Analysis of the Selection Factor of Online Transportation in the VIKOR Method in Pematangsiantar City

Tia Imandasari¹, Mhd Gading Sadewo¹, Agus Perdana Windarto²*, Anjar Wanto², Harma Oktafia Lingga Wijaya³, Rudi Kurniawan³

¹Student of STIKOM Tunas Bangsa Pematangsiantar, Sumatera Utara, Indonesia
²STIKOM Tunas Bangsa Pematangsiantar, Sumatera Utara, Indonesia
³STMIK Musirawas Lubuklinggau, Indonesia

*agus.perdana@amiktunasbangsa.ac.id

Abstract. Transportation plays an important role in helping every community activity and also has an important function in economic, social and developmental development. Online transportation provides alternative transportation solutions in the middle of the density of vehicles to be fast and able to reach places that are likely to be inaccessible to other public vehicles. People who usually use public transport or conventional taxi services have begun to switch to online-based taxis that are considered cheaper and more practical. Market research institutes in Southeast Asia show that 250 million Indonesians are quickly adapting the growth of application-based transportation (taxis and ojek online) to facilitate their lives. Various factors that influence people prefer online transportation compared to public transport or conventional taxis. The purpose of the study is to determine the main factors that people prefer to use Online transportation. The study used the VIKOR method system which obtained the results based on the VIKOR index value where alternative A1: Easy and Safe (VIKOR index value 0) as a rank one and alternative A2: Price (VIKOR index value 0.1809520) as the second rank.

1. Introduction
Increasing community activity is now inseparable from the role of transportation. Transportation plays an important role in assisting every community activity and has a role and function in economic, social and developmental development. To improve the regional economy and increase the mobility index, a type of transportation is needed that can support continuous, orderly and reliable services. Basically, the community relies more on public transport so that it can help in fulfilling each activity. However, public transportation is only found on major roads and has certain routes. At present, there is a creative revolution in the field of transportation services. Like online transportation that provides alternative transportation solutions in the middle of the density of vehicles to be fast and able to reach places that are likely not accessible by other public vehicles. People who usually use public transport or conventional taxi services start to switch to online taxis which are considered cheaper and more practical. Market research institutes in Southeast Asia show that 250 million Indonesians are quickly adapting the growth of application-based transportation (taxis and online motorbikes) to facilitate their activities. Many factors influence why people switch from public transportation to online transportation.

Recognizing the importance of finding community factors in choosing online transportation, it is necessary to have a decision support system that can help online transportation service providers to improve their services. Some studies like [1] Which discusses about online application-based
transportation: Go-Jek as a means of transportation for the people of Surabaya, where the results obtained from this research are social actions carried out by users are instrumental and affective rationales. Many branches of computer science can solve complex problems. This is evidenced by several studies in the field of datamining [2]–[9], field of artificial neural networks [10]–[14], in the field of decision support systems [15]–[19]. Several studies in the field of decision support systems [20]–[26] who use the Vikor method as an alternative solution to the problem. In this study also applied the VIKOR method in determining the main factors of the community choosing to use online transportation rather than public transportation.

This research is expected to help the parties of online transportation service providers in order to improve and develop facilities and services so that they can continue to maintain consumer loyalty. With the system used in this study, it is also expected to be able to keep up with the current era of the 4.0 industrial revolution.

2. Methodology

This research was conducted in the city of petamatsiantar. The research data was obtained by giving questionnaires or questionnaires to more than 80 respondents. After the questionnaire data is obtained when the average value of each alternative is sought for each criterion. This study consisted of 4 (four) alternatives and 13 (thirteen) criteria. In the weighting criteria using fuzzy weighting which consists between 0-1 where the criteria that value close to one is the most important criteria. The data obtained is converted first using the Fuzzy Data matrix decision weighting. After the data is converted, it enters the calculation phase using the VIKOR method. Decision making is carried out in several stages, namely intelligence, design, choice and implementation. The following are data that has been converted first into fuzzy weighting.

| No | Alternative | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 |
|----|-------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| 1  | A1          | 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3  | 0,3  | 0,4  |
| 2  | A2          | 0,3| 0,4| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3  | 0,3  | 0,3  |
| 3  | A2          | 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,3| 0,2| 0,2  | 0,3  | 0,3  |
| 4  | A4          | 0,3| 0,2| 0,3| 0,2| 0,2| 0,2| 0,2| 0,3| 0,2| 0,3  | 0,2  | 0,3  |

