Evaluation of Airport Train Fare Based on Willingness to Pay of Users (Case Study Soekarno-Hatta International Airport)

1st Nuryani Tinumbia
Civil Engineering Department
Faculty of Engineering, Pancasila University
Jakarta, Indonesia
Nuryani@univpancasila.ac.id

2nd Prima Jiwa Osly
Civil Engineering Department
Faculty of Engineering, Pancasila University
Jakarta, Indonesia
primajiwa.osly@univpancasila.ac.id

3rd Bambang Cahyadi
Industrial Engineering Department
Faculty of Engineering, Pancasila University
Jakarta, Indonesia
bambang.cahyadi@univpancasila.ac.id

4th Glorya Rombe Datu
Civil Engineering Department
Faculty of Engineering, Pancasila University
Jakarta, Indonesia
gloglory1996@gmail.com

***Abstract*— The presence of the Airport Train provides an alternative for users to access Soekarno-Hatta International Airport in avoiding congestion on the road due to increased traffic volume. Since the first operation, there has been a rapid change in fare and a significant increase that has affected the people's purchasing ability. This study aims to evaluate the Airport Train fare based on Willingness to Pay (WTP) of users. Data collection was conducted by user interviews (stated preference) at the station and on the train. The analysis of WTP uses the Discrete Choice Model by comparing scenario improvement services (like shorter headway and travel time) and the existing services. The finding is that the estimated value of WTP is IDR 83,969. When it is compared to the existing fare, it is certainly very possible to increase the fare by improving service performances.**

Keywords—Willingness to Pay, Fare, Airport Train.

I. Introduction

An airport is one of the transportation nodes where intermodal integration occurs. The easy and smooth integration of modes will support the movement of people and goods thus it can increase economic growth indirectly. Increase of travel time from/to the airport due to congestion is a problem faced by big cities in Indonesia including Jakarta. The development of rail-based public transportation such as Airport Train is an alternative solution for congestion problem. However, the Airport Train fare is considered expensive by users..

The Airport Train is an alternative mode that transfers passengers from downtown Jakarta to Soekarno-Hatta International Airport and vice versa. It stops at several stations namely Sudirman Baru Station (BNI City Station), Batu Ceper Station, and Soekarno-Hatta Airport Station with a total distance of 36 kilometers. The presence of this public transport service provides an alternative choice for users to avoid congestion on the road due to increased traffic volume. Since it started operating at the end of December 2017, the Airport Train service has changed its fares (due to opening promotions). There has been a big change change in its fare and a significant increase that has affected the people's purchasing ability. It needs a study to provide an overview of appropriate fare that can give benefit to all.

The study aims to evaluate the Soekarno-Hatta Airport Train fare based on people's purchasing ability expressed in User's willingness to Pay-WTP of users. The route studied is BNI City station to Soekarno-Hatta station and vice versa. Interviewed respondents are airline passengers and visitors.

II. Literature Review

Many researchers have examined the evaluation of transport mode fare based on Vehicle Operating Costs [1], Ability to Pay (ATP) and Willingness to Pay [2, 3] and a combination of Vehicle Operating Costs, ATP and WTP [4-6]. WTP is the highest price that an individual wants to pay for the services obtained. Many methods were developed in estimating WTP [7], through direct surveys or indirect surveys. Direct surveys are experts/sales force surveys and customer surveys, meanwhile indirect surveys are Conjoint Analysis and Discrete Choice Models. In a direct survey, individuals are asked to state how much they would pay for some products.

There are two approaches in preference surveys, they are Revealed Preference (RP) and Stated Preference (SP). The Revealed Preference analyzes people's choices based on existing reports. Statistical techniques are used to identify factors affecting people's choices. The Stated Preference finds out people's preferences when they face a choice. The researcher can fully control the factors in the hypothesized situation. Each individual is asked about his response if faced with the situation given in the actual situation (how does his preference about the choice offered).

Discrete Choice Model (DCM) uses the principle of utility maximization [8]. The individual is modelled on choosing an alternative with the highest utility among the other available utility options. The model consists of the utility function of the observed independent variables and the unknown ones, the values are estimated from the sample choices made by the individuals when they face choices. DCM analysis has been widely used in transportation studies which generally use the logit model analysis [3, 9-13].

