ANALYSIS OF INTERACTION BETWEEN PREFERENCES AND INTENTION FOR DETERMINING THE BEHAVIOR OF VEHICLE MAINTENANCE PAY AS A BASIS FOR TRANSPORTATION ROAD SAFETY ASSESSMENT

Pungkas Hendratmoko[1*], Guritnaningsih[2], Tri Tjahjono[1]

[1]*Department of Civil Engineering, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI Depok, Depok 16424, Indonesia*
[2]*Faculty of Psychology, Universitas Indonesia, Kampus Baru UI Depok, Depok 16424, Indonesia*

ABSTRACT

In transportation science, the individual's willingness to pay (WTP) to decrease the number of fatal traffic accidents is one approach to determining the value of road safety (VRS). Such an approach can be performed with the stated preference method, which refers to the concept of preferences contained in microeconomic theory. The concept explains that humans' behavior is based on their preferences. Researchers have criticized this method because an individual's preference does not necessarily reflect one's behavior (B). However, in psychology, this is known as the theory of planned behavior (TPB), which states that human behavior is formed on the basis of intention (I). Until now, VRS determination has lacked an instrument to control the suitability of preference value, which respondents may provide in contrast to their actual behavior; therefore, VRS determination is exposed to potential bias. The purpose of this research is to make intention an instrument for controlling and analyzing the interactions between the preferences and intentions of road users in determining the behavior of paying for vehicle maintenance as a basis for determining VRS. The analytical technique used to analyze the interaction is Structural Equation Modeling (SEM). The research data was obtained through the distribution of a survey form regarding the preferences and intentions of toll road users in Indonesia. The number of samples in this research model were 250 respondents, consisting of 175 men and 75 women who met the criteria for research subjects. Based on the SEM analysis, I had a more significant effect on B than on WTP (63.1% > 35.2%) in correcting the determination of VRS.

Keywords: Behavior; Intention; Preferences; Value of road safety

1. INTRODUCTION

Traffic safety has become a global transportation issue, as well as a social issue. On May 11, 2011, all members of the United Nations (UN) agreed to create the Decade of Action for Road Safety (DoA) 2011-2020. This program's goal is to reduce the number of traffic fatalities by 50% by 2020. A decrease in the number of people injured and killed on the road reflects the effectiveness of investments in the field of road transportation safety. Therefore, assessing the feasibility of investments requires the proper calculation of benefits, which can be done by setting the value of road safety (VRS).

While VRS determination can be performed with several approaches (Jones Lee, 1990), the

most common method is calculating willingness to pay (WTP). One way to determine WTP is the stated preference (SP) method, which directly asks respondents about their preferences and willingness to pay to decrease the number of traffic accident fatalities in designed conditions (hypothesis). VRS determination with the WTP approach of the stated preference method is done by referring to the value of statistical life (VoL) theoretical model. The VoL model applies the microeconomic concept of the marginal rate of substitution (MRS) between a number of items in a package (bundle). In relation to this model, the substitution in question is a sum of money that is willing to be paid for vehicle maintenance to decrease the number of fatal traffic accidents. A sum of money that is willing to be paid is known as the value of preference/WTP Safety (Andersson, 2013). Furthermore, the value of preference/WTP Safety is used as a basis for determining VoSL and VRS.

