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Influence of Qualitative Factors on Mode Choice between High Speed Train and Airplane using Logit Model with Dummy Variables: Case Study Jakarta – Surabaya Corridor

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Abstract: The Indonesia National Railway Master Plan has stated the plan for development of high-speed railway between Jakarta and Surabaya. Introduction of high-speed train will create competition with the existing modes. This study aims to understand the effect of qualitative variables on mode choice between the upcoming HST and existing airplane services. The mode choice behaviour was modelled based on logit binomial model. Dummy variables were used to represent the qualitative variables in the utility function. The result indicates that gender and occupation significantly influence mode choice. The result can give the stakeholders a better understanding of the potential market of the HST.

Keywords : Mode Choice, High Speed Train, Dummy Variable, Logit Binomial

1 Introduction

The two largest cities in Indonesia, Jakarta and Surabaya, serve as the point of attraction for the surrounding areas. The population of both cities combined is about 12 million residents. Both cities also serve as the centre of their respective agglomeration area. Jakarta is the centre of Jabodetabek Agglomeration area that consists of Jakarta, Bogor, Depok Tangerang and Bekasi. About 27.9 million people reside in Jabodetabek area. At the other end, Surabaya is the centre of an agglomeration area that consists of Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo and Lamongan (Gerbangkertosusila). The population of this agglomeration is about 9,1 million people. These regions have high economic potential. It contributes to around 56% of the GDP of Java, while Java GDP contributes to 47% of national GDP. The economic growth in these regions causes increase in the travel demand between Jakarta - Surabaya every year. In 2016, the executive train served about 1.1 million passengers that travelled between Jakarta and Surabaya. In 2030, the number is expected to increase and reach 3.1 million passengers/year. Meanwhile, the aircraft passengers demand in 2016 was about 8.04 million pax/year. The demand is projected to reach 30.5 million pax/year in 2030 [1)]. The data indicates that the demand for airplane in Jakarta-Surabaya Corridor is still higher than demand for the existing executive train. It is due to the shorter travel time between Jakarta – Surabaya using airplane. If using an airplane, the current door-to-door travel time between Jakarta and Surabaya is about 5 hours, while the door-to-door travel time using an executive train takes about 9 to 12 hours. The Jakarta – Surabaya air service corridor will soon be saturated due to the increasing number of airplane passengers that will reach the capacity. The corridor capacity is limited by the capacity of the airport, and runway, as well as the number of flights.

In order to accommodate the increasing demand of Jakarta – Surabaya Corridor, the government is building high speed train (HST) between Jakarta to Bandung, and plan to extend it to Surabaya, to increase the corridor capacity, travel speed, safety, and comfort. This plan is included in the Indonesia National Railway Masterplan (RIPNAS)[2)]. The HST will be an alternative option to travel between Jakarta and Surabaya to increase the capacity of the corridor. When it is opened, the expected average door-to-door travel time between Jakarta and Surabaya using HST is about 5 hours. The travel will be almost the same as the current average travel time between Jakarta – Surabaya using airplane. The HST will not only serve as an alternative mode but also is expected to increase the economic growth of both terminal cities and other cities along the corridor. The existence of public transportation is believed to be able to invigorate cities[3)].

Introduction of a new transport mode potentially will induce shifting from the current existing mode to the new

transport mode. In this, case the introduction of Jakarta – Surabaya HST is expected to create a strong competition with the existing airplane services due to the competitive travel. Various studies have shown that operation of HST corridor will cause shifting of passengers from airplane to HST, which reduces the demand for airplane[4–7]. Mode choice model is usually used to predict the proportion of passenger shift from existing mode to new one. Understanding of the passenger shift is important in the planning process, especially for planning the operational aspect. The tendency to choose something over others is called preference. Preference can be influenced by internal and external factors [8]. Passenger mode preference can be influenced by many factors in terms of both qualitative and quantitative variables. Studies have included quantitative variables in explaining the mode choice behaviour. Quantitative variables that influence mode choice behaviour include duration of travel, travel cost, distance to transport hub, area population, GDP, etc.[7,9,10]. Meanwhile, there are not many studies that included qualitative variables into mode choice model since a qualitative variable does not have quantifiable measurements that can be directly included in the mathematical formulation.

