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Model of Mode Selection Analysis at Pontianak – Ketapang Route with Stated Preference Method

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Abstract

There are various reasons and considerations underlying travellers in choosing a mode of transportation. The diversity of transportation mode is an essential factor for transportation business actors in competing to provide a choice of transportation modes that are very popular or no longer in demand for use by travellers traveling from one city to another. Currently, the most frequently used mode of transportation on the Pontianak - Ketapang city route or vice versa is airplane transportation or travel, and this is because both modes of vehicle arrive in the city of Ketapang without transiting in other towns or regions. This study aims to determine the factors that influence the choice of transportation mode and obtain the probability of airplane and travel passengers.

This research is conducted with a stated preference method by distributing questionnaires to people traveling from the Pontianak - Ketapang city route using airplanes and travel modes. For the survey, data is collected using a questionnaire distributed to 420 respondents through Google form using four attributes, namely cost, time, headway, and service. Based on the analysis results for calculating transportation mode choice with the stated preference method, a utility model is obtained as follows: $U(PT\text{-}TR) = 0.291 + -2.883E\text{-}6.\Delta x_1 + -0.226.\Delta x_2 + 0.218.\Delta x_3 + 0.023.\Delta x_4$ with an airplane probability of 55.92%, while the travel probability is 44.08%. The most sensitive attribute affecting the choice of transportation mode is the time attribute. It is because changes in travel time will result in a relatively greater probability of mode choice when compared to changes in cost, headway, and service attributes.

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1. Introduction

Transportation is an activity that involves the movement of passengers and goods from one place to another (Putri et al., 2016). transportation has elements of movement consisting of several components, such as passengers, goods, facilities, and infrastructure (Haradongan, 2014). The role of transportation is significant in the process of development and infrastructure development of a region (Rahmad et al., 2017). A comprehensive, efficient, and effective transportation system is formed through good and ideal interactions between these components (SITINJAK & SITINDAON, 2019). In addition, selecting transportation routes is also essential according to individual needs in traveling. Transportation routes include trade, educational, health, and worship facilities (Rahmalia et al., 2020). Good route selection can comfort passengers, reduce pollution, and save fuel (Sodikin et al., 2018). Transportation services are outputs from transportation companies with various types, such as shipping services, train services, airline

services, bus transportation services, and others (Levyda, 2021). According to (Ketapang, 2021), a population of 579,927 spread across 20 districts, 9 urban villages, and 253 villages. From this data, Ketapang has the sixth largest population in West Kalimantan. At this time, transportation trips between Pontianak and Ketapang have several advantages in terms of time, travel rates, and facilities provided. Air transportation, for example, offers a fast travel process and maximum service. Travel time by airplane ranges from 30-45 minutes, but the fare is quite expensive for the Ketapang – Pontianak route. One of the reasons is the lack of airlines that provide flights to and from Pontianak - Ketapang, causing a price monopoly by air transportation service providers. An alternative road trip can be made using travel, which offers a more affordable price but takes about 10 hours. This study aims to determine the factors that influence the choice of transportation mode and obtain the probability of airplane and travel passengers. The benefit of this study is to provide references and recommendations to readers who want to travel from Pontianak to Ketapang in choosing transportation modes by the factors and priorities that have been explained. This research can also be a reference in analysing the selection of transportation modes for the Pontianak - Ketapang route. For fellow students, this research can be used as an additional reference in compiling final projects or lecture materials related to analysing transportation mode selection.

2. Materials and Methods

2.1 Theoretical Frame Work

The choice of transportation mode is an essential stage in transportation planning that aims to determine the distribution of trips or the proportion of the number of passengers and goods that will choose the various types of transportation available to serve a particular route. This selection aimed to meet specific travel needs (SETIJOWARNO; DJOKO; FRAZILA; RUSS BONA, 2003). Public transport, also known as public transport, is a mode of transportation that serves many people with common interests. This public transportation has the same destination and end point and is bound by route rules and schedules that have been set. Public transport users are expected to abide by these rules, according to research conducted by (Muntsari et al., 2021)

2.2 Research Location

The location to be studied is the route between Pontianak City to Ketapang City using the preferred mode of transportation (airplane and travel)

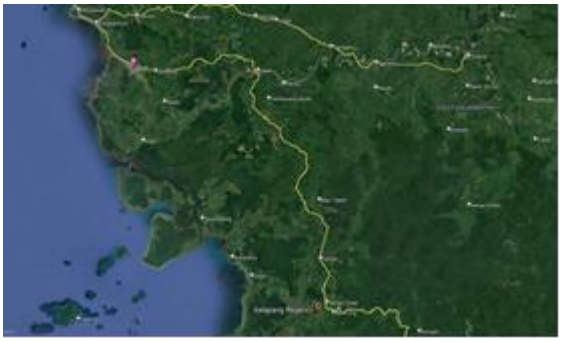


Figure 1. Research Location

2.3 Data

The data needed in this study includes two types of data, which are primary and secondary. Primary data collection will be carried out by distributing questionnaires online. These data have the Number of respondents/samples, Characteristics of transportation users, and Characteristics of transportation selection. In this study, secondary data collection will be carried out through literature studies. Namely, this data will be obtained through official requests from related agencies relevant to the research topic. These data include travel expenses, departure time, and transport characteristics.

2.4 Analysis Method

- **Stated Preference Method**

The stated preference technique is a method that involves approaching respondents to get their responses to different situations or alternatives. This technique may include giving respondents new or alternative options that do not yet exist under current conditions. Using this technique, researchers can collect data on respondents' preferences and assessments of possible alternatives (Ridwan et al., 2018).

The general formula of utility functions is linear, as follows:

$$U_i = a_0 + a_1.x_1 + a_2.x_2 + ... + a_n.x_n$$

U_i is mode choice utility. X_n is mode attribute value. a_n is coefficient. a_0 is constant.

