Preferences of selecting public transit for inter-city passengers using the stated preference method with RUM and RRM Model

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Abstract. At four step model analysis there are two model choice must be known, a vehicle choice mode (mode choice), and the selection of the route (Route Choice). So far, the model developed in the world of transportation (RUM) has been based on economic theory, which emphasizes rationality in an election. Regret theory (RRM) developed a theory of voter behavior (choice behavior), where there is a state of uncertainty in it. Regret theory is used in various disciplines such as marketing, micro economy, psychology, management, and transportation. This study aims to demonstrate differences in the results of calculation of the analysis (RUM and RRM), in the case of choosing the type of vehicle, with Medan to Balige route, North Sumatera, where there are two alternative modes of vehicles, with three utilities in each of these alternatives. The results showed a significant difference in the results of the developed model.

1. Introduction
Ramming (2002), has been conducting research regarding the use of various forms of route selection models (discrete choice) and to link it with the knowledge of the network of individuals who will choose a route journey. In the dissertation, ramming concluded that discrete models that have failed in assuming that a person's drivers have perfect information related to traffic conditions and journey, and that a driver has an unlimited ability to process information. Ramming compare the results of such models: multinomial logit (MNL), cross logit (C-logit), path size logit (PSL), cross nested logit (CNL), logit kernell and the implicit availability / perception logit (IAP logit).

Cherchi (2009) reviews the theory of decision making related to a person's behavior when choosing (choice behavior). Cherchi in the development of transport theory describes how the regret theory has evolved and is one of the theories developed from the failure of economic theory to explain how people behave (choice behavior) and choose (choice Preferences) on the available options. He even put it into one of the recent discussion of 7 discussions on areas of study travel behavior.

Regret theory is a theory developed from behavior to choose (choice behavior), in a state of uncertainty. During its development, regret theory is used in various disciplines such as marketing, micro economy, psychology, management, and transportation (Chorus 2010).

This paper aims to demonstrate the difference between Random Utility Maximization (RUM) with the concept of Random Regret Minimization (RRM), on Mode Choice model, at Medan – Balige Route. Previous research conducted by Surbakti M (2018) is the selection of modes between buses and trains with Bandung-Jakarta route. While the selection of inter-city bus between provinces has not been done.
2. Literature Review

2.1. Discrete Choice

To be able to show custom (habit) of a person in making a choice, in the form of discrete choice model is a model that has been used. The use of discrete models is not just limited to the selection mode of the vehicle, but also used in various fields of science such as economics, agriculture, marketing, and so forth. Discrete models have many kinds, and all of these models must meet the following criteria:

- The set of choices or classifications must be finite.
- The set of choices or classifications must be mutually exclusive; that is, a particular outcome can only be represented by one choice or classification.
- The set of choices or classifications must be collectively exhaustive, that is all choices or classifications must be represented by the choice set or classification.

Discrete model that evolved was conceived and developed a model of economic theory, random utility, where the models are then developed to minimize the error either to the independent variable X and dependent variable Y.

There are several assumptions that are used when using discreet choice model, developed by way of random utility theory (Train, 2009), namely:

- An individual is faced with a finite set of choices from which only one can be chosen.
- Individuals belong to a homogenous population, act rationally, and possess perfect information and always select the option that maximizes their net personal utility.
- If C is defined as the universal choice set of discrete alternatives and J the number of elements in C, then each member of the population has some subset of C as his or her choice set. Most decision-makers, however, have some subset Cn, that is considerably smaller than C. It should be recognized that defining a subset Cn, that is the feasible choice set for an individual is not a trivial task; however, it is assumed that it can be determined.
- Decision-makers are endowed with a subset of attributes \( x_n \in X \), all measured attributes relevant in the decision making process.