In determining alternatives and criteria, researchers have conducted interviews directly with several informants. In this study there are four alternatives and thirteen criteria:

Alternative:
A1: Easy and Safe
A2: Price
A3: Service
A4: Process

| No | Criteria | Name | Weight |
|----|----------|------|--------|
| 1  | C1       | Easy to find | 0,09   |
| 2  | C2       | Safe and comfortable | 0,09   |
| 3  | C3       | Easier Payments | 0,09   |
| 4  | C4       | Clear Driver Identity | 0,09   |
| 5  | C5       | Traif is more transparent | 0,09   |
| 6  | C6       | Can Pay Non-Cash | 0,09   |
| 7  | C7       | Rates In Accordance With Travel Distance | 0,07   |
| 8  | C8       | Services Provided Easy and Fast | 0,07   |
| 9  | C9       | Drivers Are Friendly and Polite | 0,07   |
| 10 | C10      | Arrive on time | 0,07   |
| 11 | C11      | Honest and Reliable Driver | 0,06   |
2.1. Decision support system

Decision support system is an information system at the management level of an organization that combines data and sophisticated analytical models to support decision-making in condition of semistructured and unstructured[27].

2.2. VIKOR Method

VIKOR is an MCDM method that focuses on ranking and choosing from a series of alternatives in the presence of conflicting factors. This technique is based on proximity to ideal solutions [26]. The Vikor method was developed for complex multi-criteria system optimization. It determines the list of compromise ranks, compromise solutions, and weight stability intervals for the stability of the compromise solution obtained with initial weights (given)[28]. The following are some steps in the completion of the VIKOR method.

a. Matrix normalization by means of the best value in one criterion reduced by the value of the sample data i criteria j, then divided by the best value in one criterion reduced by the worst value in one criterion.

\[ R_{ij} = \frac{x_{ij} - x_{ij}^*}{x_{ij}^* - x_{ij}^-} \]  (1)

b. Calculate values Utility Measure (S) dan Regret Measure (R).

\[ S_i = \sum_{j=1}^{n} w_j \left( \frac{x_{ij} - x_{ij}^*}{x_{ij}^* - x_{ij}^-} \right) \]  (2)

\[ R_i = \max_j \left[ w_j \left( \frac{x_{ij} - x_{ij}^*}{x_{ij}^* - x_{ij}^-} \right) \right] \]  (3)

c. Calculating the VIKOR index by means of the value S minus the value S ^ minus divided by the value S ^ plus minus the value S ^ and multiplied by v and summed with the value of R minus the value R ^ minus divided by the value R ^ plus minus the value of R ^ and multiplied by 1 minus v = 0.5.

\[ Q_i = \left[ \frac{(S_i - S^)}{(S^ + - S^-)} \right] v + \left[ \frac{(R_i - R^)}{(R^ + - R^-)} \right] (1 - v) \]  (4)

d. Rating VIKOR (Q_i). Ranking of Q_i values is based on the largest value to the smallest value (ascending order), with the smallest value being the best candidate. So that there will be three lists/ranking versions.

3. Result and Discussion

In completing using the Vikor method there are several stages including:

a. Matrix Normalization

In normalizing the matrix, equation (1) is used. Before calculating matrix normalization, the value X_{ij} ^ ^ plus - X_{ij} ^ ^ minus is determined first. Following is the result of normalizing the matrix using equation (1).

\[ R= \begin{bmatrix} 0 & 0.5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \ 0.5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \ 0.5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \ 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \ \end{bmatrix} \]

b. Calculating values Utility Measure (S) dan Regret Measure (R).

| Tabel 3. Nilai Utility Measure (S) dan Regret Measure (R) |
|-----------------|-----------------|-----------------|
| Utility Measure | S               | R               |
| 0               | 0.045           | 0               |
| 0               | 0               | 0.045           |
| 0               | 0.06            | 0.06            |
| 0               | 0.06            | 0.06            |
| 0               | 0.045           | 0.045           |
| 0               | 0.06            | 0.06            |

3
The Utility Measure (S) value is determined using equation (2) and Regret Measure (R) is determined using equation (3).

c. Calculate the VIKOR index
Determined using equation (4) by means of the value S minus the value S then divided by the value S - minus the value S - (-) and multiplied by v and summed with the value R minus the value R - then divided by the value R - minus the value of R - and multiplied by 1 minus v.