The utility consists of two components, they are measurable attributes (travel time and cost) and unmeasurable attributes (comfort and safety). Most individual show inconsistencies in choosing or considering factors that cannot be identified by researchers. This concept is a random utility, where there are error terms in the utility function. It reflects unobservable elements of the choice behaviour.

$$\text{Random Utility of Product } i = U_i + \varepsilon_i \quad (1)$$

Where Ui is the utility of product-i; and εi = error term

The logit binomial is the logit model consisting of two alternatives (i and j). The probability of choosing i-alternative by an individual is expressed in the equation as follows [14]:

$$P(i) = \frac{\exp(U_i)}{\sum \exp(U_i + U_j)} \quad (2)$$

And the probability of choosing *j*-alternative is:

$$\text{P}(j) = 1 - P(i) = \frac{1}{1 + \exp(U_i + U_j)} \quad (3)$$

The probability of choosing i-alternative ($P(i)$) is a function of utility differences between both alternatives ($U_i - U_j$). Assuming utility function is linear, it is expressed in the equation as follows:

$$U_i - U_j = \beta_0 + \beta_1(X_1U_i - X_1U_j) + \beta_2(X_2U_i - X_2U_j) + \cdots + \beta_n(X_nU_i - X_nU_j) \quad (4)$$

Where $X_1,..X_n$ is the product attributes; $\beta_1,\ldots \beta_n$ is the coefficient of attributes; and β_0 is a constant.

III. Methodology

Data collection was carried out with a stated preference survey of 206 passengers who travelled from BNI City Station to Soekarno-Hatta Airport Station (and vice versa) using the Soekarno-Hatta Airport Train. The interview surveys were conducted at BNI City station, Soekarno-Hatta Airport station, and on the board. The time of the survey was on weekdays and weekends. The number of samples is calculated using the Slovin Formula [15].

The value of Willingness to Pay (WTP) of the Airport Train users is calculated using the Discrete Choice Model (DCM) with two choices (Binary Choice). The binomial logit model is built based on the stated preference survey data. Modelling is done by comparing performance if there are improvements (do-something scenario) and existing performance (do-nothing scenario) of the Airport Train Services. It is expressed in whether or not to use the Airport Train if there are some improvements in service performance. The probability that individuals choose to use the Airport Train if there are some service performance improvements is a function of the difference utilities between the attributes of the do-something (DS) scenario and the do-nothing (DN) scenario. The attributes are travel time, headway, and travel costs. The model is built in a general, departure trip, arrival trip, business trip, and non-business trip model. The value of WTP is obtained based on the probability of choosing the alternatives, it is a 50% probability when the user chooses DS and DN [3] according to WTP interval [16, 17].

The elasticity value of the model is calculated with the measures of responsiveness of market shares to changes in each attribute. This is to find out the percentage changes in choosing to use the Airport Train (with do-something scenario) caused by a 1 percent change in the certain attribute. [14, 18]

IV. Result & Analysis

Socio-economic and trip characteristic data of respondents are presented in the following table.

TABLE I. SOCIO-ECONOMIC AND TRIP CHARACTERISTIC DATA

Socio-economic Data	%
Gender	
Male	59.22
Female	40.78
Age	
<20 years	1.46
20-30 years	43.69
31-40 years	42.23
41-50 years	9.71
> 50 years	2.91
Occupation	
Student	19.90
Employee	43.69
Entrepreneur	20.87
Civil Servant	10.19
Army/Police	1.46
Housewife	3.88
Education Background	
High School	19.42
Diploma	6.80
Bachelor	61.17
Postgraduate	12.62
Income (per month)	
< Rp.3,500,000	9.22
Rp.3,500,000 – Rp.5,000,000	15.05
Rp.5,000,001 – Rp.6,500,000	6.31
Rp.6,500,001 – Rp.8,000,000	16.02
Rp.8,000,001 – Rp.9,500,000	13.11
Rp.9,500,001 – Rp.11,000,000	22.82
> Rp.11,000,000	17.48