- **Estimation of Stated Preference Parameters**

Regression techniques are often used in transport modelling, including in Stated Preference analysis. Using regression techniques, researchers can identify the most influential attributes and measure the strength of the relationship between these attributes and individual responses expressed in the form of the following equation:

$$y = a + b_1x_1 + b_2x_2 + ... + b_nx_n$$

- **Binomial Logit Method**

In the Mode choice model, the binomial logit method is used. In this method, decision-

making is faced with a pair of discrete alternatives, where the option to be chosen is the one with the most excellent utility; utility, in this case, is seen as a random variable (Septianto et al., 2017). The utility model used for the equation of 4 variables in this study is:

$$U_i=a_0+a_1(\Delta_{cost})+a_2(\Delta_{time})+a_3(\Delta_{headway})+a_4(\Delta_{service})$$

With the probability of choosing an airplane mode is:

$$P_{PT}=\frac{\exp^{U_{PT}}}{\exp^{U_{PT}}+\exp^{U_{TR}}}=\frac{\exp^{(U_{PT}-U_{TR})}}{1+\exp^{(U_{PT}-U_{TR})}}$$

The probability of choosing a mode of travel transportation is:

$$P_{TR}=1-P_{PT}=\frac{1}{1+\exp^{(U_{PT}-U_{TR})}}$$

P_{PT} is probability of airplane mode choice. P_{TR} is probability of travel mode choice. U_{PT} is utility of airplane mode choice. U_{TR} is utility of travel mode choice.

- **Elasticity of Mode Selection**

Capital choice elasticity is a concept used in the analysis of transportation mode choice to measure the sensitivity or responsiveness of mode choice to changes in attributes that affect decision-making (Sugiyanto et al., 2009). The analysis of mode choice models may also emphasize the sensitivity of mode choice to some of the service attributes of the mode (Kanafani, 1983).

3. Result and Discussion

3.1 Survey Implementation and Data Collection

This survey is conducted for 29 calendar days, from January 30, 2023, to March 1, 2023, among 420 respondents. This data is collected on respondents who travelled from Pontianak City to Ketapang City or vice versa and used Airplane mode or Travel. The survey is conducted by distributing questionnaires online through Google form links distributed through several social media, such as WhatsApp and Instagram. When running a survey, respondents were asked in advance about their willingness to take the time to be able to fill out a questionnaire containing several questions about Travel that had been done using one mode or both mode offered. Of the 420 respondents disseminated through the Google form, 374 answers were obtained that can be continued for data processing, and the remaining 46 answers were declared ineligible.

3.2 Presentation of Survey Results

Respondents in this survey are people who use airplane and travel transportation modes. Based on the results of the survey that has been conducted, respondents who often use airplane transportation have as many as 178 respondents, while respondents who often use Travel have as many as 196 respondents.

Tabel 1. Distribution of Transportation Used Types by User Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Type of Transportation Used	Airplane	178	100	0	0
	Travel	0	0	196	100
	Sum	178	100	196	100

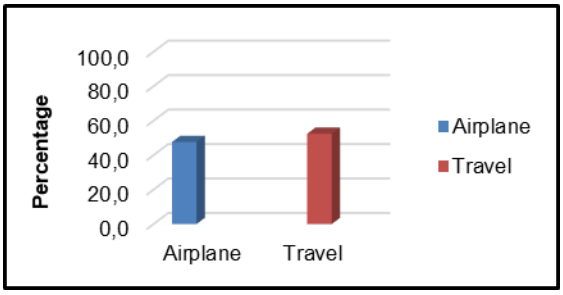


Figure 2. Distribution Diagram of The Type of Transportation Used by The Respondent

- **Gender of The Traveler**

Based on gender, it can be seen that airplane users are more male, which is around 53.9% of 178 respondents. As for travel users, more are female, approximately 53.6% of 196 respondents.

Table 2. Gender Distribution of Transportation User Respondent

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Gender	Man	95	53,4	91	46,4
	Woman	83	46,6	105	53,6
	Sum	178	100	196	100

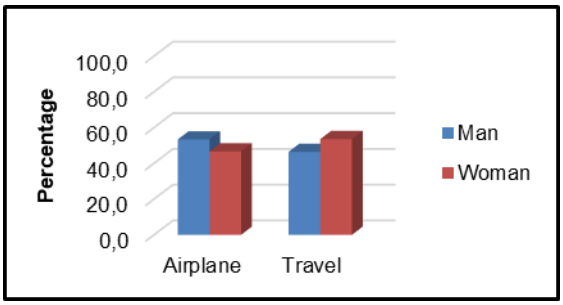


Figure 3. Gender Distribution Diagram of Transport User Respondent

- **Age**

The respondents with age group of 25-40 years are the most airplane passenger, which are 42.1% of 178 respondents. The most travel users are the respondents with age of 17-25 years, which are 60.7% of 196 respondents.

Table 3. Age Distribution of Transportation User from Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Age	17 - 25 Years	52	29,2	119	60,7
	25 - 40 Years	75	42,1	45	23,0
	40 - 58 Years	44	24,7	30	15,3
	> 58 Years	7	3,9	2	1,0
Sum		**178**	**100**	**196**	**100**

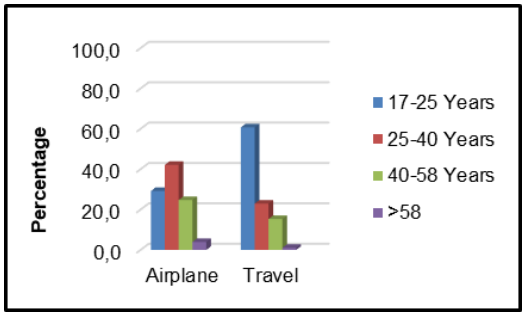


Figure 4. Age Distribution Diagram of Transportation User from Respondents

- **Job**

Based on the job, it is evident that respondents who use airplane transportation are predominantly classified as civil servants, accounting for approximately 26.4% of the 178 respondents. Meanwhile, those who use other modes of travel are mainly categorized as Students, constituting around 51.0% of the 196 respondents.

