Study of willingness to pay the Jakarta-Bandung highspeed train: a case study of Argo Parahyangan train passangers

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Abstract. Currently the increase in vehicle volume in the cities of Bandung and Jakarta has grown very rapidly. This is accompanied by an increase in the volume of vehicles traveling from Jakarta to Bandung and vice versa. High Speed Train (HST) becoming the government's choice as a form of mass transportation modernization in Indonesia building inter-city connectivity and regional development. Study or research on willingness to pay (WTP) is needed to find out the prices that are desired by prospective users. The method used in this study are distribution of questionnaires and interviews with stated preference techniques. The result that the highest probability value is in scenario 1 frequency with a probability value of 96.00%. Or it can be interpreted that as many as 96.00% of respondents of Argo Parahyangan train users will use the HST if the facilities offered are the frequency of train departures once an hour. The biggest WTP is in the scenario conditions offered, namely intermodal accessibility connected with the LRT (Light Rail Transit) mode, and also once a hour frequency scenario where the WTP value reaches.

1. Introduction
Currently the increase in vehicle volume in the two cities has grown very rapidly. This is accompanied by an increase in the volume of vehicles traveling from Jakarta to Bandung and vice versa. Construction of the Cipularang toll road (Cikampek-Purwakarta-Padalarang) has caused the road to become more burdened and has a negative impact without increasing the performance of other modes of service. Even the Cipularang toll road is currently unable to accommodate the large volume of vehicles passing through the toll road. Based on data from the Badan Pengatur Jalan Tol (BPJT), the Jakarta-Cikampek Toll Road is the highest volume toll road in Indonesia, with the highest volume reaching 205,111,304 in 2017. While in normal conditions the traffic is 140 thousand vehicles per day. In addition, the Jakarta - Bandung toll road segment is currently being accelerated with the construction of the Jakarta - Cikampek elevated project. This condition makes the distance of Jakarta-Bandung along 142.3 Km which should be reached in 2-2.5 hours to 3-4 hours in normal conditions, in conditions of weekends.

In normal conditions, Bus and travel are very widely used by users of public transportation from Bandung to Jakarta or vice versa. However, at present, many bus users and travel users switch to using trains because the transportation modes are scheduled and free of traffic jams. Based on PT. KAI's Annual Report in 2017 the Jakarta-Bandung corridor railroad namely the Argo Parahyangan Train can only serve 2,000-2,500 passengers per day. Currently the occupancy of users of the Argo Parahyangan...
Jakarta - Bandung train tends to be high, even at certain times (peak season), the PT KAI provides additional (facultative) trains to accommodate the large number of occupant passengers.

Therefore the government need to harmonize the infrastructure development of the Jakarta-Bandung corridor with the movement of economic development that occurs around Jakarta and Bandung. Under these conditions, the HSR became the government's choice as a form of mass transportation modernization in Indonesia in building inter-city connectivity and regional development. PT Kereta Cepat Indonesia–China (KCIC) is a company that operates the Indonesian fast train network which is planned to be built with the Jakarta-Bandung route with a distance of 142.3 km. This company is a joint project with Pilar Sinergi BUMN Indonesia (a consortium of four Indonesian state-owned enterprises: Kereta Api Indonesia (KAI), Wijaya Karya (Wika), PTPN VIII, and Jasa Marga) with China Railways.

The Jakarta-Bandung Highspeed Train is a new alternative mode that will later compete with existing modes of transportation. With the new transportation, the thing that must be considered is the purchasing power and WTP the tariff of the service user. Where this ability can be a willingness based on user perceptions, namely WTP which can be defined as the WTP service users for compensation for an item or service enjoyed [1]. The WTP concept is useful in visualizing the perspective of system users [2] in [3].