Trip Characteristic	%
Trip	
Departure	59.22
Arrival	40.78
Frequency of travel by airplane (per year)	
1-2 times	1.46
3-5 times	43.69
6-11 times	42.23
>12 tims	9.71
Frequency of trip to airport (per year)	
1-2 times	19.90
3-5 times	43.69
6-11 times	20.87
>12 times	10.19
Trip purpose	
Business	19.42
Vacation	6.80
Education	61.17
Others	8.25
Most used mode of transportation to airport	
Airport train	6.80
Private car	32.04
Taxi	25.73
Bus	23.30
Others	12.14
Transport Cost (per month)	
< Rp.500,000	19.42
Rp.500,000 - Rp.1,000,000	64.08
Rp.1,000,001 - Rp.1,500,000	5.34
Rp.1,500,001 – Rp.2,000,000	7.77
Rp.2,000,001 – Rp.2,500,000	0.97
Rp.2,500,001 – Rp.3,000,000	1.94
> Rp.3,000,000	0.49

A. Utility Function

The utility function is estimated by the Maximum Likelihood. Several statistical tests were carried out [19, 20] in the utility function model with these three attributes. The results of statistical tests show that the travel time is not significant for the dependent variable, thus it is omitted from each function. It means that Travel Time does not significantly affect user's choice [20]. The statistical output of the utility functions with two attributes (headway and travel cost) shows as follows:

TABLE II. STATISTICAL OUTPUT OF UTILITY FUNCTION

Parameters	General	Departure	Arrival	Business	Non-business
n	2472	1212	1260	1164	1308
Log likelihood func.	-1281.35339	-648.98609	-630.45369	-643.06404	-626.15538
$\chi^2_{statistic}$	260.56575	121.30574	140.58816	139.00105	124.15407
p-value	0.000	0.000	0.000	0.000	0.000
Num. of Parameter	3	3	3	3	3
β0	0.14241	0.12182	0.17008	0.39731	-0.08365
β1 (HDWY)	-0.04977	-0.05113	-0.04849	-0.05142	-0.0492
β2 (COST)	-0.00006364	-0.00005932	-0.00006841	-0.000064636	-0.000063986
Std. Error β0	0.11468	0.16146	0.1632	0.16198	0.16462
Std. Error β1	0.00665	0.00931	0.00951	0.00937	0.00956
Std. Error β2	0.000004651	0.000006439	0.000006747	0.000006468	0.000006791
z β0	1.24	0.75	1.04	2.45	-0.51
z β1	-7.49	-5.49	-5.1	-5.49	-5.15
z β2	-13.68	-9.21	-10.14	-9.99	-9.42
p-value β0	0.2143	0.4506	0.2974	0.0142	0.6113
p-value β1	0	0	0	0	0
p-value β2	0	0	0	0	0
$\chi^2_{critical}$	5.991464547	5.991464547	5.991464547	5.991464547	5.991464547
$z_{critical}$	1.960924881	1.961926469	1.961851518	1.962007618	1.961782081

The likelihood-ratio test shows that headway (HDWY) and travel cost (COST) attribute in all models simultaneously influence the dependent variable ($\chi^2_{statistic} > \chi^2_{critical}$). The partial test statistic z (Wald test) also shows that each attribute has got significant influence on the choice of the individual ($|z| > z_{critical}$). Based on the statistical output above, the five utility function models can be rewritten as general (5), departure (6), arrival (7), business (8), and non-business (9).

$$U_{DS} - U_{DN} = 0.14241 - 0.04977*(HDWY_{DS} - HDWY_{DN}) - 0.000063638*(COST_{DS} - COST_{DN}) \quad (5)$$

$$U_{DS} - U_{DN} = 0.12182 - 0.05113*(HDWY_{DS} - HDWY_{DN}) - 0.000059321*(COST_{DS} - COST_{DN}) \quad (6)$$

$$U_{DS} - U_{DN} = 0.17008 - 0.04849*(HDWY_{DS} - HDWY_{DN}) - 0.000068411*(COST_{DS} - COST_{DN}) \quad (7)$$

$$U_{DS} - U_{DN} = 0.39731 - 0.05142*(HDWY_{DS} - HDWY_{DN}) - 0.000064636*(COST_{DS} - COST_{DN}) \quad (8)$$

$$U_{DS} - U_{DN} = -0.08365 - 0.0492*(HDWY_{DS} - HDWY_{DN}) - 0.000063986*(COST_{DS} - COST_{DN}) \quad (9)$$

For general model the negative sign on travel cost coefficient means that if there is a Rp. 1 increase in travel cost results in 0.000063638 decreasing of utility, thus it will decrease the probability of choosing DS service (do-something scenario) and vice versa it will increase the probability of choosing DN service (do-nothing scenario), and so on for other models. It is a similar definition to the headway attribute condition.