Table 4. Job Distribution of Transportation User From Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Job	Civil Servant	47	26,4	16	8,2
	Private Employees	35	19,7	22	11,2
	Businessman	27	15,2	4	2,0
	Student	46	25,8	100	51,0
	Housewives	7	3,9	21	10,7
	Other	16	9,0	33	16,8
Sum		**178**	**100**	**196**	**100**

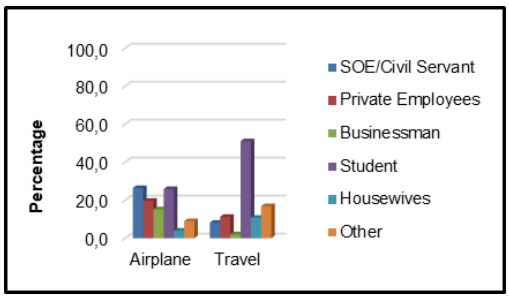


Figure 5. Job Distribution Diagram of Transportation User from Respondents

- **Average Salary**

From the respondent survey, airplane user earn more than Rp. 4,500,000, which is 64.6% of 178 respondents. Meanwhile travel user salary has less than Rp. 1,500,000 of income value, which is around 50% of 196 respondents.

Table 5. Average Salary Distribution of Transportation User from Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Average Salary	< Rp. 1,500,000	18	10,1	98	50
	Rp. 1,500,000 - Rp. 3,000,000	17	9,6	51	26
	Rp. 3,000,000 - Rp. 4,000,000	28	15,7	27	13,8
	> Rp. 4,500,000	115	64,6	20	10,2
Sum		**178**	**100**	**196**	**100**

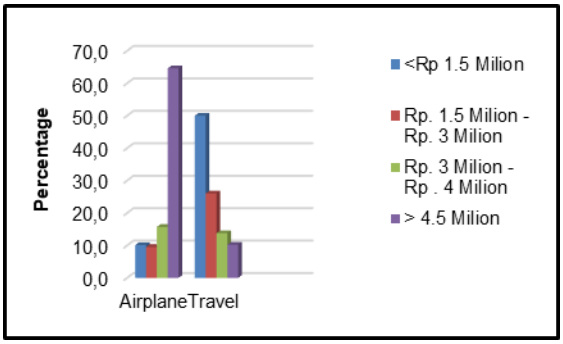


Figure 7. Average Salary Distribution Diagram of Transportation User from Respondents

- **Frequency of Travel in Every Month**

Based on the monthly travel frequency data from respondents for each transportation option, namely airplane transportation and other uncertain choices, it is observed that 63.5% of respondents opt for air travel, while 84.2% choose uncertain options. This implies that individuals do not frequently or rarely travel between Pontianak City and Ketapang City every month.

Table 6. Distribution of Travel Frequency in Every Month from User Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
The Number of Trips Each Month	1 - 2 Times	33	18,5	28	14,3
	3 - 4 Times	32	18,0	3	1,5
	Indefinite	113	63,5	165	84,2
Sum		**178**	**100**	**196**	**100**

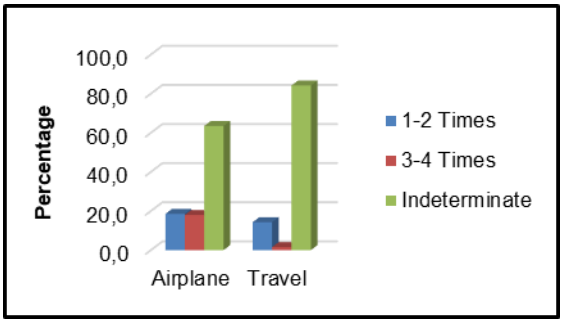


Figure 8. Distribution Chart of Total Trips in Each Month from Transportation User Respondents

- **Travel Purposes**

The purposes of trips consist of business or work, education, vacation, and other. The airplane user has more significant passengers for business or work with 178 respondents or 41.6%, but 41.3% of 196 respondents use travel for other destination.

Table 7. Travel Purposes Distribution of Transportation User from Respondents

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Travel Purposes	Business/Job	74	41,6	17	8,7
	Education	35	19,7	64	32,7
	Tour	35	19,7	34	17,3
	Other	34	19,1	81	41,3
Sum		**178**	**100**	**196**	**100**

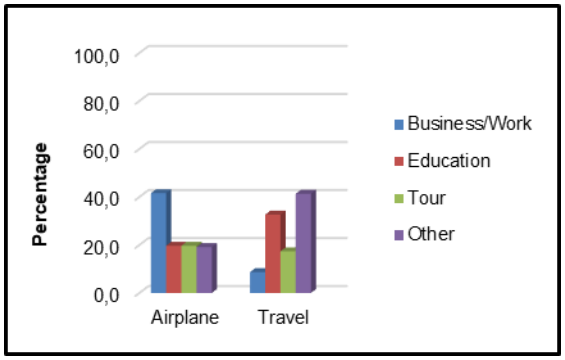


Figure 9. Distribution Chart of Travel Purposes from Transportation User Respondents

- **Background of Mode Selection for Transportation**

Several backgrounds can impact choosing a mode of transportation. Some users have their considerations to pick a mode. It contains the quickness of transportation, safety and security, comfort, amenity, and price.

Table 8. Background Distribution of Mode Selection for Transportation User

Characteristics of Respondents	Options	Airplane		Travel	
		Sum	Percentage	Sum	Percentage
Background of Choosing a Mode for Transportation	The Quickness	119	66,9	0	0,0
	Safety & Security	11	6,2	7	3,6
	Comfort	23	12,9	6	3,1
	Amenity	22	12,4	19	9,7
	Price	3	1,7	164	83,7
Sum		**178**	**100**	**196**	**100**

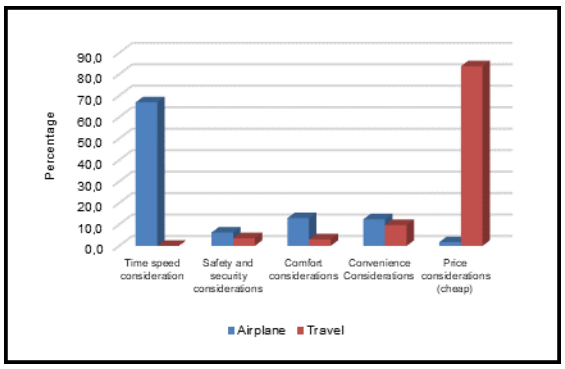


Figure 10. Distribution Chart of Background in Mode Selection for Transportation User

3.3 Stated Preference Analysis

In the questionnaire used in mode selection with stated preference method, respondents consisting of Airplane and Travel passengers are given a questionnaire containing five scales of choice in mode selection. The explanation of the scale of choice given to respondents is as follows:

Option 1 : Definitely Choose an Airplane

Option 2 : Maybe Choose an Airplane

Option 3 : Balanced Choice

Option 4 : Maybe Choose Travel

Option 5 : Definitely Choose Travel

In this research, 4 meanings of choices were given that would be used in choosing a mode. The first attribute (ΔX_1) is the difference in travel costs (cost), the second attribute (ΔX_2) is the difference in travel time (time), the third (ΔX_3) is the difference in departure frequency (headway), and the fourth attribute (ΔX_4) is the service provided (service). The following is the distribution of respondents' answers to changes in attributes and options provided.