The form of discrete models which are expressed in probabilities is as follows (Train, 2009):

Logit

\[
P_1 = \frac{\exp(V_1)}{\exp(V_1) + \exp(V_2)}
\]

Probit

\[
P_1 = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{\exp \left\{ \frac{1}{2 \sigma_1^2} \left[ \left( \frac{V_1}{\sigma_1} \right)^2 - \frac{2 \rho x_1 x_2}{\sigma_1 \sigma_2} + \left( \frac{V_2}{\sigma_2} \right)^2 \right] \right\}}{2 \pi \sigma_1 \sigma_2 \sqrt{1 - \rho^2}} \, dx_2 \, dx_1
\]

Nested Logit

\[
P_{nl} = \frac{e^{V_{nl} / AK} \left( \sum_{l=1}^{K} e^{V_{nl} / AK} \right)^{\lambda - 1}}{\sum_{l=1}^{K} \left( \sum_{j \in B_l} e^{V_{nl} / AK} \right)^{\lambda}}
\]

Mixed Logit

\[
P_{nl} = \sum_{m=1}^{M} S_m \left( \frac{e^{b_{nl}^{m} X_{nl}}}{\sum_j e^{b_{nl}^{m} X_{nj}}} \right)
\]

Discrete choice models have long been used by transportation researchers such as; Multinomial Logit (e.g. Ben Akiva, 1974), Nested Logit (e.g. Williams, 1977), Multinomial
Probit (e.g. Daganzo, 1980), Generalized Extreme Value (e.g. Daly and ierlane, 2006), Mixed Logit (e.g. Brownstone et al, 2000) and Multiple discrete-Continues Extreme Value (e.g. Bhat, 2005).

There are many discussions that have been done which are basically trying to criticize the use of utility theory in transportation. This is due to the limited human ability to process data and analyze it within a certain timeframe.

Critics of the utility of this theory were developed as researchers Kahnemen and Tversky (1984). These criticisms are the basis for the application of theories other than utility theory. Some theories are:

1. Regret theory
2. Prospect Theory
3. Bounded Rationality

2.2. Random Regret Minimization

In 2010, Chorus has made changes to the model to reduce the limitations of its formula, and it has change as shown at this formula bellow.

\[
\bar{R}_i = \sum_{j \neq i} \sum_{m=1,M} \ln \left( 1 + \exp \left[ \beta_{jm} \left( x_{jm} - x_{im} \right) \right] \right)
\]

For the probability, the choice of a common form used is the result of the adoption multinomial logit formula, by maximizing the negative random regret, which can be written as follows:

\[
P_i = \frac{\exp(-\bar{R}_i)}{\sum_{i=1,J} \exp(-\bar{R}_i)}
\]

3. Data and Survey

This research was conducted to observe the movement of people (passengers) between the City of Medan to Balige, by taking Karya Agung and Koperasi Bintang Tapanuli bus in Medan – Balige route. Survey carried out directly on the bus counters in Medan.

Both bus route are: Amplas Station Medan - Tanjung Morawa - Lubuk Pakam - Perbaungan - Sei Rampah – Tebing Tinggi - Siantar - Prapat - Porsea - Balige. Distance path in the network of the road from Medan - Balige is as far as 245 km.

Existing data attributes both modes are as follows:

| Table 1: Performance Attribute data for each Mode |
|-----------------------------------------------|
| **Attribute** | **Existing Mode** |
| 1 Travel Cost | Karya Agung | IDR 35,000 | Koperasi Bintang Tapanuli | IDR 40,000 |
| 2 Average Travel Time | 6.5 Hour | 5.5 Hour |
| 3 Headway | every 15 minute | every 15 minute |

From the table above shows that there is a difference between the values of the attribute is the type of travel cost and travel time average. There is no difference in the frequency of departures.

In addition to the above differences, other characteristics related to transportation is the bus Karya Agung reserved seats for 17 people, while Koperasi Bintang Tapanuli reserved seat for
12 people. The operation of fleet of Karya Agung carried out starting at 8 am until 20:00 pm, while the bus Koperasi Bintang Tapanuli operate for 24 hours, but for certain hours (early morning) the frequency of vehicle departure to 30 minutes - 1 hour.

From 130 questionnaires that have been distributed to users of public transport from Medan to Balige gained 85 questionnaire answers are eligible, and 45 questionnaires have answers that are not eligible, because the answers are not consistent so as not qualified stated preference logic. The results of questionnaires resumes that do not qualify are as follows:

| No. | Criteria                                              | Number |
|-----|-------------------------------------------------------|--------|
| 1.  | Questionnaire not returned                           | 1      |
| 2.  | Respondents are fanatical about one mode              | 37     |
| 3.  | The answer is incomplete / not ready                  | 4      |
| 4.  | Inconsistent answers                                  | 2      |
| 5.  | The answer is more than one                           | 1      |
|     | **Total**                                             | **45** |

4. Analysis

Some of the results obtained from the survey are shown in table 3-5 below, concerning the characteristics of respondents and the choices they did.