The SP method is built on the microeconomic perspective's deterministic utility model, which is used to determine individual behavior (the behavior of one's willingness to pay for vehicle maintenance). In such a model, the utility function of its preference forming is coherent and invariant (Arrow et al., 1996). However, this assumption has been tested and rejected in various studies conducted in the field of psychology. According to Fujii and Garling (2002), if it is assumed that the utility function of its preference forming is coherent and invariant, this means that a series of alternatives to individual preferences, built in the same condition, is designed with a series of alternatives to the individual preferences on the actual conditions. In fact, a series of alternatives to individual preferences depends on the context (Dawes, 1998; McFadden, 1999). Then, if the assumption is true, each individual's response to a series of preference alternatives should be the same, not different (Kahneman et al., 1991; Keuhberger, 1998). When presented with a series of alternative preference choices that are the same, the individual's perception can vary, depending on one's rationality and cognitive abilities (Payne et al., 1993). Various contexts documented in psychology studies have been frequently mentioned as biased or anomalous (Dawes, 1998; Kahneman et al., 1991). Therefore, the selection model should accommodate for inaccuracies in the information and incorporate probability elements for individuals who do not understand a series of alternatives in the question so that the choice for a series of alternatives is expressed in terms of the probability of choice. The utility model that accommodates an uncertainty element is called a probabilistic utility model. As with the deterministic choice theory, the individual is assumed to choose an alternative if the utility is greater than the utility of other alternatives. Utility functions that are considered contain two main elements: 1) the utility obtained based on the attributes that can be observed existing in the alternatives and 2) the element that is the difference between the utility that can be predicted and the actual utility received by consumers (Koppelman & Bhat, 2006). The difference between the two utilities is stated in the random variables because the actual utility received by individuals cannot be known. Utilities considering the probability element can be represented as follows:

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

where;

U_{it} :   actual utility and alternative "I" at the decision makers "t";

V_{it} :   a deterministic portion, or a portion observed from the utility estimated by investigators;

ε_{it} :   an error, or a portion, and a utility that are not known by the observers.

The main objective of this research is to develop a predictive model of the national road's IRI based on the data that has been collected by the IIRMS. The further objective of this research is In psychology, attitude variable is more stable when predicting behavior (Eagly & Chaiken, 1993). The most important part of the attitude theory is explaining the intention to

behave/behavioral intention, which is the best predictive variable to determine behavior, as explained in the Theory of Reason Action and the Theory of Planned Behavior.

Considering the aforementioned arguments, it is believed that the SP method used for the determination of preference value/WTP Safety, which is built on microeconomic behavior theory, is not optimal for predicting the behavior of willingness to pay for vehicle maintenance. This is because there is no instrument that controls the suitability of the respondents' views concerning their willingness to pay the cost of vehicle maintenance to increase safety in comparison to their actual behavior. However, from the psychological perspective, intention to behave is believed to be the best variable for predicting behavior. Therefore, to control the value of reference/WTP Safety that was stated, it is necessary to develop a new alternative framework of thought (innovation) by adding the intention variable as an instrument that controls the determination of preference value/WTP Safety. In this study, the intention variable will be referred to as the intention for safety.

The purpose of this research is to make intention an instrument of controlling and analyzing the interactions between the preferences and intentions of road users in determining the behavior of paying for vehicle maintenance as a basis for determining VRS. Related to this research, the main variables in this study are: 1) Behavior of willingness to pay vehicle maintenance (B), 2) Safety Preferences (WTP), and 3) Intention for Safety (I). In accordance with the objective that the intention for safety will be used as an instrument to control the determination of preference value/WTP Safety, this study will analyze the interactions between the preferences and intentions for safety in determining the behavior to pay for safety. The interaction is expected to reveal their relationship, and this relationship will be used to reconstruct the determination of preference value/WTP Safety, which will eventually be used as a basis for determining VRS.

2. METHODOLOGY

Based on the model of VRS determination with the WTP approach and SP method (Figure 1), the preference/WTP Safety provided by respondents on the SP survey is deemed to have reflected their behavior. Furthermore, the preferences are used as the basis for determining VoSL and VRS.
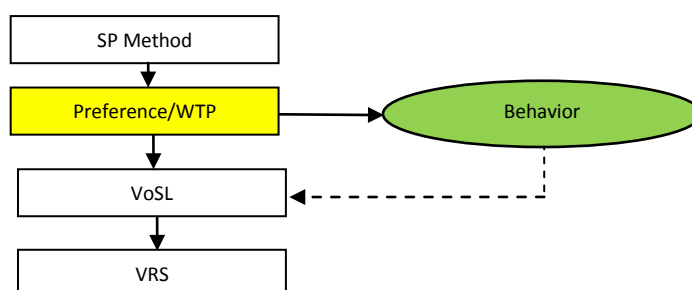