2. Literature review

Research studies aim to complement the basic theories taken from literature studies, so that they can contribute to further research. Previous research studies that were related were in scope (High Speed Rail), probability of using new mode, WTP, interview/survey interview, stated preference techniques and regression analysis. The summary of previous research is as follows:

HSR (High Speed Rail) is an excellent alternative mode because of its ability to capture a relatively large market share, especially for medium distances [4]. In Japan (as Pioneer HSR since 1964) there was a rapid decline in air transportation recorded after the extension of the HSR network. According to Taniguchi (1992), HST is more competitive with a distance of less than 438 miles due to higher frequency services, cheaper rates, proximity to the city center and service and security reliability of [5]. Recently, in 2009, the Spanish AVE (HSR Spain) enjoyed 85% market share in Madrid - the Seville Route, more than 70% on the Madrid - Malaga route, and about 50% in the Madrid - Barcelona corridor in 2009. But this advantage is reduced for the Barcelona-Seville route, considering the distance is more than 400 miles. Thus, AVE only enjoys a 30% market share of seats on this Barcelona-Seville route.

The Seoul-Jeju route analyzed as an empirical case study, in which the construction of an undersea tunnel to connect Seoul and Jeju city by HSR has been considered. This study analyzes passengers' choice of the mode of transportation when air transportation is in-competition with HST. The study also included two new variables, ‘safety of transportation’ and ‘availability of duty free shopping’ in addition to traditional transport choice variables such as travel time, travel costs and frequency of service to reflect special characteristics of the market [6].

Using Stated-Preference, this study discusses changes in air transportation demand with the entry of 'LCC' into domestic services, and with the beginning of the operation of the Linear Chuo Shinkansen [7]. To create a choice model, it is estimated to use the Nested-Logit model parameters by two types of travel objectives to consider differences in price sensitivity between business and non-business. Travel attributes used include:

- Total Travel Costs (TotalFares)
- Total Travel Time (Total Travel Time)
- Frequency and others (Frequency and other)

Analyzed competition from (HST) with several alternative modes in the Madrid- Zaragoza-Barcelona corridor. This analysis is based on the estimation of the disaggregate demand model using Revealed Preference (RP) and a mixture of database Revealed Preferences (RP) and Stated Preferences (SP). Model specifications aim to explain changes in demand for HST as a result of changes in travel time, travel costs, outbound access, reliability and convenience in all modes competing in this corridor [8].
3. Method
The data needed is in the study is primary data. Primary data, is data obtained directly in the field by distributing questionnaires. The questionnaire contains questions related to the characteristics of modal users, and the characteristics of travel. This questionnaire was designed to find out the characteristics of the respondents who traveled in the Jakarta-Bandung corridor by asking about age, gender, occupation, travel frequency, the most frequently used transportation modes, travel time, purpose of the trip, and the cost of one trip.

3.1. Designing the Stated Preference Questionnaire
In designing the questionnaire that will be used is a stated preference technique. Stated preference techniques are approaches to respondents to find out their responses to different situations. Each individual is asked for his response if they are faced with the situation given in the actual situation (how they prefer the choice offered). In the literature study that has been done, [6], [7], [8] and [11] show that the variables or attributes that most influence the choice of modes are rates, travel time, frequency and accessibility. When building a new route, applying new variables that reflect actual market conditions will help understand the passenger mode of behavior choices in a more realistic way [5]. The new variable here is the frequency of train departure or headway and intermodal accessibility because this variable will characterize the advantages of the HST compared to other modes.

Respondents will be faced with several scenario choices, which they will choose whether they are willing to use the HST with a number of conditions offered. The tariff scenario offered for HST uses assumptions based on the comparison of Argo Parahyangan Priority train rates, which have relatively the same facilities. Argo Parahyangan Priority train tariff is Rp. 240,000 so that in this study a price range starting from Rp. 240,000 - Rp. 300,000.