There are various methods that can be used to understand people's preferences to something. Logistic regression is a method that is commonly used to model relationships between factors that influence people's willingness or preference[11]. It explains how people's preferences (dependent variable) could be influenced by one or more factors (independent variables). Another method that can be used to model one's preference is multidimensional scaling (MDS) analysis. MDS represents the relationship between variables in a multidimensional space. The preference is represented by the distance of variables in a multidimensional space. MDS is commonly used in physics, psychology, market research, and political science[12]. Multiple linear regression is another method that can be used to determine variables that can influence one's choice[13]

Discrete choice model is one of the common forms to model the mode choice behaviour. However, discrete choice model has a limitation, as it can only include quantitative or tangible attributes of the choices and socio-economic factors. In recent years "hybrid choice" models have emerged to incorporate the influence of intangible factors in the mode choice behaviour. The qualitative attributes of users' characteristics and alternatives can be incorporated using latent variables[14]. Previous studies have shown that incorporating qualitative attributes through latent variables (LV) contributes to improve the fitness of the model[15].

Latent variables (LV) are defined as intangible attributes in mode choice model that represent qualitative aspects of choice behaviour. These variables represent factors that influencing individual mode choice behaviour but cannot be quantified, such as gender, trip purpose, etc. The inclusion of LV should be supported by the design of revealed preference (RP) or stated preference (SP) survey, to capture users' preference towards the alternatives under several scenarios. Before starting a survey, the LV needs to be chosen and included in the survey variables. In designing the survey, the potential factors that can be used to determine perception indicators should be identified beforehand. This procedure is applied in any context[16].

The inclusion of qualitative aspects, such as attitudes and perception, in choice model has been an interest for a long time as an attempt to have a better understanding of individual mode choice behaviour. Previous studies have indicated that the inclusion of variables that represent attitude and perception towards the mode can significantly improve the goodness-of-fit of models[17,18]. This study focuses on the inclusion of gender, trip purpose, and occupation as qualitative variables on the mode choice model that explains the competition between the upcoming HST and existing airplane services. As those variables are qualitative and intangible, the model used dummy variables to represent them. This study aims to understand the influence of qualitative variables on the competition between the upcoming HST and existing airplanes along the Jakarta – Surabaya Corridor. The results will give an understanding of the influence of intangible factors on transport mode preferences.

2 Methodology

Passenger mode choice behaviour is influenced by various qualitative and quantitative variables. Quantitative variables are intangible attributes such as, travel time and travel cost. Qualitative variables are variables that represent subjective elements in mode choice but cannot be quantified directly. Latent variables try to represent those qualitative variables that potentially influence the mode choice behaviour and perceptions[19]. Qualitative variables include schedule inconvenience, comfort and convenience of travel, reliability and safety, gender, education, occupation, travel purpose, weather, etc.[19,20]

2.1 Independent Variable

There are many factors that can affect passengers in choosing their transport mode. These factors are represented as the independent variables of the models. The independent variables can be categorised and referred to as qualitative independent variables and quantitative independent variables. In this study, total travel time and total travel cost served as the quantitative independent variables, while gender, trip purpose, and occupation served as the qualitative independent variables.

2.1.1 Travel Time

Travel time is defined as the door-to-door travel time from the initial point of the journey until the destination, which includes access time to the transport hub, check-in time, waiting time, boarding, in-vehicle time, baggage

claim time, and egress time to final destination. The average travel time from Jakarta to Surabaya using an airplane was about 300 minutes, which includes 90 minutes of travel time from-and-to the airport, 60 minutes at the airport (including check-in and waiting), 30 minutes boarding time, 90 minutes on board of the aircraft and 30 minutes baggage handling and time to travel out of the airport to the destination [1)]. The expected travel time for the HST between Jakarta – Surabaya is maximum at about five hours (300 minutes) from station to station. Therefore, the differences of HST travel time to airplane is expected to vary between 60 minutes slower to 60 minutes faster.

2.1.2 Travel Cost

Travel cost from origin to the destination consists of access travel cost, air ticket including tax, egress cost from the airport to the destination. The travel cost of HST was set with consideration of operating cost and airfare. The average airfare in 2016 was set as the highest airfare. Then, other travel cost scenarios were set in the range of 10% - 20% lower and 10% - 20% higher than the highest value. The variations were set with the assumption that when the upcoming HST enters the market, the air fares will be set to a certain range to maintain the demand and competitiveness of the air transport services.