3.4 Linear Regression Analysis of Utility Difference Function Mode Choice

In this study, the analysis used to obtain the utility modal of mode choice is linear regression analysis. Research with a regression approach was carried out for stated preference data where respondents made their choices using a rating technique with a 5-point semantic scale, namely 1). Choose an airplane, 2). Choose an aircraft 3). Not choosing (balanced), 4). Choose travel, 5). Choose travel.

Attributes are defined as Differences between airplane transportation and travel. The options mentioned above are based on responses based on ratings where respondents are asked to indicate their degree of preference. This semantic scale is then transformed into a numerical scale (a value that expresses an individual's response to a choice statement) using linear transformations of the binary logit modal on the probability for each rating point. The numerical scale value is a Dependent Variable in regression analysis and, as an independent variable, is the difference in the value of each airplane and travel attribute.

3.5 T-Test

T-Test is carried out to find out the difference between two variables. It compares the value of t-critical and t-stat. The determination of t-critical values in hypothesis testing of regression coefficients is determined using regular distribution tables by taking into account the level of significance (α) and degree of freedom (V) = n - (k + 1), with n = number of observations and k = number of attributes.

This analysis uses 5% of the significance level value with several data, which are 374 observations, 4 attributes and ± 1,960 of critical value. If the value of t-stat > t-critical, then there is an influence of variable X on variable Y, so by considering the importance of t-stat in Table 9, It is concluded that all attributes, namely COST, TIME, HEADWAY, and SERVICE in alternative 14 have t-stat values > t-critical values which means that all details individually significantly affect the utility of mode selection.

Table 9. T-Distribution Value

dk	one tail test					
	0,25	0,10	0,05	0.025	0,01	0.005
	two tail test					
	0,50	0,20	0,10	0,005	0,02	0,01
1	1.000	3.078	6.314	12.706	31.821	63.657
2	0.816	1.886	2.920	4.303	6.965	9.925
3	0.765	1.638	2.353	3.182	4.541	5.841
4	0.741	1.533	2.132	2.776	3.747	4.604
5	0,727	1.476	2.015	2.571	3.365	4.032
6	0.718	1.440	1.943	2.447	3.143	3.707
7	0.711	1.415	1.895	2.365	2.998	3.499
8	0.706	1.397	1.860	2.306	2.896	3.355
9	0.703	1.383	1.833	2.262	2.821	3.250
10	0.700	1.372	1.812	2.228	2.764	3.169
11	0.697	1.363	1.796	2.201	2.718	3.106
12	0.695	1.356	1.782	2.179	2.681	3.055
13	0.692	1.350	1.771	2, 160	2.650	3.012
14	0.691	1.345	1.761	2.145	2.624	2.977
15	0.690	1.341	1.753	2, 131	2.602	2.947
16	0.689	1.337	1.746	2, 120	2.583	2.921
17	0.688	1.333	1.740	2.110	2.567	2.898
18	0.688	1.330	1.734	2, 101	2.552	2.878
19	0.687	1.328	1.729	2.093	2.539	2.861
20	0.687	1.325	1.725	2.086	2.528	2.845
21	0.686	1.323	1.721	2.080	2.518	2.831
22	0.686	1.321	1.717	2.074	2.508	2.819
23	0.685	1.319	1.714	2.069	2.500	2.807
24	0.685	1.318	1.711	2.064	2.492	2.797
25	0.684	1.316	1.708	2.060	2.485	2.787
26	0.684	1.315	1.706	2.056	2.479	2.779
27	0.684	1.314	1.703	2.052	2.473	2.771
28	0.683	1.313	1.701	2.048	2.467	2.763
29	0.683	1.311	1.699	2.045	2.462	2.756
30	0.683	1.310	1.697	2.042	2.457	2.750
40	0.681	1.303	1.684	2.021	2.423	2.704
60	0.679	1.296	1.671	2.000	2.390	2.660
120	0.677	1.289	1.658	1.980	2.358	2.617
∞	0.674	1.282	1.645	1.960	2.326	2.576

3.6 F-Test

Establishing t-critical values for hypothesis testing regression coefficients involves referencing regular distribution tables. It is done by considering both the significance level (α) and the degrees of freedom (V), which is calculated as the difference between the number of observations (n) and the number of attributes (k).

The test uses same significance level, and number of observations and attributes with T-Test. The value of F-Critical is obtained ± 2,370. From Table 10, it can be seen that the F-stat value of the modal in alternative 14 is more significant than F-critical (127.025 > 2.370), so all attributes, if tested simultaneously, will affect the choice of mode of people who usually travel from the Pontianak City – Ketapang City route.

