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The use of Crowdsourcing Technology and TOPSIS Method in the Development of Tourism Decision Support System Based on Wisdom of the Crowd

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ABSTRACT

Decision support systems have often been used in making tourism destination selection decisions. The multi-criteria decision-making methods used in the decision support system still use the weighting criteria of each alternative using the assessment of one or several experts. This makes the recommendations generated by the DSS are not updated automatically over time. The authors want to change the paradigm from DSS based on experts assesment to DSS based on crowd assesment. This reserach aims to developmt a DSS application for selecting tourist spot based on the wisdom of the crowd and personal tastes of each user. By using crowdsourcing technology and the TOPSIS method, a DSS application can be built for the selection of tourist attractions based on the wisdom of the crowd and users' personal preferences.

KEYWORDS
Crowdsourcing
Tourism
Decision Support System
Wisdom

1. Introduction

Decision support systems have often been used in making tourism destination selection decisions (Mumtaz, 2020) (Santiary et al., 2018) (Ciptayani et al., 2018). To produce recommendations for tourist destinations that are in accordance with the personal tastes of each user, several decision-support systems implement multi-criteria decisionmaking methods such as AHP (Mumtaz, 2020), Topsis, SAW (Santiary et al., 2018), and others (Ciptayani et al., 2018).

The multi-criteria decision-making methods used in the decision-making system still use the weighting criteria of each alternative using the assessment of one or several experts (Mumtaz, 2020) (Santiary et al., 2018), (Ciptayani et al., 2018). This makes the recommendations generated by the DSS are limited based on the experience of one or a few experts and are not updated automatically over time.

Information technology has made it possible for a large number of people to rate an object (Modaresnezhad et al., 2020), such as a tourist spots. Ratings from a large number of people towards a tourist spots can result in an assessment based on the wisdom of the crowd (Hendrikx et al., 2018). Wisdom of the crowd is able to produce recommendations that are more balanced and real-time updated as long as tourist rating participation (Phuttharak & Loke, 2019).

Therefore, the authors has the idea of replacing the alternative weighting in the multi-criteria decision-making method, from based only on the assesment of one or several experts, to based on the wisdom of the crowd. This reserach aims to developmt a DSS application for selecting tourist spot based on the wisdom of the crowd and personal tastes of each user.

2. Previous Works

TOPSIS (Technique for Order Preference by Similarity Solution) is a multi-criteria method used to identify solutions from a set of alternatives based on simultaneous minimization of the ideal point distance and maximizing the distance from the lowest point (Hwang et al., 1993).

Based on reference (Hwang & Yoon, 1981), There are 5 steps in TOPSIS method. The first step is determining criteria and alternative solutions. Every alternative solution will be given a weight on each

determined criteria by several selected experts. The results of the weighting of the criteria for each alternative are placed in the solution matrix and then normalized into a normalized matrix N.

The second step, the normalized solution matrix N is multiplied by a 1-dimensional matrix of preference criteria weights P (1). The weight of preference criteria is given by DSS user.

$$\begin{bmatrix} N11 & \cdots & N1n \\ \vdots & \ddots & \vdots \\ Nm1 & \cdots & Nmn \end{bmatrix} . [P1 \quad \ldots \quad Pj] = \begin{bmatrix} W11 & \cdots & W1n \\ \vdots & \ddots & \vdots \\ Wm1 & \cdots & Wmn \end{bmatrix} \tag{1}$$

The third step is to determine the positive ideal solution Sj+ (2) and the negative ideal solution Sj- (3) for each criterion.

$$Sj+ = max\,(W1j, W2j, \ldots\, Wmj) \tag{2}$$

$$Sj- = min(\,W1j, W2j, \ldots\, Wmj) \tag{3}$$

The fourth step is to determine the weighted distance of each alternative solution to the positive (4) and negative (5) ideal solutions.

$$Di\ positive\ = \sqrt{\sum_1^n (Wij - Sj+)^2} \tag{4}$$

$$Di\ negative\ = \sqrt{\sum_1^n (Wij - Sj-)^2} \tag{5}$$

The last step is to determine an alternative solution that has the closest distance to the positive ideal solution and the farthest distance to the negative ideal solution Vi.

$$vi = \frac{Di\ Negative}{Di\ Negative + Di\ Positive} \tag{6}$$

In this article, the multi-criteria decision-making method used is the TOPSIS method. The TOPSIS method is preferred over the AHP method, because in the TOPSIS method, the weight giver only rate based on their perceived of quality of single alternative solution and they don't need to compare it with the other alternative solutions. The TOPSIS method is suitable for recomender tourists who only visit an alternative solution and never visit another alternative solution. It will also make user interaction on DSS applications become simpler.