2.2 Dummy Variable

A qualitative variable is defined as an intangible variable that can influence individual behaviour in their mode choice such as gender, education, trip purpose, occupation, weather, and related policy. In this study, the analysis on the qualitative variable will focus on gender, trip purpose, and occupation attributes. The qualitative variable that is represented by values 1 and 0 is referred to as the dummy variable. If the number of categories is n, then the number of dummy variables is n – 1.

Gender has only two categories which mean the number of dummy variable is one. Female was represented by value 1, while male was represented by value 0. Meanwhile, the trip purpose was classified into two groups leisure and non-leisure. It was quantified by giving value 1 for non-leisure trips and 0 for leisure trips. The occupation of the respondents was categorised into working and non-working group. The working group was represented by value 1 while non-working group was represented by value 0.

2.3 Data Collection

2.3.1 Stated Preference Survey

Stated preference (SP) survey is commonly used to determine the preferences of users towards new products, including new transport mode, compared to existing ones. Another type of preference survey is Revealed Preference (RP). While SP is designed to capture the response based on existing and hypothetical alternatives, RP is designed to observe the actual market condition. Therefore, RP can only include existing products or transport modes. In transportation field, SP has been commonly used to collect data that can be used to predict the demand for different transport modes, especially the upcoming mode of transport that have not been implemented yet.

There are several advantages and disadvantages of SP as compared to RP. SP survey design is easier to be controlled since the researchers have full authority in choosing the alternatives that will be included, including hypothetical alternatives. Meanwhile, the alternatives that can be included in RP survey are only the ones that are already existent in the actual market. It makes SP a popular method to collect data for studying the potential demand for new products[21,22)]. Another advantage of SP is that the collinearity between variables can be controlled by the researchers[22)]. However, SP also has disadvantages. Since SP used hypothetical scenarios of products or conditions that are not implemented yet, in some cases the responses may not be able to fully reflect the actual behaviour when those scenarios are implemented in the future[22)]. It requires the ability of the surveyors to carefully explain the scenarios, so the respondents can have a good understanding of those hypothetical scenarios.

SP survey suits the purpose of this study as it compares a proposed new mode, the HST, with the existing one, airplane. In the survey, respondents were asked to make a choice between HST and airplane based on a hypothetical scenario of variation between the travel time and travel cost. The respondents of the survey were airplane passengers on Jakarta – Surabaya route.

2.3.2 Questionnaire Design

The questionnaire was designed based on the combination of dependent and independent variables that would be introduced to the respondent. For this, study the independent variables are the differences of travel time and travel cost between the upcoming HST and the existing airplane services. This study set the travel time differences into four levels: slower by 30 minutes, slower by 60 minutes, same as the current mode, faster by 30 minutes and faster by 60 minutes. Meanwhile, for the travel cost difference, combinations between cheaper and more expensive travel cost were applied. A total of 23 combinations of travel time and travel cost differences were included in the study. The respondents were asked to response to all 23 scenarios. Table 1 shows the scenario combination for the SP survey.

In addition to the user preferences data, the questionnaire also included questions regarding the demographic of the respondents as well as their trip characteristics. The demographic data included age, gender education, occupation, and income. Meanwhile, the trip characteristics data included aspects such as the estimated travel time, origin, destination, trip purpose, travel cost and travel distance. The trip characteristics were based on the trip that the respondent was doing at the time of the survey. Those data were used to analyse the characteristics of the respondents as well as their trip characteristics.

Table 1. Scenario combination for the stated preference survey

New Mode (HST)				
Δ Time	Δ Cost			
30 minutes slower	IDR 0	- IDR 30,000	- IDR 40,000	- IDR 110,000
60 minutes slower	IDR 0	- IDR 40,000	- IDR 90,000	- IDR 150,000
30 minutes faster	IDR 0	+ IDR 50,000	+ IDR 100,000	+ IDR 150,000
60 minutes faster	IDR 0	+ IDR 50,000	+ IDR 100,000	+ IDR 200,000
Same as Airplane	IDR 0	+ IDR 30,000 - IDR 30,000	+ IDR 40,000 - IDR 40,000	+IDR 110,000 - IDR 110,000

IDR : Indonesian Rupiah (100,000 IDR = USD 6.7)