Of the four variables used (time, cost, frequency and accessibility) the scenario formed:
- Scenario 1 (Rp. 300k, 30 min)
  Scenario 1 offers a tariff of Rp. 300.000 (flat tariff) with a travel time of 30 minutes
- Scenario 2 (Rp. 280k, 40 min)
  Scenario 2 offers a tariff of Rp. 280.000 (flat tariff) with a travel time of 40 minutes
- Scenario 3 (Rp. 260k, 50 min)
  Scenario 3 offers a tariff of Rp. 260.000 (flat tariff) with a travel time 50 minutes
- Scenario 4 (Rp. 240k, 60 min)
  Scenario 4 offered a tariff of Rp. 240.000 (flat tariff) with a travel time 60 minutes
- Scenario 5 (frequency once an hour)
  Scenario offered is the frequency of train departures once an hour
- Scenario 6 (frequency every 2 hours)
  Scenario offered is the frequency of train departures every 2 hours
- Scenario 7 (frequency every 3 hours)
  Scenario offered is the frequency of train departures every 3 hours
- Scenario 8 (Connect with LRT)
  Scenario offered are intermodal accessibility connected with LRT mode (Light Rail Transit)
- Scenario 9 (Connect with Bus)
  Scenario offered are intermodal accessibility connected with Bus mode
3.2. Number of Samples
Determination of the number of samples in this study is using Slovin formula 1.

\[ n = \frac{N}{1 + Ne^2} \]  

(1)

where:
- \( n \): Sample size
- \( N \): Population size
- \( e \): Percent of allowance for inaccuracy due to sampling errors. Assuming that the population is normally distributed.

The population size is obtained from the number of Argo Parahyangan Railway passengers based on data from the PT. KAI Annual Report, which is 2,500 passengers per day, so the calculation of sample size is as follows

\[ n_{KA} = \frac{2500}{1 + 2500(0.1)^2} = 99.960015 \sim 100 \text{ Respondents} \]  

(2)

So the minimum number of samples needed in this study is 100 respondents.

4. Data analysis
The analysis used to determine the passenger characteristics of the Jakarta-Bandung corridor used descriptive statistical methods. By using the statistical method, it can be seen the description of the collected data in the form of the highest percentage percentage of each passenger characteristic of the Jakarta-Bandung corridor. The next analysis is binary logistic regression analysis. Binary logit regression analysis (binary logistic regression) is used to determine the probability percentage of respondents who choose to be willing to use the (HST). In addition, binary logistic regression analysis can also be used to determine the dominant variables / attributes affecting respondents to choose the mode [9]. To determine the approximate value of probability mode selection can be calculated using the following formula

\[ \ln \frac{p}{1-p} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K \]  

(3)

\( \beta_0 + \beta_1 + \beta_2 + \cdots + \beta_K \): Binary data with two responses, for example not willing to use the HST (0), are willing to use the HST (1). Binary data is a dependent variable \( X \): Is an independent variable, which has an influence factor in the choice of mode.

After this calculation is complete, the exponential (exp) value is obtained which will be used to calculate the estimated probability value using the following formula:

\[ P_{(HST)} = \frac{\exp^{\text{logit}(p)}}{1+\exp^{\text{logit}(p)}} \]  

\[ P_{(others)} = \frac{1}{1+\exp^{\text{logit}(p)}} \]  

(4)

(5)

To determine the factors that influence the independent variable with the dependent variable, it can be determined by comparing the significant value, i.e. if the value is sig. < \( \alpha \), with a tolerance value of \( \alpha =0.05\% \), then the variable has an effect, but if the value is sig. > \( \alpha \) then the variable has no effect.

5. Result of analysis
The data collection process is done by distributing questionnaires at Bandung Station and Gambir Station. The survey was conducted at that location because it was to directly interview passengers who actually traveled with that mode. Based on the calculation of the number of samples, the minimum sample needed for this study was 100 respondents. The results of the survey in the field obtained samples from argo parahyangan train passengers as much as 177. This because for the analysis needed more
samples to minimize respondents' answers that are incomplete / valid and to get a more valid model in the analysis. From the primary data obtained from the survey in the field it is known the characteristics of passenger trains. As well as to find out how much the probability of train passengers who will move using HST are then analyzed using stated preference techniques. To analyze the data using the SPSS program (Statistical Package for the Social). The characteristics of train users and the results of logistic regression testing for each variable can be seen in Table 1