Table 10. F-Distribution Value

	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253
2	18,5	19,0	19,2	19,2	19,3	19,3	19,4	19,4	19,4	19,4	19,4	19,4	19,4	19,5	19,5	19,5	19,5	19,5
3	10,1	9,55	9,28	9,12	9,01	8,94	8,89	8,85	8,81	8,79	8,74	8,70	8,66	8,64	8,62	8,59	8,57	8,55
4	7,71	6,94	6,59	6,39	6,26	6,16	6,09	6,04	6,00	5,96	5,91	5,86	5,80	5,77	5,75	5,72	5,69	5,66
5	6,61	5,79	5,41	5,19	5,05	4,95	4,88	4,82	4,77	4,74	4,68	4,62	4,56	4,53	4,50	4,46	4,43	4,40
6	5,99	5,14	4,76	4,53	4,39	4,28	4,21	4,15	4,10	4,06	4,00	3,94	3,87	3,84	3,81	3,77	3,74	3,70
7	5,59	4,74	4,35	4,12	3,97	3,87	3,79	3,73	3,68	3,64	3,5	3,51	3,44	3,41	3,38	3,34	3,30	3,27
8	5,32	4,46	4,07	3,84	4,69	3,58	3,50	3,44	3,39	3,35	3,28	3,22	3,15	3,12	3,08	3,04	3,01	2,97
9	5,12	4,26	3,86	3,63	3,48	3,37	3,29	3,23	3,18	3,14	3,07	3,01	2,94	2,90	2,86	2,83	2,79	2,75
10	4,96	4,10	3,71	3,48	3,33	3,22	3,14	3,07	3,02	2,98	2,91	2,85	2,77	2,74	2,70	2,66	2,62	2,58
11	4,84	3,98	3,59	3,36	3,20	3,09	3,01	2,95	2,90	2,85	2,79	2,72	2,65	2,61	2,57	2,53	2,49	2,45
12	4,75	3,89	3,49	3,26	3,11	3,00	2,91	2,85	2,80	2,75	2,69	2,62	2,54	2,51	2,47	2,43	2,38	2,34
13	4,67	3,81	3,41	3,13	3,03	2,92	2,83	2,77	2,71	2,67	2,60	2,53	2,46	2,42	2,38	2,34	2,30	2,25
14	4,60	3,74	3,34	311	2,96	2,85	2,76	2,70	2,65	2,60	2,60	246	2,39	2,35	2,31	2,27	2,22	2,18
15	4,54	3,68	3,29	3,06	2,90	2,79	2,71	2,64	6,59	2,54	2,48	2,40	2,33	2,29	2,25	2,20	2,16	2,11
16	4,49	3,63	3,24	3,01	2,85	2,74	2,66	2,59	2,54	2,49	2,42	2,35	2,28	2,24	2,19	2,15	2,11	2,06
17	4,45	3,59	3,20	2,96	2,81	2,70	2,61	2,55	2,49	2,45	2,38	2,31	2,23	2,19	2,15	2,10	2,06	2,01
18	4,41	3,55	3,16	2,93	2,77	2,66	2,58	2,51	2,46	2,41	2,34	2,27	2,19	2,15	2,11	2,06	2,02	1,97
19	4,38	3,52	3,13	2,90	2,74	2,63	2,54	2,48	2,42	2,38	2,31	2,23	2,16	2,11	2,07	2,03	1,98	1,93
20	4,35	3,49	3,10	2,87	2,71	2,60	2,51	2,45	2,39	2,35	2,28	2,20	2,12	2,08	2,04	1,99	1,95	1,90
21	4,32	3,47	3,07	2,84	2,68	2,57	2,49	242	2,37	2,32	2,25	2,18	2,10	2,05	2,01	1,96	192	1,87
22	4,30	3,44	3,05	2,82	2,66	2,55	2,46	2,40	2,34	2,30	2,23	2,15	2,07	2,03	1,98	1,94	1,89	1,84
23	4,28	3,42	3,03	2,80	2,64	2,53	2,44	2,37	2,32	2,27	2,20	2,13	2,05	2,01	1,96	1,91	186	1,81
24	4,26	3,40	3,01	2,78	2,62	2,51	2,42	2,36	2,30	2,25	2,18	2,11	2,03	1,98	1,94	1,89	1,84	1,79
25	4,24	3,39	2,99	2,76	2,60	2,49	2,40	2,34	2,28	2,24	2,16	2,09	2,01	1,96	1,92	1,87	1,82	1,77
30	4,17	3,32	2,92	2,69	2,53	2,42	2,33	2,27	2,21	2,16	2,09	2,01	1,93	1,89	1,84	1,79	1,74	1,68
40	4,08	3,23	2,84	2,61	2,45	2,34	2,25	2,18	2,12	2,08	2,00	1,92	1,84	1,79	1,74	1,69	1,64	1,58
50	4,08	3,18	2,79	2,56	2,40	2,29	2,20	2,13	2,07	2,02	1,95	1,87	1,78	1,74	1,69	1,63	1,56	1,50
60	4,00	3,15	2,76	2,53	2,37	2,25	2,17	2,10	2,04	1,99	1,92	1,84	1,75	1,70	1,65	1,59	1,53	1,47
100	3,94	3,09	2,70	2,46	2,30	2,19	2,10	2,03	1,97	1,92	1,85	1,80	1,68	1,63	1,57	1,51	1,46	1,40
120	3,92	3,07	2,68	2,45	2,29	2,18	2,09	2,02	1,96	1,91	1,83	1,75	1,66	1,61	1,55	1,50	1,43	1,35
∞	3,84	3,00	2,60	2,37	2,21	2,10	2,01	1,94	1,88	1,83	1,75	1,67	1,57	1,52	1,46	1,39	1,32	1,22

3.7 Influence Percentage of All Attributes (r^2)

The percentage of influence of all attributes on the utility of mode choice is indicated by the magnitude of the coefficient of determination (r^2). For example, the r^2 value of the modal on the airplane – travel = 0.054, meaning that the effect of all attributes on changes in utility in the aircraft – travel is 5.4%. In comparison, the remaining 94.6% is influenced by other details not considered in this modal.

Of all the existing alternatives, alternative 14 has the enormous r^2 value; based on the results of this modelling, it can be concluded that both model's existing modes using the four attributes considered (namely: Cost, Time, Headway, and Service) still need additional other features that are significant in influencing utility to obtain a better mode.

3.8 Modal Equation

From the analysis of data, based on the results of interpretation and statistical tests on each alternative, the alternative equation The utility in function chosen is alternative 14 because it has a small constant value, a sizeable F-stat value, and the largest r^2. The modal of transportation mode choice between airplane and travel transportation modes for the Pontianak City – Ketapang City route obtained in this study is the Binomial Logit Modal with the function of the utility difference between airplane and travel in the form of a linear equation.

The equation of mode selection is analysed into airplane and travel. It is calculated the differences of 2 probabilities equations.