2.4 Modelling

Logit mode choice model is based on the cumulative logistic probability of choosing one mode over the other. Equation 1 showed the formulation that is used for logit model

$$P_i = \frac{1}{1+e^{-U(x_i)}} \quad (1)$$

The utility function is produced by multiplying both sides of equation (1) with $(1 + e^{U(x_i)})$. Equation (2) shows the formulation of the utility function.

$$\text{Ln}\left(\frac{P_i}{1-P_i}\right) = U(x_i) = \alpha + \beta x_i \quad (2)$$

In this study, the utility function represents the tendency of passengers in choosing between mode A (upcoming HST) and mode B (existing air transport services) with influence from the travel time and travel cost differences. Coefficient α in the utility function represents the other variables that have not been included in the utility function. This study will add gender, trip purpose, and occupation as the dummy variable in three separate models. Equation (3) and (4) show the general formulation of utility function with dummy variable D_i, which represent the influence of either gender, trip purpose, or occupation.

$$\text{Ln}\left(\frac{P_A}{1-P_A}\right) = U(x_A) = a_0 + a_1\Delta cost + a_2\Delta time + a_3 D_i \quad (3)$$

or

$$\text{Ln}\left(\frac{P_A}{1-P_A}\right) = U(x_A) = a_0 + a_1(cA - cB) + a_2(tA - tB) + a_3 D_i \quad (4)$$

Each dummy variable has two categories: $D_i = 1$ and $D_i = 0$. In general, the utility functions of HST under those two categories are shown in Equation (5) and (6).

$$U(x_A|D_i = 1) = (a_0 + a_3) + a_1(cA - cB) + a_2(tA - tB) \quad (5)$$

$$U(x_A|D_i = 0) = a_0 + a_1(cA - cB) + a_2(tA - tB) \quad (6)$$

Gender, trip purpose, and occupation were modelled into three separate models. For the first model that used a dummy variable to represent gender, $D_i = 1$ represented female while $D_i = 0$ represented male. In the second model that included trip purpose as the dummy variable, $D_i = 1$ represented non-leisure trip while $D_i = 0$ represented leisure trip. Equation (4) can substitute the Equation (5) and (6) to form Equation (7) and (8)

$$\text{Ln}\left(\frac{P_1}{1-P_1}\right) = (a_0 + a_3) + a_1(cA - cB) + a_2(tA - tB) \quad (7)$$

$$\text{Ln}\left(\frac{P_0}{1-P_0}\right) = a_0 + a_1(cA - cB) + a_2(tA - tB) \quad (8)$$

Equation (7) represents the tendency of one category to choose the upcoming HST over the existing airplane services. Meanwhile, the tendency of the other category to choose HST is represented by Equation (8). The likeliness of one category in choosing HST compared to the other category is indicated by the odds ratio. The odds ratio can be calculated using the formula as shown in Equation (9).

$$Odds\ Ratio = \text{Ln}\left(\frac{P_1}{1-P_1}\right) \Big/ \text{Ln}\left(\frac{P_0}{1-P_0}\right) \quad (9)$$

3 Results and Discussion

3.1 Respondent Characteristics

A total of 1252 respondents were interviewed at Soekarno-Hatta International Airport, Jakarta and Juanda International Airport, Surabaya. The respondents were airplane passengers who were travelling from Jakarta to Surabaya, or vice versa. About 75% of the respondents were male, while 25% of them were female. The age of the respondents were ranged between 15 years old to 75 years old. The average age of respondents was 38.2 years old. It indicates that the respondents were mostly in the productive age range. The majority of the respondents, 45%, were employees of private company or state-owned companies. It was followed by civil servants (21%) and entrepreneurs (17%). It reflects the characteristics of those groups of age and occupations that have high inter-city mobility for business or on working trips. In the modelling process, those three groups were classified as the 'working' group in the dummy variable, while students, housewives and others were classified as 'non-working' group. Figure 1 shows the distribution of occupation of respondents.