| Characteristics                  | Willingness to Move |         |
|----------------------------------|---------------------|---------|
|                                  | Yes     | No     |
| Male                             | 20      | 63     |
| Female                           | 35      | 59     |
| Sig. value 0.61 (> value α 0.1) then the variable not significant |
| 17 to 30 years                   | 44      | 87     |
| 31 to 45 years                   | 11      | 32     |
| Sig. value 0.621 (> value α 0.1) then the variable not significant |
| Government                       |         |         |
| Employees                        | 19      | 46     |
| Private Employees                | 10      | 50     |
| Entrepreneur                     | 10      | 9      |
| Sig. value 0.962 (> value α 0.1) then the variable not significant |
| < Rp 3 to 5 mio                  | 36      | 59     |
| Rp 5 to 7 mio                    | 14      | 43     |
| > Rp 7 mio                       | 5       | 20     |
| Sig. 0.104 (> value α 0.1) then the variable not significant |
| Consideration of ease of mode and mobility | 7 | 7 |
| Comfort and safety               | 18      | 41     |
| Consideration of time and speed  | 28      | 68     |
| Sig. 0.470 (> value α 0.1) then the variable not significant |
| Work                             | 20      | 43     |
| Family Visit                     | 11      | 42     |
| Tourism                          | 16      | 27     |
| Others                           | 5       | 6      |
| Sig. 0.310 (> value α 0.1) then the variable not significant |
| Once a month                     | 19      | 34     |
| 2 times a month                  | 6       | 30     |
| 3 times a month                  | 10      | 6      |
| Others                           | 20      | 52     |
| Sig. 0.014 (> value α 0.1) then the variable not significant |
5.1. Logistic regression test for scenario 2 (Rp.280k, 40 min)
The dependent variable in this section is the willingness to move using the HST with the scenario offered, which is 40 minutes travel time with a ticket price of Rp.280,000. The test results of each independent variable with binary logistic regression can be seen in Table 2.

Table 2. Logistic regression test results for frequency variable

| Step 1* | Frequency | B     | S.E   | Wald  | df  | Sig. | Exp(B) |
|---------|-----------|-------|-------|-------|-----|------|--------|
| Frequency (1) | -1.02 | 0.531 | 3.743 | 1     | 0.05 | 0.05 |
| Frequency (2) | 1.09  | 0.591 | 3.424 | 1     | 0.06 | 2.982|
| Constraint   | -0.582 | 0.286 | 4.127 | 1     | 0.042| 0.559|

- Logit (P) for the frequency of travel 2 times a month
  
  \[ \text{Logit (P)} = \ln \frac{p}{1-p} = \beta_0 + \beta_1 \]
  
  \[ -0.582 - 1.028 \text{ (2 times a month)} \]
  
  \[ -1.61 \]

- Logit (P) for the frequency of travel 3 times a month
  
  \[ \text{Logit (P)} = \ln \frac{p}{1-p} \beta_0 + \beta_1 \]
  
  \[ -0.582 + 1.093 \text{ (3 times a month)} \]
  
  \[ 0.511 \]

5.1.1. Determining the probability value

The equation of modeling the test results of each variable free frequency of travel 1 month 3 times

\[ \text{Logit (P)} = \ln \frac{p}{1-p} \]

\[ -0.582 + 1.093 \text{ (3 times a month)} \]

\[ 0.511 \]

Then the probability of respondents with a frequency of 3 times a month to choose to be willing to use the HST with scenario 2 (Rp.280k, 40 min)

\[ P \text{ (3 times a month)} = \frac{\exp^{\text{logit}(P)}}{1 + \exp^{\text{logit}(P)}} \]

\[ P \text{ (3 times a month)} = \frac{\exp^{0.511}}{1 + \exp^{0.511}} \]

\[ = 0.625041 \]

\[ = 62.50\% \]