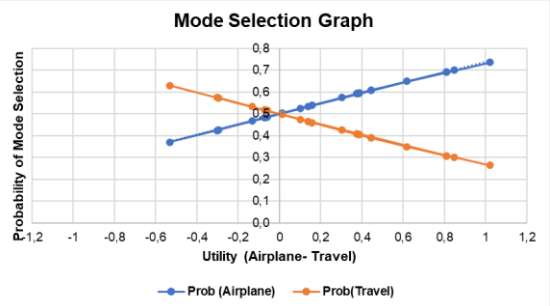
$$U_{(PT-TR)} = 0.291 + -2.883E\text{-}6.\Delta x_1 + -0.226.\Delta x_2 + 0.218.\Delta x_3 + 0.023.\Delta x_4$$

Δx_1 is the difference travel costs between airplane and travel. Δx_2 is the travel time difference between airplane and travel. Δx_3 is the departure frequency between airplane and travel. Δx_4 is the difference of the level of facilities and comfort between airplane and travel.

3.9 Mode Selection Graph

The mode selection graph is the relationship between the probability of choosing a Mode and the difference in utility value between the two modes offered; the higher the difference in utility, the greater the chance of someone choosing one of the modes provided. For the graph of mode choice in airplane and travel transportation, the probability of selection is balanced, where some respondents prefer to use airplane transportation and travel. Here, respondents choose the mode they want because they think it is more profitable. Changes in utility are very influential in the probability of selecting a mode. The more significant the change in the utility of a mode, the greater the influence on the likelihood of choosing the mode offered. For example, the more influential the cost difference proposed, the less likely people want to use the mode and vice versa. The magnitude of the utility value and the probability of choosing this mode can be seen in Table 11.

Table 11. Probability of Mode Selection



No	Option	Cost (x_1)	Time (x_2)	Headway (x_3)	Service (x_4)	U (PT-TR)	Prob (Airplane)	Prob (Travel)
1	a	750000	-9,25	-2	10	0,0132	0,5033	0,4967
	b	650000	-9,25	-2	10	0,3016	0,5748	0,4252
	c	600000	-9,25	-2	10	0,4457	0,6096	0,3904
	d	400000	-9,25	-2	10	1,0223	0,7354	0,2646
	e	600000	-9,25	-2	10	0,4457	0,6096	0,3904
	f	800000	-9,25	-2	10	-0,1309	0,4673	0,5327
2	a	700000	-7,25	-2	10	-0,2946	0,4269	0,5731
	b	700000	-8,25	-2	10	-0,0686	0,4829	0,5171
	c	700000	-10,25	-2	10	0,3834	0,5947	0,4053
	d	700000	-9,25	-2	10	0,1574	0,5393	0,4607
	e	700000	-9,167	-2	10	0,1386	0,5346	0,4654
	f	700000	-9	-2	10	0,1009	0,5252	0,4748
3	a	700000	-9,25	1	10	0,8114	0,6924	0,3076
	b	700000	-9,25	-1	10	0,3754	0,5928	0,4072
	c	700000	-9,25	-3	10	-0,0606	0,4849	0,5151
	d	700000	-9,25	-3	10	-0,0606	0,4849	0,5151
	e	700000	-9,25	-1	10	0,3754	0,5928	0,4072
	f	700000	-9,25	1	10	0,8114	0,6924	0,3076
4	a	700000	-9,25	-2	0	-0,0726	0,4819	0,5181
	b	700000	-9,25	-2	-10	-0,3026	0,4249	0,5751
	c	700000	-9,25	-2	-20	-0,5326	0,3699	0,6301
	d	700000	-9,25	-2	20	0,3874	0,5957	0,4043
	e	700000	-9,25	-2	30	0,6174	0,6496	0,3504
	f	700000	-9,25	-2	40	0,8474	0,7000	0,3000

Figure 11. Mode Selection Graph

3.10 Modal Elasticity

Modal elasticity is needed to evaluate response sensitivity, which measures the percentage change in the probability of mode choice due to the percentage change in a particular attribute in the utility function of each modal (Helmmie & et al., 2021). Elasticity is divided into two, namely:

- Direct elasticity

Direct elasticity measures the percentage change in the probability of choosing a mode due to a given percentage change in one attribute within the specified mode utility function.

- Cross elasticity

Cross-elasticity measures the percentage change in the probability of choosing a mode due to a given percentage change in one attribute within the alternative utility function of the specified mode. To determine elasticity depends mainly on the same point in question (point elasticity) because each point on the graph of the probability function has a different elasticity, meaning that the value of the selected attribute largely determines the elasticity value. It is carried out to attribute different values.

The equation to get the utility and probability values of each modal is:

Utilities Airplane Transport – Travel

$U_{(PT-TR)}$ = 0.291 + -2.883E-6.Δx_1 + -0.226.Δx_2 + 0.218.Δx_3 + 0.023.Δx_4

= 0.291 + (-2.88E-06 x (683333.33)) + (-0.226x (-9.15)) + (0.218x (-1.75)) + (0.023 x (10))

= 0.2380

Airplane Probability

$$PPT = \frac{\exp(UPT\text{-}UTR)}{1+\exp(UPT\text{-}UTR)} \quad \text{.....(10)}$$

$$= \frac{\exp(0.2380)}{1+\exp(0.2380)}$$

= 0.5592

Travel Probability

$$PTR = 1 - P_{PT} \quad \text{.....(11)}$$

= 1-0.5592

= 0.4408

By obtaining the probability value of airplane transportation modes against travel, the elasticity to various attributes, both direct elasticity and cross elasticity on the average value of points, is obtained in Table 12 and Table 13.

Table 12. Direct Elasticity

Direct Elasticity			
E(P,COST)	E(P,TIME)	E(P,HEADWAY)	E(P,SERVICE)
-0,9760	0,9118	-0,1682	0,1014

Table 13. Cross Elasticity

Cross Elasticity			
E(P,COST)	E(P,TIME)	E(P,HEADWAY)	E(P,SERVICE)
0,9940	-1,1568	0,2133	-0,1286

3.11 Sensitivity Analysis

Sensitivity analysis is intended to understand changes in the probability value of airplane transport selection if a gradual change in the value of service attributes is made (Suyono & Yustrinisa, 2021). The following attribute changes are made to the modal in each group to illustrate the sensitivity:

1. Travel expenses are reduced or increased.

2. Travel time slowed down or accelerated
3. Travel frequency reduced or increased
4. Service level reduced or increased

Sensitivity analysis of the attributes of one of the above changes is carried out by assuming that this change does not affect other features or that the feedback effect is not considered.