Figure 1 Model of VRS determination with the WTP approach of the SP method

The problem is this model has no instrument to control the suitability of respondents' responses with their actual behavior. Therefore, it is believed that there will be bias towards the determination of VoSL and VRS. However, social psychology continues to pursue a theory of attitudes for predicting human behavior. One popular theory is the Theory of Planned Behavior (Figure 2), in which intentions are variables that directly affect the behavior and intentions formed by three variables: 1) Attitude (A), which is defined as the positive or negative beliefs to display a certain behavior; 2) Subjective Norm (SN), which is defined as a person's perception of the social pressure to perform or not perform the behavior; and 3) Perceived Behavior Control (PBC), which is defined as the perception of the behavior's ease or difficulty.

Meanwhile, intention (I) is defined as a person's position in the dimension of subjective probability, which involves a relationship between the person and an action and whether the person will perform certain behaviors (Fishbein & Ajzen, 1975). Intention is the construction of a different psychology with attitude. Intention represents someone's motivation in the sense that people consciously plan trying to do a behavior (Eagly & Chaiken, 1993).
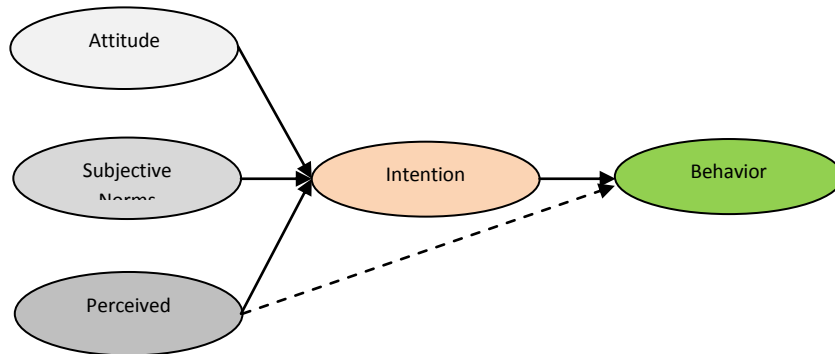
Figure 2 Model for the theory of planned behavior

In connection with this study, it will be conducted: 1) to include the safety intention in the model of VRS determination with the WTP approach of the SP method as a controlling instrument and 2) to analyze the interaction between the preference/WTP safety and safety intention in determining the behavior to pay for safety. In this research model (Figure 3), preferences and intentions interact each other and jointly influence behavior.
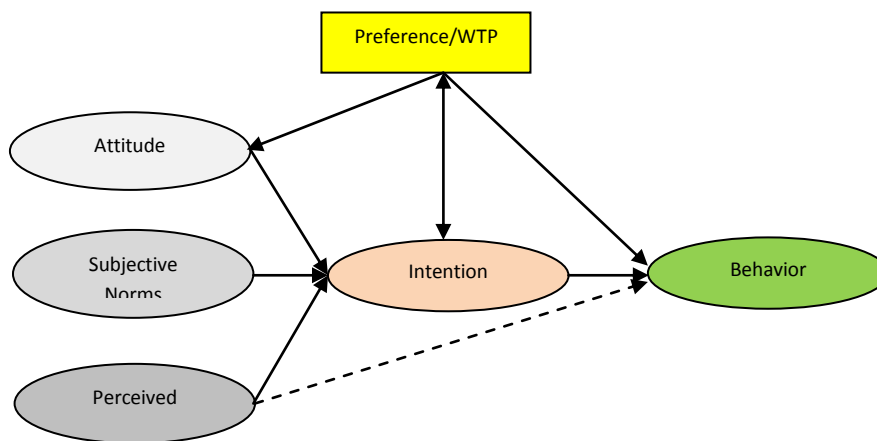
Figure 3 Model of research