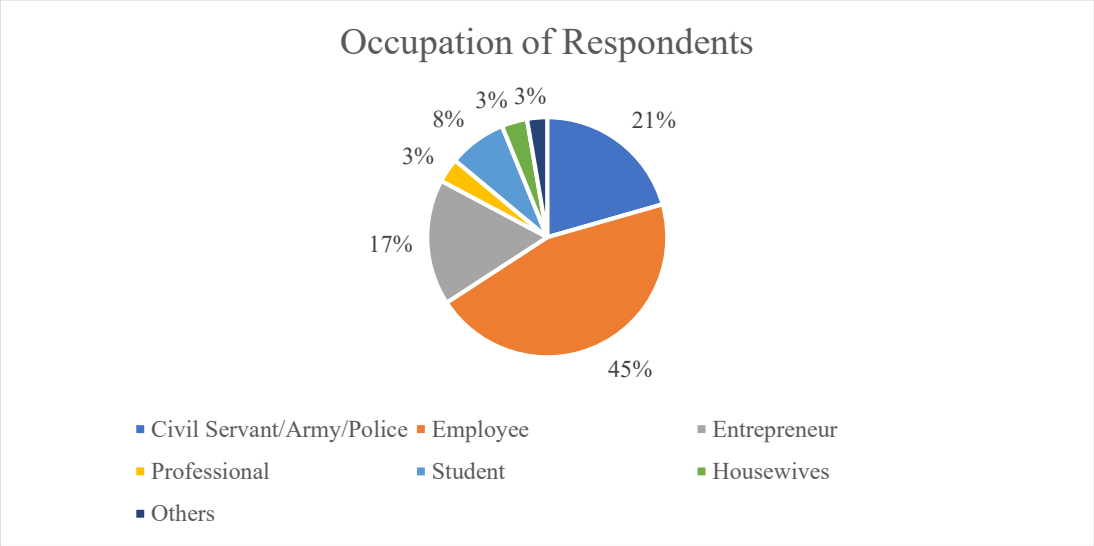

Fig. 1 Occupation of the Respondents

Data on the characteristics of the trips made by the respondents was also collected through the survey. The origin and destination of the trips were mostly in Jabodetabek and Gerbangkertasusila agglomerations, as the hinterland of the airports covers those two areas. The two agglomerations are also the main economic activity centres. Figure 2 shows the distribution of the trip purposes. The most dominant trip purposes were work trips or going home from work trips. It is in line with the occupations of the majority of the respondents that require them to often make business or working related trips. For the modelling purpose, the trip purposes were categorised into two groups: leisure trips and non-leisure trips. Non-leisure trip consisted of business trips, working trips, and study trips. The rest were categorised as the leisure trips.

Currently, traveling between Jakarta and Surabaya using an airplane on average takes about 343 minutes (door-to-door). The longest door-to-door travel time using airplane is about 1155 minutes, while the shortest travel time is about 120 minutes. The travel time includes access time from the starting point of the journey to the departure airport, egress time from the arrival airport to the destination, check-in time, waiting time at the airport, as well as on-board time. On average, the passengers spent IDR 792,705 on travel costs.

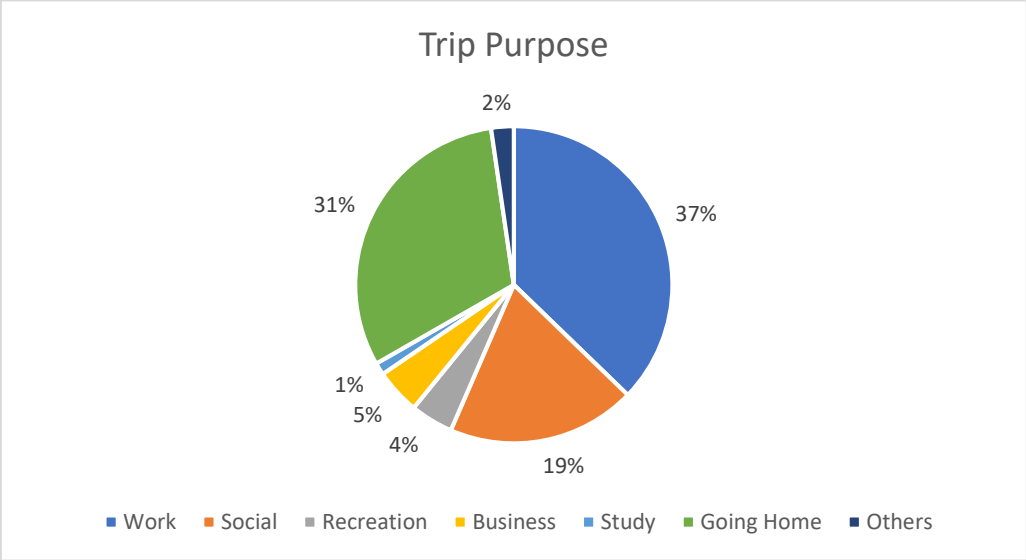

Fig. 2 Trip Purpose

3.2 Influence of Gender on Mode Choice Model

The survey data was compiled into a database tabulation. Each of the respondents responded to 23 scenarios of combinations between cost differences and travel time differences. It means, that in the database, there were 23 rows of data for each respondent that represent their characteristics as well as their responses to each scenario. As mentioned before, the differences in