B. Sensitivity of Models and Willingness to Pay

It is important to know the sensitivity of models if there is a change in attribute values. Fig. 1, 2, and 3 shows the probability of choices (both DS and DN) due to changes in fares gradually (the other attribute is assumed constant). The probability is obtained by calculating the difference in utility of the do-something scenario and the do-nothing scenario according to Equation 2. Then the values of Ability to Pay (ATP) and Willingness to Pay (WTP) can be estimated from these graphs.

$$P_{(DS)} = \frac{\exp(U_{DS} - U_{DN})}{1 + \exp(U_{DS} - U_{DN})} \quad (10)$$

Thus,

$$P_{(DS)} = \frac{\exp(0.14241 - 0.04977 \times (HDWY_{DS} - HDWY_{DN}) - 0.000063638 \times (COST_{DS} - COST_{DN}))}{1 + \exp(0.14241 - 0.04977 \times (HDWY_{DS} - HDWY_{DN}) - 0.000063638 \times (COST_{DS} - COST_{DN}))} \quad (11)$$

$$P_{(DN)} = 1 - P_{(DS)} \quad (12)$$

The slope of the line for the do-something scenario services (DS) on the graph shows the negative direction, it means that the greater the Airport Train fare (with service improvements), is the smaller the probability of choosing DS services and vice versa for the do-nothing scenario services (DN). Besides the WTP, it is necessary to it gets know the value of Ability to Pay (ATP). Both are obtained based on the probability of choosing the services. The range of ATP of the Airport Train users for the existing condition is the difference in fares on the probability of choosing DN service by 50%-90% plus the existing fare. The value of Willingness to Pay (WTP) can be estimated based on the probability of choosing service where at the probability of 50% each individual (Airport Train user) can choose freely whether to use DS service or not. The WTP is the difference in fare at the probability of 50% choosing DS or DN plus the existing fare.

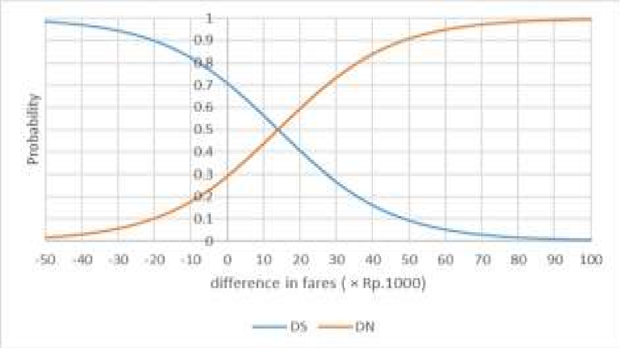

Fig. 1. The Sensitivity of The Model Due To Changes In Travel Costs

Fig. 2. The Sensitivity of The Model Due To Changes In Travel Costs For Departure Trip Model (Left) And Arrival Trip Model (Right)

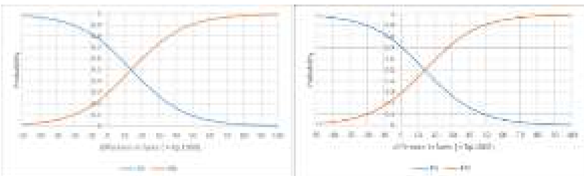

Fig. 3. The Sensitivity of The Model Due To Changes In Travel Costs For Business Trip Model (Left) And Non-Business Trip Model (Right)

TABLE III. ABILITY TO PAY (ATP) OF THE AIRPORT TRAIN USERS

Trip	Existing fare	Difference in fare	Range of ATP
General (Overall)		Rp13,969-Rp48,502	Rp83,969-Rp118,502
Departure		Rp14,982-Rp52,022	Rp84,982-Rp122,022
Arrival	Rp.70,000	Rp13,118-Rp45,241	Rp83,118-Rp115,241
Business		Rp18,080-Rp52,075	Rp88,080-Rp122,075
Non-business		Rp10,226-Rp44,572	Rp80,226-Rp114,572

TABLE IV. WILLINGNESS TO PAY (WTP) OF THE AIRPORT TRAIN USERS

Trip	Existing fare	Difference in fare	WTP
General (Overall)		Rp 13,969	Rp 83,969
Departure		Rp 14,982	Rp 84,982
Arrival	Rp.70,000	Rp 13,118	Rp 83,118
Business		Rp 18,080	Rp 88,080
Non-business		Rp 10,226	Rp 80,226

Overall for both departure and arrival trip, the range of ATP obtained is Rp 83,969 - Rp 118,502 and the WTP is Rp. 83,969. The ATP-WTP value of Departure passengers is slightly higher than Arrival passengers (difference is Rp. 1,864), it is because the Departure passengers tend to need certainty of time and short trip time so they are willing to pay a higher cost so that they do not miss their flights. The business trip passengers also tend to pay higher cost compared to non-business trip passengers (difference is Rp. 7,854).