\[
S^+ = 0.57 \\
S^- = 0.045 \\
R^+ = 0.09 \\
R^- = 0.045 \\
v = 0.5
\]

| Tabel 4. VIKOR Index Value |
|-----------------------------|
| S | R | Q |
| 0.045 | 0.045 | 0 |
| 0.06 | 0.06 | 0.180952 |
| 0.195 | 0.09 | 0.642857 |
| 0.57 | 0.09 | 1 |

d. Rating VIKOR (Q_i)
Ranking of Q_i values is based on the largest value to the smallest value (ascending order), with the smallest value being the best candidate.

| Tabel 5. Ranking |
|------------------|
| No | Alternative | Q   | Rangking |
| 1  | A1           | 0   | 1        |
| 2  | A2           | 0.180952 | 2 |
| 3  | A2           | 0.642857 | 3 |
| 4  | A4           | 1   | 4        |

Based on the results obtained from the calculation using the VIKOR method, the results are obtained based on the value of the VIKOR index where alternative A1 (VIKOR 0 index value) is the first rank, and alternative A2 (VIKOR index value 0.1809520) as the second rank. Then the results are obtained that the first alternative is the main factor of the community choosing to use online transportation.

4. Conclution
Based on the results obtained using the VIKOR method, it can be determined that the main factors of the community choose to use online transportation. The VIKOR method can be applied in determining the main factors of consumers in choosing online transportation. For further research can add alternatives and criteria used.

References
[1] Slaudiya Anjani Septi, “Transportasi Berbasis Aplikasi Online: Go-Jek Sebagai Sarana Transportasi Masyarakat Kota Surabaya,” vol. 713114330.
[2] A. P. Windarto, “Implementation of Data Mining on Rice Imports by Major Country of Origin Using Algorithm Using K-Means Clustering Method,” International Journal of artificial intelligence research, vol. 1, no. 2, pp. 26–33, 2017.
[3] U. R. Raval and C. Jani, “Implementing and Improvisation of K-means Clustering,”
International Journal of Computer Science and Mobile Computing, vol. 5, no. 5, pp. 72–76, 2016.

[4] M. K. Arzoo, A. Prof, and K. Rathod, “K-Means algorithm with different distance metrics in spatial data mining with uses of NetBeans IDE 8.2,” International Research Journal of Engineering and Technology (IRJET), vol. 4, no. 4, pp. 2363–2368, 2017.

[5] S. Kumar and S. K. Rathi, “Performance Evaluation of K-Means Algorithm and Enhanced Midpoint based K-Means Algorithm on Mining Frequent Patterns,” International Journal of Advanced Research in Computer Science and Software Engineering, vol. 4, no. 10, pp. 545–548, 2014.

[6] S. Sudirman, A. P. Windarto, and A. Wanto, “Data Mining Tools | RapidMiner: K-Means Method on Clustering of Rice Crops by Province as Efforts to Stabilize Food Crops In Indonesia,” IOP Conference Series: Materials Science and Engineering, vol. 420, no. 12089, pp. 1–8, 2018.

[7] A. Yadav and S. Dhingra, “An Enhanced K-Means Clustering Algorithm to Remove Empty Clusters,” IJEDR, vol. 4, no. 4, pp. 901–907, 2016.

[8] B. Supriyadi, A. P. Windarto, T. Soemartono, and Mungad, “Classification of natural disaster prone areas in Indonesia using K-means,” International Journal of Grid and Distributed Computing, vol. 11, no. 8, pp. 87–98, 2018.

[9] H. Siahaan, H. Mawengkang, S. Efendi, A. Wanto, and A. P. Windarto, “Application of Classification Method C4.5 on Selection of Exemplary Teachers,” in IOP Conference Series, 2018, pp. 1–6.

[10] B. Febriadi, Z. Zamzami, Y. Yunefri, and A. Wanto, “Bipolar function in backpropagation algorithm in predicting Indonesia’s coal exports by major destination countries,” IOP Conference Series: Materials Science and Engineering, vol. 420, no. 12089, pp. 1–9, 2018.

[11] N. Nasution, A. Zamsuri, L. Lisnawita, and A. Wanto, “Polak-Ribiere updates analysis with binary and linear function in determining coffee exports in Indonesia,” IOP Conference Series: Materials Science and Engineering, vol. 420, no. 12089, pp. 1–9, 2018.