Furthermore, according to Tjahjono and Hendratmoko (2014), the preference survey questions to determine the value of preference/WTP Safety in Indonesian society cannot be designed in the form of direct questions about the individual's willingness to pay the cost for improving safety, because participants may not provide an answer. Therefore, to obtain an answer, the preference survey questions should be associated with other variables. For instance, the questions could ask about the respondents' willingness to pay the costs for vehicle maintenance per year if it would reduce traffic accident fatalities by 50%. Based on data from the traffic corps (Korlantas) of the Indonesian Police, insufficient vehicle maintenance is one of the main causes of fatal traffic accidents, after humans, road infrastructure, and equipment.

2.1. Type and Size of the Data
The data type in this research is primary data obtained directly from the respondents. The

instruments used to obtain the research data is a questionnaire on 1) safety preferences and 2) safety intentions. The two parts of the questionnaire are combined in one set of survey forms. After being tested for validity and reliability, the survey forms were distributed to the research subjects, who are married couples who drive their own vehicles on toll roads in Indonesia. These subjects were chosen because they are an established group and willing to pay for the provision of road transportation safety. Five hundred survey forms were distributed, and the results from 250 forms were required for the analysis model.

2.2. Analysis Stages

The analysis of this research is conducted in four stages, which are: 1) Calculating the value of preference/WTP for determination of VoSL and VRS by determining the average value of respondents' WTP for vehicle maintenance; 2) Calculating the value of safety intentions by adding the average value of its constituent latent variables (variables of attitudes, subjective norms, and behavior control of the respondents) to pay the vehicle maintenance; 3) Analyzing the research model, the interaction between the preference/WTP with the safety intention of the road users towards the paying behavior using the analytical techniques of Structural Equation Modeling (SEM), which is a statistical analysis tool that combines factor analysis and regression to analyze the relationship between a wide range of research variables (multivariate statistical analysis); 4) Constructing the value of preference/WTP for determining VoSL and VRS by setting the values of the new preference/new WTP from the results of the research on the establishment of a SEM structural model.

3. RESULTS

3.1. The Value of Preference/WTP for Determination of VoSL and VRS

From the analysis, the average value of preference/respondents' WTP toward the paying behavior of vehicle maintenance in an effort to decrease the number of traffic accident fatalities by 50% from 20 deaths per 100,000 residents per year is 4,452,000 IDR.

Based on the average value of preference/respondents' WTP, the total funds collected from 100,000 residents each year is 4,452,000 IDR × 100,000 = 445,200,000,000 IDR, then the value of statistical life for each one (VoSL) is 445,200,000,000 IDR/10 victims rescued = 44,520,000,000 IDR per each individual. Furthermore, determining the VRS value is done by multiplying the value of VoSL and the number of victims of fatal traffic accidents that occur each year.

3.2. Intention Value

From the analysis, the average value of the constituent latent variables of intentions are described as follows: 1) the average value of ATB = 6.96; 2) the average value of SN = 8.46, and the average value of PBC = 7.56. Each latent variable is measured by three types of questionnaires as the manifest variables, which were assessed with the unipolar scale from 1 to 7 and the bipolar scale from -3 to 3; therefore, the range of values for each of the latent variables is $3 \times (7 \times \pm 3)$ or -63 to 63, which is illustrated by Figure 4.