5.1.2. Testing the logistic regression model

Before the model is declared feasible, the model must be tested statistically. Testing the binary logistic regression model uses the Hosmer and Lemeshow Test with the assumption:

- Ho: The model has been quite able to explain the data (Goodness of Fit)
- H1: The model does not adequately explain the data

Criteria:

- Accept Ho if \(p\)-value sig. > 0.1
- Reject Ho if \(p\)-value sig. < 0.1
Table 3. Hosmer and Lemeshow Test based on frequency

| Step | Chi-square | df | Sig. |
|------|------------|----|------|
| 1    | 0.0000     | 1  | 1.0000 |

It can be seen from Table 3 of the Hosmer and Lemeshow Test for the regression results of frequency variables that the chi square value of 0.00 < 2.71 chi square table value (df = 1 with significance 0.1) is 0.00 < or sig value 1.00 > 0, so that the decision is Ho accepted, with a confidence level of 90% can believe that the logistic model used is sufficient to explain the data / according to testing. This proves that the logistic regression model is feasible to interpretation.

Table 4. Classification plot for frequency variable

| Observed | Predicted | Scenario 2 (Rp. 280k, 40 min) | Percentage Correct |
|----------|-----------|-------------------------------|--------------------|
| Step 1   | Scenario 2| No                            | 95.1               |
|          |           | 116                           |                    |
|          |           | 6                             |                    |
|          |           | Yes                           | 18.2               |
|          |           | 45                            |                    |
|          |           | 10                            |                    |
| Overall percentage |         |                               | 71.2               |

Table 4 Classification plots for frequency variables show that the logistic regression used is quite good because it is able to guess correctly 71.2% of the conditions that occur.

5.1.3. Interpretation of the Binary Logistic Regression Model
The probability of Argo Parahyangan train passengers with a frequency of 3 times a month choosing to use the high speed is 62.50%.

The binary logit regression results or the probability of respondents using the HST for each scenario can be seen in Table 5.

Table 5. Summary of results of binary logit regression analysis

| Variable | Category     | Scenario           | Probability |
|----------|--------------|--------------------|-------------|
| Trip Purpose | Tourism | 1 (Rp. 300k, 30 min) | 16,27%     |
|           | Family visit | 1 (Rp. 300k, 30 min) | 13,20%     |
|           | Others       | 1 (Rp. 300k, 30 min) | 72,71%     |
| Travel Frequency | 2 times a month | 2 (Rp. 280k, 40 min) | 16,66%     |
|           | 3 times a month | 2 (Rp. 280k, 40 min) | 62,50%     |
| Income   | Rp 5 to 7 mio | 2 (Rp. 280k, 40 min) | 28,07%     |
|           | > Rp 7 mio   | 2 (Rp. 280k, 40 min) | 12,00%     |
|           | Rp 5 to 7 mio | 5 (once an hours)   | 42,12%     |
| Income   | > Rp 7 mio   | 5 (once an hour)    | 96,00%     |
| Income   | > Rp 7 mio   | 6 (every 2 hours)   | 48,00%     |
| Income   | > Rp. 7 mio  | 7 (every 3 hours)   | 20,00%     |
| Travel Frequency | 2 times a month | 9 (connect bus)  | 83,34%     |
|           | 3 times a month | 9(connect bus)     | 63,76%     |
Based on Table 5, the results show that the highest probability value is in scenario 5 (frequency once an hour) with a probability value of 96.00%. Or it can be interpreted that as many as 96.00% of respondents of Argo Parahyangan train users are willing to use HST if the facilities offered are the frequency of train departures once an hour. So it can be concluded that Argo Parahyangan train passengers are more likely to like the frequency departure facility as a consideration to switch to using the HST.

5.2. Willingness to Pay (WTP)
WTP is the willingness of the user to issue a reward for the services they obtain. WTP analysis is the average expected rate, expected service priority and WTP more for service improvement. The approach used in WTP analysis is based on the user's perception of the tariffs of the public transportation [10].