[12] Sumijan, A. P. Windarto, A. Muhammad, and Budiharjo, “Implementation of Neural Networks in Predicting the Understanding Level of Students Subject,” International Journal of Software Engineering and Its Applications, vol. 10, no. 10, pp. 189–204, 2016.

[13] A. Wanto, M. Zarlis, Sawaluddin, and D. Hartama, “Analysis of Artificial Neural Network Backpropagation Using Conjugate Gradient Fletcher Reeves in the Predicting Process,” Journal of Physics: Conference Series, vol. 930, no. 1, pp. 1–7, 2017.

[14] A. P. Windarto, L. S. Dewi, and D. Hartama, “Implementation of Artificial Intelligence in Predicting the Value of Indonesian Oil and Gas Exports With BP Algorithm,” International Journal of Recent Trends in Engineering & Research (IJRTER), vol. 3, no. 10, pp. 1–12, 2017.

[15] A. N. D. J. D. Fadhilah, “Perancangan Aplikasi Sistem Pakar Penyakit Kulit pada Anak dengan Metode Expert System Development Life Cycle,” Jurnal Algoritma Sekolah Tinggi Teknologi Garut, vol. 9, no. 13, pp. 1–7, 2012.

[16] S. Fekri-Ershad, H. Tajalizadeh, and S. Jafari, “Design and Development of an Expert System to Help Head of University Departments,” International Journal of Science and Modern Engineering, vol. 1, no. 2, pp. 45–48, 2013.

[17] M. Min, “A rule based expert system for analysis of mobile sales data on fashion market,” 2013 International Conference on Information Science and Applications, ICISA 2013, 2013.

[18] M. Mohammadi and S. Jafari, “An expert system for recommending suitable ornamental fish addition to an aquarium based on aquarium condition,” arXiv preprint arXiv:1405.1524, vol. 3, no. 2, pp. 1–7, 2014.

[19] I. Chen and B. L. Poole, “Performance Evaluation of Rule Grouping on a Real-Time Expert System Architecture,” vol. 6, no. 6, pp. 883–891, 2014.

[20] A. Aghajani Bazzazi, M. Osanloo, and B. Karimi, “Deriving preference order of open pit mines equipment through MADM methods: Application of modified VIKOR method,” Expert Systems with Applications, vol. 38, no. 3, pp. 2550–2556, 2011.

[21] L. Y. Chen and T. C. Wang, “Optimizing partners’ choice in IS/IT outsourcing projects: The
strategic decision of fuzzy VIKOR,” *International Journal of Production Economics*, vol. 120, no. 1, pp. 233–242, 2009.

[22] M. F. El-santawy, “A VIKOR Method for Solving Personnel Training,” *International Journal of Computing Science*, vol. 1, no. 2, pp. 9–12, 2012.

[23] S. Opricovic and G. H. Tzeng, “Extended VIKOR method in comparison with outranking methods,” *European Journal of Operational Research*, vol. 178, no. 2, pp. 514–529, 2007.

[24] A. Sciences, “Investment Destination Decision by Using the VIKOR Method in the European,” *American International Journal of Contemporary Research*, vol. 6, no. 2, pp. 16–24, 2016.

[25] A. Shemshadi, H. Shirazi, M. Toreih, and M. J. Tarokh, “A fuzzy VIKOR method for supplier selection based on entropy measure for objective weighting,” *Expert Systems with Applications*, vol. 38, no. 10, pp. 12160–12167, 2011.

[26] G. N. Yüceñur and N. E. Demirel, “Group decision making process for insurance company selection problem with extended VIKOR method under fuzzy environment,” *Expert Systems with Applications*, vol. 39, no. 3, pp. 3702–3707, 2012.

[27] M. Sudarma, A. Agung, K. Oka, I. Cahya, A. Info, and W. Application, “Decision Support System for the Selection of Courses in the Higher Education using the Method of Elimination Et Choix Transduit La Realite,” *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 5, no. 1, pp. 129–135, 2015.

[28] M. Ehsanifar and M. Hemesy, “Extension of VIKOR Method to Find an Optimal Layout for Fixture’s Supporting Points in Order to Reduce Work Piece Deformation,” vol. 9, no. 4, pp. 891–904, 2017.