In Figure 4, it can be explained that the respondents' attitudes toward the intention of willingness to pay for vehicle maintenance to improve road safety is a positive, but it has a weak attention, as characterized by the value of ATB < 21. This indicates that respondents are not so concerned about the risk of traffic accidents caused by internal factors (such as a flat tire and brake failure) as external factors (such as other reckless drivers). Similarly, the subjective norm and the behavior control of the respondents towards the intention of willingness to pay for vehicle maintenance to improve road safety is a positive, but it has a weak attention, as characterized by the values of SN and PBC that are less than 21. The value of SN indicates that the respondents are not so concerned about the safety of those closest to them (parents and

friends), but they are more concerned about the denial of safety support from their spouse (wife or husband).
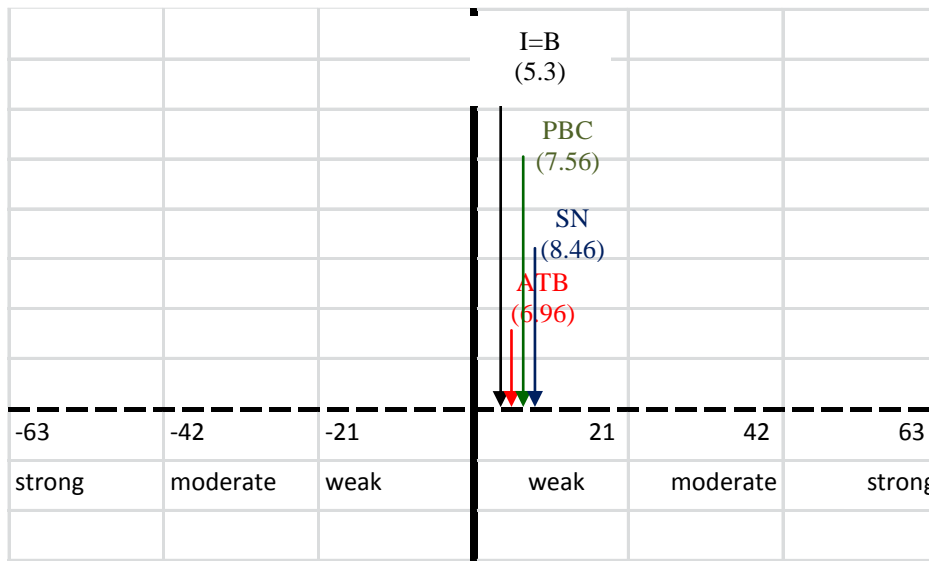

Figure 4 Interpretation value of ATB, SN, and PBC

Furthermore, the value of PBC indicates that the respondents are less likely to behave when they feel pressure to pay the vehicle maintenance (such as limited funds and the limited sale of vehicle spare parts); and although there is support to pay for vehicle maintenance (such as qualified workshops), it seems that it still cannot significantly stimulate the respondents' behaviors regarding safety concerns. All of these findings indicate that in this group, the level of concern for safety is still very low. Furthermore, based on the analysis, the value of the intention (I) = 5.3, which means that the respondents have a weak level of attention concerning road transportation safety.

3.3. Research Model Analysis using SEM Path Analysis

Research model analysis using SEM Path Analysis (Figure 5) is performed as an alternative to test a structural model when the data distribution is not normal (left as it is without eliminating outliers). Path analysis, or a path diagram, can be defined as the process of simplifying a model that is filled with indicators, creating a model that brings together the existing indicators into a box diagram that will unify all of the existing indicators into a single indicator for each variable.
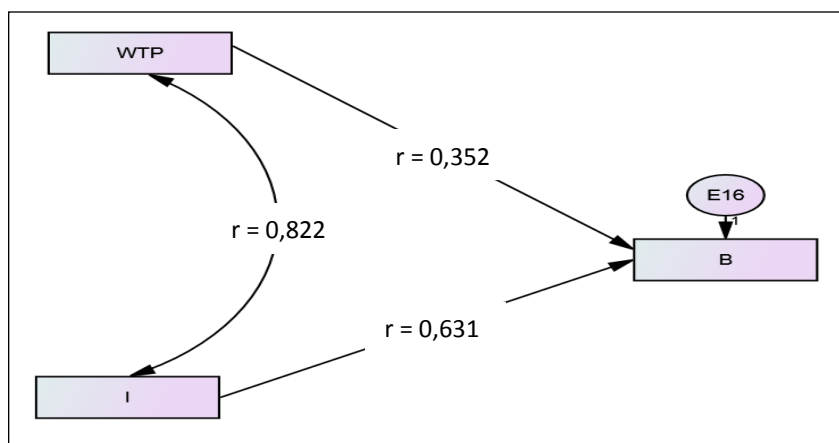