Several travel choice scenarios are given to respondents, this is where stated preference methods start running. This is because the fast train has not operated at the time the respondent was given questions about rates, frequency travel time and accessibility. For the question of the scenario with the choice of frequency and accessibility, the respondent is given the opportunity to choose the rate that the respondent wants.

The WTP value obtained from each respondent, in the form of the maximum rupiah value that the respondent is willing to pay for the tariff for railroad services, is processed to obtain the mean value of the WTP value, using the formula:

$$MWTP = \frac{1}{n} \sum_{i=1}^{n} WTP_i$$

where:
- \( n \): sample size
- \( WTP_i \): The maximum WTP value of respondents to \( i \)
- \( MWTP \): Average WTP

A summary of the WTP value can be seen in Table 6 and the graph in Figure 1.

| Scenario          | WTP Value  | Cumulative % of respondents will use the HST |
|-------------------|------------|---------------------------------------------|
| 5 (once an hour)  | Rp. 240.000 | 52.94%                                      |
| 6 (every 2 hours) | Rp. 210.000 | 45.83%                                      |
| 7 (every 3 hours) | Rp. 200.000 | 50.82%                                      |
| 8 (Connect LRT)   | Rp. 240.000 | 55.29%                                      |
| 9 (Connect Bus)   | Rp. 215.000 | 42.95%                                      |
6. Conclusion

From the results of data analysis and discussion in this study, it can be concluded that:

- The analysis results obtained by the probability model of logistic regression between the Argo Parahyangan train and the HST, obtained the result that the highest probability value is in scenario 1 frequency with a probability value of 96.00%. Or it can be interpreted that as many as 96.00% of respondents of Argo Parahyangan train users will use the HST if the facilities offered are the frequency of train departures once an hour.

- The biggest WTP value is in the scenario conditions offered, namely intermodal accessibility connected with the LRT (Light Rail Transit) mode, and also once a hour frequency scenario where the WTP value reaches.

References

[1] Mazzulla E 2008 Willingness-to-pay of public transport users for improvement in service quality European Transport \ Trasporti Europei n. 38 (2008): 107-118 Another reference
[2] Khisty C J and Lall B K 2003 Transportation engineering, an introduction Third Edition (New Jersey: Pearson Education, Inc.)
[3] Basuki J T 2009 Exploring the Willingness and Ability to Pay for Paratransit in Bandung, Indonesia Journal of Public Transportation Vol. 12 No.2
[4] Román C, Espino R, and Martin J C 2007 Competition of high-speed train with air transport: the case of Madrid–Barcelona J. Air Transp. Manage 13 277–284.
[5] Albalate D and Bel G 2012 The Economics and Politics of High-speed Rail. Lessons from Experiences Abroad (Lanham: Rowman and Littlefield Publishers (Lexington Books))
[6] Lee J-K 2016 A Study on travelers transport mode choice behavior using the mixed logit model: A case study of The Seoul-Jeju route Jurnal Air Transport Management
[7] Ono I 2015 Stated preference analysis to estimate the domestic transport demand following the future entry of LCCs and the inauguration of the Linear Chou Shinkansen in Japan Journal of Air Transport Management
[8] Román C, Espino R, and Martin J C 2010 Analyzing competition between the high speed train and alternative modes. The case of the Madrid–Zaragoza–Barcelona corridor J. Choice Model 3 (1) 84–108.
[9] R C Jou 2011 Airport ground access mode choice behavior after the introduction of a new mode: A case study of Taoyuan International Airport in Taiwan Transportation Research Part E 47 371–381
[10] P Chiambaretto 2013 Measuring the willingness-to-pay of air-rail intermodal passengers
    *Journal of Air Transport Management* **26** 50-54

[11] Widyastuti H and Willy K 2015 *Analisis Willingness To Pay Menggunakan Binary Choice Model*  
    (Studi Kasus: Rencana Re-Aktivasi Rute Kereta Api Jember-Panarukan) p. 10