travel cost and travel time, between HST and airplane, were included in the analysis as the quantitative factors. In Model 1, the dummy variable was used to represent the gender of participants. The dummy variable was generated by giving values 1 for female and 0 for male. The statistical analysis and modelling were done using R studio. Table 2 shows the statistical indicators based on the analysis results.

Table 2. Result of Statistical Analysis for Model 1

	Estimate	Standard Error	Pr(>|z|)
Intercept	-3.564e-01	1.463e-02	< 2e-16
Δ Time (t_A - t_B)	1.311e-02	4,422e-02	< 2e-16
Δ Cost (C_A-C_B)	-5.305e-05	2.113e-07	< 2e-16
Dummy Variable (D) (Gender)	8.765e-02	2.841e-02	0.00204

The result of the statistical analysis shows that the two quantitative independent variables, travel time and travel cost differences, significantly influence the user's mode choice behaviour, indicated by the p-value less than 0.10. It is in line with results from previous studies that mentioned travel time and travel cost as factors that influence mode choice[23–25]. Cost difference has a negative impact on the shifting probability. It means that the more expensive the HST, people will be less likely to change their mode of transport from the existing airplane to the HST. The results also indicate that travel time has a bigger influence on mode choice than the cost of travel. It means that the passengers are more concerned on how they can reach their destination faster and use their time efficiently.

The results also show that gender significantly influences the passenger mode choice. Previous studies indicated that gender is one of the factors that influence HST travel demand[25,26]. It might be due to different travel and mobility patterns between female and male passengers[27,28]. They may have different concerns when choosing their transport mode and have different perceptions on travel experience[29]. Then, Equation (7) and (8) were re-written based on the statistic parameter obtained from the analysis to form Equation (10) and (11) as follow.

$$ln\left(\frac{P_1}{1-P_1}\right) = 0.0131(t_A - t_B) - 0.000053(C_A - C_B) - 0.269 \quad (10)$$

$$ln\left(\frac{P_0}{1-P_0}\right) = 0.0131(t_A - t_B) - 0.0000053(C_A - C_B) - 0.356 \quad (11)$$

The results also indicate that the odds ratio is 1.09, or more than 1. It means that female passenger is more likely to shift from airplane to HST than male passenger. Female tends to be more concerned about safety and less willing to take risk [30]. Bigger media exposure and higher fatality in the case of airplane accidents than train accidents may affect public perception. Studies have shown that accident records may affect public safety perception towards one mode[31,32]. Furthermore, safety may influence mode choice behaviour[33,34]. The results also imply that gender significantly influence the mode choice behaviour, thus it is important for future study to ensure that both genders is well represented in the sample so that the result will not be biased toward one group.

3.3 Influence of Trip Purpose on Mode Choice Model

The second model was built with trip purpose as the dummy variable. Value 1 represented non-leisure trips, while 0 represented leisure trips. Non-leisure trips included work trips, business trips, and trips for study, while the rest was categorised as leisure trips. Similar with the previous model, time differences and cost differences were included as the quantitative factors. Table 3 shows the statistical indicators based on the analysis results.

Table 3. Results of Statistical Analysis for Model 2

	Estimate	Standard Error	Pr(>|z|)
Intercept	-3.094e-01	1.676e-04	< 2e-16
Δ Time (t_A - t_B)	1.308e-02	4.481e-04	< 2e-16
Δ Cost (C_A-C_B)	-5.335e-06	2.142e-07	< 2e-16
Dummy Variable (D) (Trip Purpose)	-1.633e-02	2.537e-02	0.27

The statistical analysis results indicate a consistent trend for both time differences and cost differences influence on the mode choice. The two quantitative variables significantly influence the mode choice behaviour. Meanwhile, the statistical analysis shows that the p-value for the dummy variable is 0.52. It indicates that the trip purpose parameter does not significantly affect the likelihood of users choosing the HST. This suggests that the differences in travel purposes among respondents do not influence their preference for the HST.