The elasticity of the model is calculated by assuming that the headway is constant in both scenarios. The average attribute difference for headway is 15 minutes and for the fare is Rp. 30,000, then the utility value is -1.02018 and the probability of choosing DS (P_{DS}) is 0.265. The biggest elasticity value of the model is obtained at the travel cost attribute (-1.4032), which means that every 1% increase in cost can reduce 1.4032% of the probability of choosing the do-something scenario services.

C. Evaluation of the Airport Train Fare

The range of ATP (Rp 83,969 - Rp 118,502) and the WTP (Rp. 83,969) are greater than the existing fare (Rp. 70,000), so the existing fare does not affect the users. Moreover, similar conditions occur for other kinds of trip of passengers (departure, arrival, business, and non-business trip). So the existing fare is in the freedom zone of ideal fare determination without improving service performance to the WTP value limit. The increase in the Airport Train fare that exceeds the value of WTP must be followed by improvements in service performance.

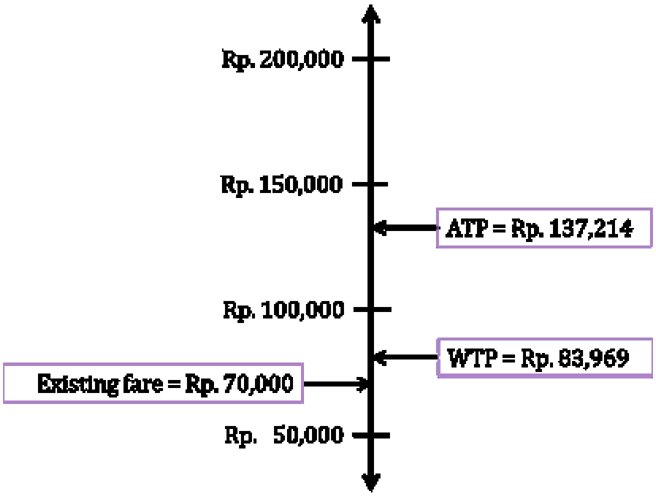

Fig. 4. Comparison of Atp-Wtp And Existing Fare

The ATP-WTP value with a relatively high sensitivity to the existing fare for departing to the airport and for users with the purpose of business trip implies that there is a need for fast mobility and certainty of time, so the service performance is needed to shorten the headway and travel time. For the existing service conditions, the implementation of pricing strategies such as giving discounts at certain times (for example on weekdays or at peak times) in order to attract more users to use the Airport Train can be conducted. In addition, this strategy has to accommodate other users with non-business trips for example by giving discounts on vacation times or giving discounts for group trips. Fare differentiation can also be done for student users.

V. Conclusion & Recommendation

The trip to the airport is generally an occasional trip thus it is greatly influenced by the transportation modes offered. Overall, the range of ATP is greater and/or equal to WTP. The fact that ATP is greater than the WTP indicates that the ATP of users is relatively higher than the utility of the Airport Train services. Meanwhile, for the condition where the value of ATP is the same as WTP, it shows the balance between user utility and the cost paid for the Airport Train service. The existing fare is in the freedom zone of ideal fare determination without improving service performance to the WTP value limit. The increase in the Airport Train fare that exceeds the value of WTP must be followed by improvements in service performance. This finding is in line with the characteristics of respondents who mostly used private cars and taxis to go to the airport in which the travel cost is relatively higher than the Airport Train fare.

However, further evaluation by comparing the value of the Train Operating Costs (Biaya Operasional Kereta Api - BOKA) would be better to determine the most ideal fare for the Airport Train. Then, if it is compared to the fare previously proposed by The Rail Operator for Rp 100,000, it must be followed by improvements in service performance.