Figure 5 Structural model research - Path Analysis 2

From the analysis of SEM, the probability value (p) of all variables in the research model has a value of p < 0.05, which means that there is a strong relationship between each variable (WTP, I, and B), with a value of correlation (r) WTP $\leftrightarrow$ I (0.822), WTP $\rightarrow$ B (0.352), and I $\rightarrow$ B (0.631).

3.4. Reconstruction of the Value of Preference/WTP for Determination of VRS

Based on the value of the correlation between variables and the formulation of Equation 1, WTP on the actual behavior may be interpreted as follows:

$$B = f \,(WTP, I)$$

$$or \tag{2}$$

$$B = (0.352 \times WTP, 0.631 \times I) = (0.352 \times 4,452,000 \text{ IDR}, 0.631 \times 5.3) = (1,567,104 \text{ IDR}, 3.3)$$

Based on the results of the reconstruction of the average value of WTP, it is known that the average value of respondents' WTP is corrected from 4,452,000 IDR to 1,567,104 IDR. This means that the total funds collected from 100,000 residents to decrease the number of fatal traffic accidents by up to 50% from 20 fatalities each year is 1,567,104 IDR×100,000 = 156,710,400,000 IDR. Furthermore, the value of each statistical life, its VoSL, is 156,710,400,000 IDR/10 victims rescued = 15,671,040,000 IDR per each individual. Determining the VRS value is done by multiplying the value of VoSL and the number of victims of fatal traffic accidents that occur each year.

4. DISCUSSION

Based on the designation of model preferences/WTP using the SP method, the individual preference/individual WTP reflects one's behavior. However, based on the theory of planned behavior, an individual's intention is what reflects one's behavior. In previous research, a combination of preference/WTP and intention has been calculated with the assumption that the interval preference value/WTP is proportional with the interval of the intention value (Hendratmoko et al., 2013). Based on this research result, the value of the preference/respondents' WTP may still increase up to 142%.

Furthermore, Hendratmoko et al. (2015) considered intention as a control instrument for determining the value preferences/WTP, the results of which were used for determining VoSL and VRS. From the analysis of the preferences/WTP, the value of the average preference/respondents' WTP toward vehicle maintenance designed to decrease the number of fatal traffic accidents by up to 50% from 20 deaths per 100,000 residents each year is 4,452,000 IDR, and the obtained value of VoSL is 44,520,000,000 IDR. Furthermore, based on the results of the intentions analysis, the average value of respondents' intentions toward vehicle maintenance designed to decrease the number of fatal traffic accidents by up to 50% from 20 deaths per 100,000 residents each year is as much as 5.3, which means that the respondents still have low attention concerning road transportation safety. In accordance with its purpose to make intention a control instrument for determining preference value/WTP based on SEM path analysis, the correlation value of the variable I $\leftrightarrow$ WTP is 0.822, which means that there is a strong relationship between the intention and the preferences, while the value of the correlation variable of WTP $\rightarrow$ B is 0.352, and the value of the correlation variable of I $\rightarrow$ B is 0.631, which means that intention has a greater influence on the paying behavior for vehicle maintenance compared to preference. Based on the results of the analysis and connecting it with the theoretical basis of the equation (1), the value of respondents' WTP decreases from 4,452,000 IDR to 1,567,104 IDR, and the value of respondents' VoSL is corrected from 44,520,000,000 IDR to 15,671,040,000 IDR.

The results obtained in this research differ from the previous research; this is possible due to the use of different methodologies. In this research, it is believed that: 1) Respondents are concerned about road transportation safety, but the attention is still low, and 2) The respondents' intentions are very influential on behavior; this is proved by the correlation variable value I → B, which is greater than the value of the correlation variable WTP → B.