3.4 Influence of Occupation on Mode Choice Model

Occupation was included as the dummy variable in Model 3. The occupation of the respondents was categorised into two groups: working group and non-working group. Working group consists of civil servant, army, police, private employee, entrepreneur, and professional, while the rest belong to non-working group. Working group was represented by value 1 and non-working group was represented by 0. Time differences and cost differences were included in the analysis as the qualitative variable. Statistical analysis and modelling were done to understand the influence of those three variables on the mode choice. Table 4 shows the results of the statistical analysis.

Table 4. Results of Statistical Analysis for Model 3

	Estimate	Standard Error	Pr(>|z|)
Intercept	-2.283e-01	3.262e-02	2.77e-13
Δ Time (t_A - t_B)	1.308e-02	4.482e-04	< 2e-16
Δ Cost (C_A-C_B)	-5.336e-06	2.142e-07	< 2e-16
Dummy Variable (D) (Occupation)	-9.148e-02	3.519e-02	0.00932

The results of the statistical analysis conducted indicate that the obtained p-value for the dummy variable is 0.00932. This signifies that the occupation parameter has a significant influence on the likelihood of users selecting the HST. The variation in occupations among respondents will impact their perceptions in choosing a mode of transportation. It is in line with findings from previous studies that occupation significantly influences mode choice [35,36]. In this study, occupations were categorised into two groups: working group and non-working group. The equation resulting from the conducted statistical analysis is shown in Equation (12) and (13) below.

$$ln\left(\frac{P_1}{1-P_1}\right) = 0.0131(t_A - t_B) - 0.000053(C_A - C_B) - 0.320 \quad (12)$$

$$ln\left(\frac{P_0}{1-P_0}\right) = 0.0131(t_A - t_B) - 0.0000053(C_A - C_B) - 0.228 \quad (13)$$

The calculated odds ratio is 0.91. This suggests that passengers belonging to the working group are about 9% less likely to choose the HST over a plane for travel, compared to passengers in the non-working group. Non-working group may have more flexibility to change their mode of transport than working group, since employees have a list of transport service providers that is usually used by the company or institution. Therefore, they are less likely to change from airplane, that they regularly use, to HST as a new mode.

4 Conclusions

Mode choice behaviour can be influenced by many factors, both quantitative and qualitative variables. While many studies have covered the issues of the inclusion of quantitative variables, only a few studies have incorporated qualitative variables into the model. The traditional logit binomial model that is widely used for mode choice model can only accommodate quantitative variables. This paper tried to include the qualitative variables, in this case focus on the influence of gender, trip purpose, and occupation, on the mode choice behaviour, when the passengers need to choose between HST and airplane. Gender, trip purpose, and occupation were represented by the dummy variables in the analysis process. The results indicate that gender and occupation have a significant influence on mode choice.

The result also finds that the odds ratio for gender is 1.09, which mean that female passengers are more likely to shift to HST than male passengers. One of the possible reasons is female passengers may view train as a safer mode than airplane, due to the fatality rate in case of accidents. This result can be used by the planner as an indication of the characteristics of the potential passenger. HST operator and government should consider developing strategies to attract male passengers. The operator and government may also consider enhancing the facilities to attract more female passenger as the potential market of the HST.

In the case of occupation as the qualitative variable, the odd ratio is 0.91. It means that working group is 9% less likely to choose HST over airplane for their trip. One of the possible reasons is non-working group passengers have more flexibility to choose their mode of travel. HST operators may need to come out with a strategy to attract companies into choosing HST as one of the possible transport modes.

This study introduces new factors to be considered in mode choice model. However, there are many other qualitative factors that can influence mode choice behaviour. Future research should consider examining the influence of other qualitative variables to get a better insight into the mode choice behaviour. Future study could also look into the combination of several qualitative variables on mode choice behaviour.

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Nomenclature

P_i	Probability of choosing mode i
$U(x_i)$	Utility function of mode i
P_A	Probability to choose HST
$U(x_A)$	Utility function of HST
$\Delta cost$	Total travel cost difference between HST and airplane
$\Delta time$	Total travel time difference between HST and airplane
D_i	Dummy variable i
a_0	Intercept
a_1, a_2	Constant
a_3	Differential intercept coefficient
t_A	Travel time by HST
t_B	Travel time by airplane
C_A	Travel cost by HST
C_B	Travel cost by airplane

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