On the Table bellow can be seen that respondents who use both buses are the people with the primary purpose are the social / family up to 50%. Followed by holiday travel, businesses and schools purpose travel.

On the question of reason in the mode selection, it appears there were consistency in the answers of the respondents both modes with two modes of data attributes. For Koperasi Bintang Tapanuli passengers comfort and speed is a major factor in their choosing modes, while for passenger of Karya Agung comfort factor and the of cheap tariff being the main reason.

| Table 3. Respondent Distribution on Bus |
|-----------------------------------------|
| No | Respondent Mode Choice | Number | Percentage% |
|----|------------------------|--------|-------------|
| 1  | Karya Agung             | 38     | 44.7        |
| 2  | Koperasi Bintang Tapanuli | 47   | 55.3        |

| Table 4. Respondent Distribution for travel purpose |
|-----------------------------------------------------|
| No | Travel Purpose  | Karya Agung | Koperasi Bintang Tapanuli |
|----|-----------------|-------------|---------------------------|
|    | number          | %           | number                    | %           |
| 1  | Work/Business   | 7           | 18.4                      | 5           | 10.6                     |
| 2  | vacation        | 6           | 15.8                      | 12          | 25.5                     |
| 3  | school          | 5           | 13.2                      | 7           | 14.9                     |
| 4  | social          | 19          | 50.0                      | 23          | 48.9                     |
| 5  | others          | 1           | 2.6                       | 0           | 0                        |
|    | **Total**       | **38**      | **100.0**                 | **47**      | **100.0**                |
Table 5. Respondent distribution based on the reason choose the mode

| No | Reason            | Karya Agung |  | Koperasi Bintang Tapanuli |  |
|----|-------------------|-------------|---|---------------------------|---|
|    |                   | Number | %  | Number | %  |                |
| 1  | Comfortness       | 15     | 39.5 | 32   | 68.1 |
| 2  | Fare              | 13     | 34.2 | 0    | 0   |
| 3  | Travel Time       | 3      | 7.9  | 13   | 27.7 |
| 4  | More practical consideration | 7 | 18.4 | 1 | 2.1 |
| 6  | Frequency         | 0      | 0    | 1    | 2.1 |
|    | Total             | 38     | 100.0 | 47   | 100.0 |

The results of the analysis using software biogeme 1.8, to the selection of the two bus modes, by comparing the results of the analysis using the binomial logit and regret minimization can be seen in the table below.

Table 6. Resume Comparison of RRM and RUM

|                     | Random Regret Parameter | Logit Binomial Parameter |
|---------------------|-------------------------|--------------------------|
| Const               | -1.642                  | -1.2452                  |
| Cost                | -0.265                  | -0.427                   |
| Time                | -0.032                  | -0.023                   |
| Headway             | -0.003                  | -0.002                   |
| Log Likelihood      | -82                     | -82                      |
| rho square          | 0.442                   | 0.401                    |
| Number of cases     | 75                      | 75                       |

From the table above it can be concluded that there is no significant difference between the RRM and RUM both constant values in the second equation, and the coefficients of each attribute.

With the value of rho square is relatively small (less than 0.5), it can also be concluded that there are other parameters that have not entered into this discussion, so that the model cannot be formed properly explain the correlation selection mode with the observed attribute.

A negative coefficient indicates the opposite relationship exists between selections modes with the value attribute. The greater the value of an attribute, then the person would not choose alternative modes.

Random regret and binomial logit alike uniform sign, both for constants and coefficients of each parameter. By looking at there is no significant difference in the two types of models, it is necessary to study further the behavior selection mode for reasons other trips, such as the reasons for school trips, work and so on.

5. Conclusion
1. There was no significant difference in the two models both constants and coefficients, for all the proposed parameters.
2. The minus sign on the coefficient indicates that the second parameter models in terms of attributes that negative influence on the selection of vehicle mode. The greater the value of that attribute, the passengers will be less interested in using these modes.

3. A small square rho values indicate that the model is not able to reflect a good model to describe the reason in choosing the mode of transport of passengers from Medan to Balige.

4. In the analysis above, the reason for most of the trip journey is a matter of social/family; there was no significant difference between the two models.

6. Reference

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