
	66-71	4	1.6
Family Size (Person)	1	4	1.6
	2	23	9.2
	3	50	20
	4	67	26.8
	5	69	27.6
	6	21	8.4
	> 6	16	6.4
Occupation Field	Industry/Manufacture	10	4
	Construction	10	4
	Communication/Transportation	3	1.2
	Bank/Finance/Insurance	13	5.2
	Business	42	16.8
	Electrical/Gas/Water	2	0.8
	Central Government	4	1.6
	Local Government	114	45.6
	Service Industry	7	2.8
	Military/Police	5	2
	Teacher/Lecturer	14	5.6
21 Others	26	10.4	
Education	Elementary School	1	0.4
	Junior High School	2	0.8
	Senior High School	59	23.6
	Diploma (D3)	9	3.6
	Bachelor (S1)	154	61.6
	Master/Doctor (S2/S3)	25	10
Income (IDR)	< 2,000,000	22	8.8
	2,000,001- 3,000,000	39	15.6
	3,000,001 – 5,000,000	93	37.2
	5,000,001- 7,500,000	62	24.8
	7,500,001- 10,000,000	24	9.6
	10,000,001 – 15,000,000	7	2.8
> 15,000,000	3	1.2	

$$P_i = \frac{e^{-\beta_1 x_{1i} - \beta_2 x_{2i} - \beta_3 x_{3i} + \beta_0}}{e^{-\beta_1 x_{1i} - \beta_2 x_{2i} - \beta_3 x_{3i} + \beta_0} + e^{-\beta_1 x_{1j} - \beta_2 x_{2j} - \beta_3 x_{3j} + \beta_0}} \quad (4)$$

$$P_i = \frac{e^{-\beta_1 x_{1i} - \beta_2 x_{2i} - \beta_3 x_{3i} - \beta_4 x_{4i} - \beta_5 x_{5i} + \beta_0}}{e^{-\beta_1 x_{1i} - \beta_2 x_{2i} - \beta_3 x_{3i} - \beta_4 x_{4i} - \beta_5 x_{5i} + \beta_0} + e^{-\beta_1 x_{1j} - \beta_2 x_{2j} - \beta_3 x_{3j} - \beta_4 x_{4j} - \beta_5 x_{5j} + \beta_0}} \quad (5)$$

In calculating the values of the parameters of both conditional logit models, we utilized *STATA 12.0*, an econometric package tool which suitable for calculating parameters of a discrete choice model.

### 18 3. Results and discussion

#### 3.1. The characteristics of the respondents

Table 3 presents the result of the data compilation from the interview survey. The table shows that the respondents have age on the work age level, from twenty-four until fifty-three years old. However, there is a significant portion of the respondents who have age around eighteen until twenty-three years old. In further, table 3 shows that the respondents are dominant, having three until five persons for their family size. For occupation filed, a large portion of the respondents has an occupation as staff of the local government and a businessman. As well as, the respondents have dominant education from senior high school until bachelor degree. Also, majority of the respondents have monthly income around three million rupiahs until seven point five million rupiahs.

#### 20 3.2. The calculation results of the model's parameters

Regarding the calculation results of the model's parameters using STATA, an econometric tool which suitable for a discrete choice model, we got the results as shown in table 2, and table 3 for the result of the first scenario model (Model-1), and the second scenario model (Model-2), respectively.

Table 4. The calculation results of Model-1.

Variables	Coef.	P(Value)
Travel cost	-0.0304	0.000
Travel time	-0.7886	0.000
Frequency	0.2395	0.000
Number of obs		3,086
Pseudo R <sup>2</sup>		0.2606

Table 5. The calculation results of Model-2.

Variables	Coef.	P(Value)
Travel cost	-0.0320	0.000
Travel time	-0.9064	0.000
Frequency	0.1236	0.000
Transfer Travel time	-0.0060	0.186
Transfer travel cost	-0.0170	0.000
Number of obs		3,086
Pseudo R <sup>2</sup>		0.2865

Table 2 shows that generally, the calculation of model-1 has excellent performance, as shown by the likelihood ratio around 0.2606. This value is available in the range 0.2 until 0.4 which indicated that the model calculation result has accepted. In further, the values of the parameters of model-1 has achieved

a significant level, which indicated by P(value) of all parameters more than 0.05. Also, the sign of the three attributes of the mode is inline with the expected sign.

Table 3 shows that the likelihood ratio of the model-2 is around 0.2865, which indicated the model calculation generally has excellent performance. As similar to model-1 results, the ratio also is in the range 0.2 until 0.4 which mean the model has accepted. Furthermore, the model's parameters have values smaller than 0.05, which indicated a significant level of achievement. Briefly, the parameter's sign of the five attributes are in line with the expected sign.

Model-1 which only consider three main attributes taking account into the model calculation indicated that travel time, travel cost, and the service frequency had played the critical role for the preference of the inter-city travel in choosing the new railway mode and the passenger car mode. These results are suitable for all previous study results in the field research area [13, 14]. The phenomena are also correspondence to our habit commonly when facing the inter-city travel situation.

Furthermore, the choice experiment results model-2 showed that the inter-city travel passengers have a little bit different in responding to the additional travel cost and the additional travel time for travel mode choice. In this regard, the passenger more calculates the additional travel cost than the additional travel time. The phenomenon is in line with the collective behavior of the passengers for inter-city travel condition.

#### 4. Conclusion

The present study has elaborated the inter-city travel passengers' preference when the passenger will face a new railway mode implementation shortly. Through a case study for railway operation plan in Makassar – Parepare line, the study has analyzed some main attributes of both available modes, railway mode as a new mode, and the passenger car as the existing mode in the line. By applying the stated preference survey and conditional logit model, we have found that the passengers have significantly considered travel time, travel cost, and frequency of the travel modes. However, the passengers have more prefer the additional travel cost than the additional travel time for travel from their origin place to the station of the travel mode. These results provide a look forward for the development of seamless connectivity for multi-mode transport in the operation plan of the new railway mode in Makassar – Parepare line.

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