Table 14. Sensitivity Analysis of Cost Attribute

Attribute Average (Differences PT-TR)				PT-TR	
Cost	Time	Headway	Service	U(PT-TR)	Pr(Airplane)
900000	-9,1528	-1,75	10	-0,3867	0,4045
750000	-9,1528	-1,75	10	0,0458	0,5114
600000	-9,1528	-1,75	10	0,4782	0,6173
450000	-9,1528	-1,75	10	0,9107	0,7131
300000	-9,1528	-1,75	10	1,3431	0,7930
150000	-9,1528	-1,75	10	1,7756	0,8552
0	-9,1528	-1,75	10	2,2080	0,9010
-150000	-9,1528	-1,75	10	2,6405	0,9334
-300000	-9,1528	-1,75	10	3,0729	0,9558
-450000	-9,1528	-1,75	10	3,5054	0,9708
-600000	-9,1528	-1,75	10	3,9378	0,9809
-750000	-9,1528	-1,75	10	4,3703	0,9875
-900000	-9,1528	-1,75	10	4,8027	0,9919

Based on the sensitivity analysis in cost attributes, alteration in cost attributes is shown in the sensitivity graph in Figure 12 and Table 14, and it can be seen that the slope of the sensitivity graph line in a negative direction, which states the more expensive the airplane fare, the less chance of choosing the airplane mode. By only paying attention to the difference in costs, for the magnitude of the probability between airplane and travel, it can be explained that the likelihood of choosing an aircraft will be greater than the probability of selecting travel if the difference in costs between planes and travel is minor Rp. 750,000.

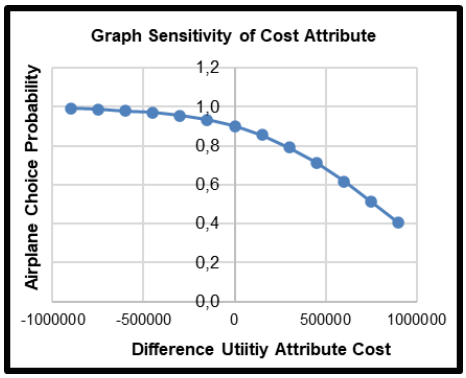


Figure 12. Sensitivity Graph of Cost Attribute

Table 15. Sensitivity Analysis of Time Attribute

Average Attribute (Difference of PT-TR)				PT-TR	
Cost	Time	Headway	Service	U (PT-TR)	Pr (Airplane)
683333,33	12	-1,75	10	-4,5426	0,0105
683333,33	10	-1,75	10	-4,0906	0,0165
683333,33	8	-1,75	10	-3,6386	0,0256
683333,33	6	-1,75	10	-3,1866	0,0397
683333,33	4	-1,75	10	-2,7346	0,0610
683333,33	2	-1,75	10	-2,2826	0,0926
683333,33	0	-1,75	10	-1,8306	0,1382
683333,33	-2	-1,75	10	-1,3786	0,2012
683333,33	-4	-1,75	10	-0,9266	0,2836
683333,33	-6	-1,75	10	-0,4746	0,3835
683333,33	-8	-1,75	10	-0,0226	0,4944
683333,33	-10	-1,75	10	0,4295	0,6057
683333,33	-12	-1,75	10	0,8815	0,7071

Based on sensitivity analysis to changes in the Time attribute, the results of the sensitivity calculation to changes in the travel time attribute can be seen in Table 15 and Figure 13. It can be seen that the slope of the sensitivity graph line is negative, which states that the longer the difference in travel time, the smaller the chance of choosing the Airplane mode. By only paying attention to changes in travel time difference, it can be explained that the probability of selecting an airplane will be greater than the probability of choosing travel if the difference in travel time is smaller than – 8 hours or the travel time of an aircraft is 8 hours or faster than the travel time.

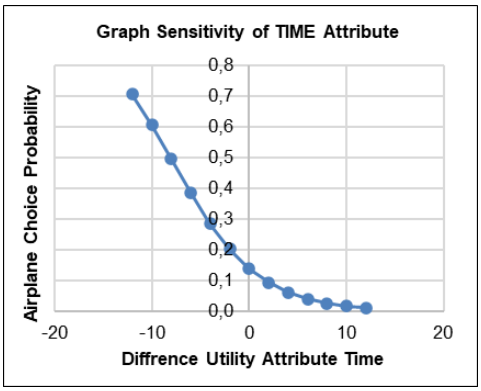


Figure 13. Sensitivity Graph of Time Attribute

Table 16. Sensitivity Analysis of Headway Attribute

Average Attribute (Difference of PT-TR)				PT-TR	
Cost	Time	Headway	Service	U (PT-TR)	Pr (Airplane)
683333,33	-9,1528	6	10	1,9275	0,8730
683333,33	-9,1528	5	10	1,7095	0,8468
683333,33	-9,1528	4	10	1,4915	0,8163
683333,33	-9,1528	3	10	1,2735	0,7813
683333,33	-9,1528	2	10	1,0555	0,7418
683333,33	-9,1528	1	10	0,8375	0,6979
683333,33	-9,1528	0	10	0,6195	0,6501
683333,33	-9,1528	-1	10	0,4015	0,5990
683333,33	-9,1528	-2	10	0,1835	0,5457
683333,33	-9,1528	-3	10	-0,0345	0,4914
683333,33	-9,1528	-4	10	-0,2525	0,4372
683333,33	-9,1528	-5	10	-0,4705	0,3845
683333,33	-9,1528	-6	10	-0,6885	0,3344

Based on the analysis of sensitivity to changes in Headway attributes, the results of the calculation of sensitivity to changes in travel time attributes can be seen in Table 16 and Figure 14; it can be seen that the slope of the sensitivity graph line in a positive direction which states that the more significant the difference in departure frequency, the greater the chance of choosing the airplane mode. By simply paying attention to changes in the difference in departure frequency, it can be explained that the probability of selecting an airplane will be greater than the probability of choosing travel if the headway difference between the airplane and travel is more remarkable than -2 or the headway is two times or higher than the travel headway with eight hours or more than travel time.