5.   CONCLUSION

From the results of the discussion on the analysis of interactions between preferences and user intentions in determining the paying behavior for vehicle maintenance as the basis of determining road safety value regarding road users in Indonesia, it can be concluded as follows:

1. Preference (WTP) and intentions (I) of the respondents in the research model are interacting in determining the paying behavior for vehicle maintenance with a correlation value of WTP ↔ I amounting to 0.822. This result indicates that the relationship between the two variables is very strong and that intentions can be used as an instrument of control for adjusting the value of the preference/WTP expressed by respondents.

2. Together, the respondents' preferences (WTP) and intentions (I) have a positive effect on the paying behavior (B) for vehicle maintenance by 0.352 to WTP → B and 0.631 to I → B. These results indicate that the respondents are willing to, and intend to, pay for vehicle maintenance.

3. The value of the preference/WTP to pay for vehicle maintenance in the research model is corrected from 4,452,000 IDR to 1,567,104 IDR; and for VoSL, it is corrected from 44,520,000,000 IDR per each individual to 15,671,040,000 IDR per each individual.

6.   REFERENCES

Andersson, H., 2013. Consistency in Preference for Road Safety : An Analysis of Precautionary and Stated Behavior. *Research in Transportation Economics*, Volume 43(1), pp. 41–49

Arrow, K.J., Colombat, E., Perlman, M., Schmidt, C., 1996. *The Rational Foundations of Economic Behaviour*. London: Macmillan Press

Dawes, R.M, 1998. *Behavioral Decision Making and Judgment. In*: Gilbert, D.T., Fiske, S.T., Lindzey, G., (Eds.), Handbook of Social Psychology, Fourth Ed. Mcgraw-Hill, Boston, MA, pp. 497–548

Eagly, A.H., Chaiken, S., 1993. *The Psychology of Attitudes*. Harcourt Brace College Publishers, Fort Worth, TX

Fishbein, M., Ajzen, I., 1975. *Belief, Attitude, Intention, and Behavior: An Introduction to Mode and Research*. Reading, MA: Addison-Wesley

Fujii, S., Garling, T., 2002. Application of Attitude Model for Improved Predictive Accuracy of Stated Preference Methods in Travel Demand Analysis. *Transportation Research,* Part A 37, pp. 389–402

Hendratmoko, P., Tjahjono, T., Susilo, A.E., 2013. Development of Value of Road Safety Model by Combining Behavioral Theory of Perspective Economics and Psychology as the Basis Preferences. *European Journal of Business and Management*, Volume 6(4), pp. 253–261

Jones Lee, M.W., 1990. The Value of Transport Safety. *Oxford University Press and The Oxford Review of Economic Policy Limited*, Volume 6(2), pp. 39–60

Kahneman, D., Knetsch, J.L., Thaler, R.H., 1991. Anomalies: The Endowment Effect, Loss Aversion and Status Quo Bias. *Journal of Economic Perspectives,* Volume 5, pp. 193–206

Keuhberger, A., 1998. The Influence of Framing on Risky Decisions: A Meta-analysis. *Organizational Behavior and Human Decision Processes,* Volume 75(1), pp. 23–55

Koppelman, F.S., Bhat, C., 2006. A Self-instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models. Prepared for U.S. Department of Transportation *Federal Transit Administration*

Mcfadden, D., 1999. Rationality for Economists. *Journal of Risk and Uncertainty*, Volume 19, pp. 73–105

Payne, J.W., Bettman, J.R., Johnson, E.J., 1993. *The Adaptive Decision Maker*. New York: Cambridge University Press

Tjahjono, T., Hendratmoko, P., 2014. Calculation of Willingness to Pay to Determine the Value of Road Transport Safety in Particular Road User Groups [in Bahasa]. *In*: The 17th FSTPT International Symposium, Jember University