In addition, to increase ridership of the Airport Train, it is necessary to improve the accessibility and integration with other transportation modes. Consideration of feeder transport to link the departure station of the Airport Train is one of the important aspects for users in using this service. Now, with the operation of the Airport Train to Manggarai and Bekasi Station, further research will be more represented by various market segments.

REFERENCES

[1] Listiani, Asti Sri, Farida, Ida, Walijodjati, E., 2013. evaluasi tarif angkutan umum berdasarkan biaya operasional kendaraan (BOK). evaluasi tarif.

[2] Astuti, P. and Tertia, V., 2012. Study Of Ability To Pay And Willingness To Pay For Passanger Of Commuter Line Jakarta-Bogor. Proceeding 8th International Seminar on Industrial Engineering and Management.

[3] Wulansari, D.N., Maulana, A.C. and Astari, M.D., 2018. Analysis of ability to pay and willingness to pay for Jakarta light rail transit in Jakarta, Indonesia. 3rd International Conference on Computing, Engineering, and Design, ICCED 2017.

[4] Tamin, O.Z., Rahman, H., Kusumawati, A., Munandar, A.S. and Setiadji, B.H., 1999. Evaluasi Tarif Angkutan Umum Dan Analisis “Ability To Pay” (Atp) Dan “Willingnes To Pay” (Wtp) di Dki Jakarta. Jurnal Transportasi: Forum Studi Transportasi antar Perguruan Tinggi (FSTPT).

[5] Krisnanto, A.R., Legowo, S.J. and Yulianto, B., 2015. Evaluasi Tarif Berdasarkan Biaya Operasional Kendaraan (BOK), Ability to Pay (ATP), Willingness to Pay (WTP), dan Analisis Break Even Point (BEP) Bus Batik Solo Trans (studi kasus: Koridor 1). e-Journal Matrics Teknik Sipil.

[6] Murwandono, P., Joko Legowo, S. and Musthofiah Hidayah, A., 2015. Evaluasi Tarif Berdasarkan Biaya Operasional Kendaraan (BOK), Ability to Pay (ATP), Willingness to Pay (WTP), dan Analisis Break Even Point (BEP) Bus Batik Solo Trans (studi kasus: Koridor 1). e-Journal Matrics Teknik Sipil.

[7] Breidert, C., 2006. Estimation of willingness-to-pay: Theory, measurement, application,

[8] Ben-Akiva, M. and Lerman, S.R., 1985. Discrete Choice Analysis: Theory and Application to Travel Demand, Cambridge, Massachusetts, USA.: MIT Press.

[9] Eboli, L. and Mazzulla, G., 2008. Willingness-to-pay of public transport users for improvement in service quality. European Transport.

[10] Vanany, I., Ciptomulyono, U., Khoiri, M., Hartanto, D. and Imani, P.N., 2015. Willingness to Pay for Surabaya Mass Rapid Transit (SMART) Options. Procedia Manufacturing.

[11] Joewono, T., 2015. Exploring the Willingness and Ability to Pay for Paratransit in Bandung, Indonesia. Journal of Public Transportation.

[12] Kusuma, A., Tinumbia, N. and Leksono, P., 2017. The Characteristics of Potential Passengers of an Indonesian High-Speed Train (Case Study: Jakarta-–Bandung). International Journal of Technology.

[13] Aloulou, F., 2018. The Application of Discrete Choice Models in Transport. Statistics - Growing Data Sets and Growing Demand for Statistics.

[14] Ortuzar, J. de D. and Willumsen, L.G., 2011. Modelling Transport

[15] Sugiyono, 2013. metodologi penelitian kuantitatif kualitatif dan R & D. Bandung: Alfabeta.

[16] Schlereth, C., Eckert, C. and Skiera, B., 2012. Using discrete choice experiments to estimate willingness-to-pay intervals. Marketing Letters.

[17] Wang, T. and Hu, M.Y., 2018. Differential pricing with consumers’ valuation uncertainty by a monopoly. Journal of Revenue and Pricing Management.

[18] Louviere, J.J., Hensher, D.A. and Swait, J.D., 2000. Stated Choice Methods: Analysis and Applications. Analysis and Applications.

[19] AGRESTI, A., 2006. AN INTRODUCTION TO CATEGORICAL DATA ANALYSIS: SECOND EDITION,

[20] Hensher, D.A., Rose, J.M. and Greene, W.H., 2005. Applied choice analysis: A primer,