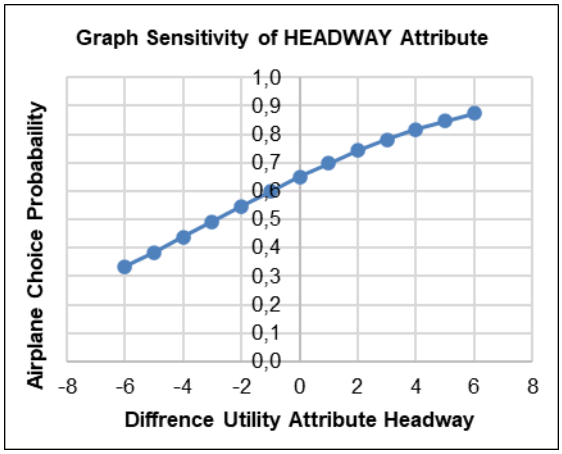


Figure 14. Sensitivity Graph of Headway Attribute

Table 17. Sensitivity Analysis of Service Attribute

Average Attribute (Difference of PT-TR)				PT-TR	
Cost	Time	Headway	Service	U (PT-TR)	Pr (Airplane)
683333,33	-9,1528	-1,75	60	1,3880	0,8003
683333,33	-9,1528	-1,75	50	1,1580	0,7610
683333,33	-9,1528	-1,75	40	0,9280	0,7167
683333,33	-9,1528	-1,75	30	0,6980	0,6677
683333,33	-9,1528	-1,75	20	0,4680	0,6149
683333,33	-9,1528	-1,75	10	0,2380	0,5592
683333,33	-9,1528	-1,75	0	0,0080	0,5020
683333,33	-9,1528	-1,75	-10	-0,2220	0,4447
683333,33	-9,1528	-1,75	-20	-0,4520	0,3889
683333,33	-9,1528	-1,75	-30	-0,6820	0,3358
683333,33	-9,1528	-1,75	-40	-0,9120	0,2866
683333,33	-9,1528	-1,75	-50	-1,1420	0,2419
683333,33	-9,1528	-1,75	-60	-1,3720	0,2023

Based on examining how alterations in service attributes impact the outcomes, the outcomes of evaluating the susceptibility to adjustments in service attributes are illustrated in Table 17 and Figure 15. These visual representations demonstrate that the incline of the sensitivity curve is positive, indicating that as the variance in service levels increases, the likelihood of opting for the airplane mode also increases. By focusing solely on shifts in the disparity of service levels, it can be deduced that selecting an airplane becomes more probable if the divergence in service levels surpasses 10% or if the airplane's service level exceeds that of the travel service.

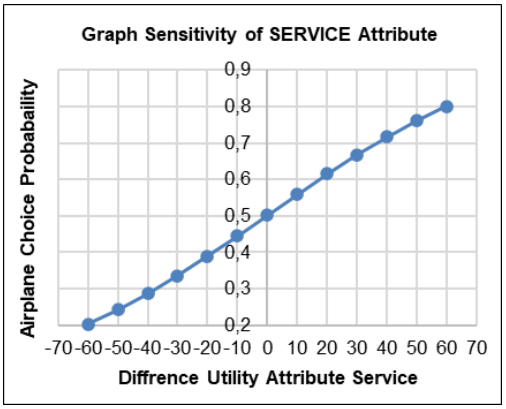


Figure 15. Sensitivity Graph of Service Attribute

4. Conclusion

Factors that influence the choice of transportation mode are: Based on the purpose of travel carried out by people traveling from the Pontianak - Ketapang route or vice versa, most airplane transportation users travel for business or work purposes, which is 41.6% while traveling transportation users. Most travelled with other purposes, such as returning home and family visits, amounting to 41.3%. Based on employment, people who use airplanes have the type of work for SOES / civil servants, which is 26.4%, while people who use travel have the type of student work/students, which is 51.0%. Based on monthly income, people who use airplanes have an income range of > 4.5 million per month, which is 64.6%, while travel transportation users have an income range of <1.5 million per month, which is 50%. Of the several main reasons for choosing a mode of transportation, airplane transportation users generally tend to choose the reason for time speed considerations 66.9%. In contrast, travel transportation users generally tend to choose the reason for price considerations (cheap), which is 83.7%. Based on the analysis results for calculating mode choice with the stated preference method, the best utility modal was obtained as follows: U (PT-TR) = 0.291 + -2.883E-6.Δx_1 + -0.226.Δx_2 + 0.218.Δx_3 + 0.023.Δx_4 with cost (Δx_1), time (Δx_2), headway (Δx_3) and service (Δx_4). From the equation of the difference function between airplane and travel utilities Based on the results of the analysis, the probability of the binomial logit modal of passengers choosing to use airplanes is 55.92%, while passengers who choose travel is 44.08%, based on the results of elasticity analysis of each attribute, it is concluded that the probability of the modal being more sensitive affects the selection of travel transportation compared to airplanes, this is seen from the value of cross elasticity > direct elasticity, then based on sensitivity analysis, the attribute that is considered sensitive is the time attribute because changes in travel time will result in changes in the probability of choosing a relatively larger moda when compared to changes in other features.

5. Acknowledgment

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something as a reference in choosing transportation modes on the Pontianak - Ketapang city route. I also thank my friends who have supported me so that I can complete this task. I would also like to thank Jurnal Teknik Sipil UNTAN (JTS) team, who have agreed to publish the research results so that it can be a reference for everyone, especially in selecting transportation modes in Pontianak – Ketapang.

6. Author's Note

Everything written in this article is original because it sums up my studies with Mr. Heri Azwansyah, S.T., M.T., IPM, and Mrs. Dr. Elsa Tri Mukti, S.T., M.T. The contents of this article have been reviewed in a thesis defense at the Department of Civil Engineering, the University of Tanjungpura, on 16 May 2023 by Mr. Ir. ASEAN Eng., ACPE and Mrs. S.Nurlaily Kadarini, S.T., M.T., IPM.

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