3. The Wisdom of the Crowd Paradigm

At the solution weighting step, the TOPSIS method uses one or several experts as weight giver (Hwang & Yoon, 1981). The weights assigned to experts do not change over time as long as it is not updated. The author changes this paradigm from the wisdom of the experts to the wisdom of the crowds.

Information technology has enabled humans to capture the wisdom of the crowd in the form of a crowd rating of the quality of a tourist location (Modaresnezhad et al., 2020). The weight givers are a crowd of tourists, no longer only a collection of experts. Based on their perception, tourists rate all criteria of a single tourist location. The weight of each alternative is derived from the average rating of participants. Fig. 1 shows the wisdom of the crowd paradigm at TOPSIS method.

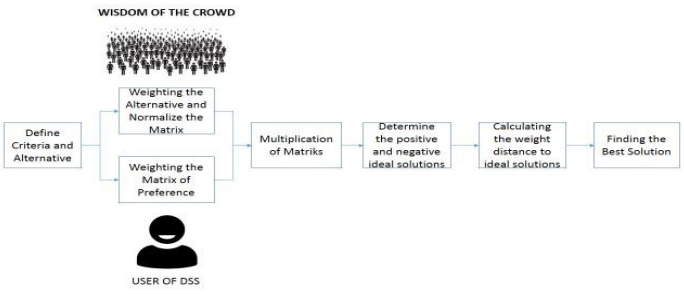

Fig. 1. The wisdom of the crowd paradigm at TOPSIS method

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4. Implementation

In this section, we will discuss the use of crowdsourcing technology and the implementation of the TOPSIS method in DSS mobile applications. The criteria that was used in this application are attractiveness, facilities, security, service, and cost. The alternative solution that was used in this application are 5 tourist spots in Jakarta, capital province of Republic of Indonesia. There are Monumen Nasional, Museum Sejarah Jakarta, Taman Impian Jaya Ancol, TMII, and Ragunan.

3.1. Crowdsourcing Feature

To realize the wisdom of the crowds in the application, the author develops crowdsourcing features in the application. In this feature, tourists who have visited a tourist place can rate the quality of tourist spot based on predetermined criteria.

Each criterion in crowdsourcing feature has a rating hierarchy. Table 1 until 5 will describe rating hierarchy for each criterion and its weight.

Table 1. Attractiveness Hyrarchy

No	Weight	Value
1	Awful	1
2	Not Attractive	2
3	Enough Attractive	3
4	Attractive	4
5	Very Attractive	5

Table 2. Facilities Hyrarchy

No	Weight	Value
1	Lack of Facilities	1
2	Not Complete	2
3	Good Enough	3
4	Complete	4
5	Very Complete	5

Table 3. Security Hyrarchy

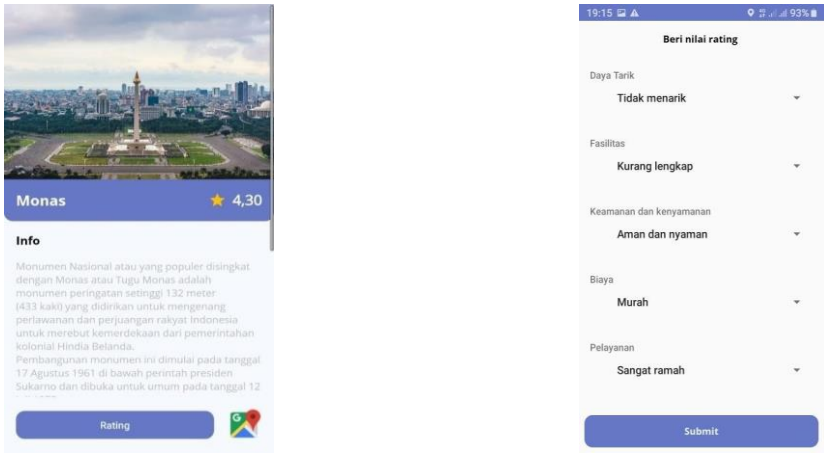
No	Weight	Value
1	Awful	1
2	Insecure	2
3	Good Enough	3
4	Secure	4
5	Very Secure	5

Table 4. Service Hyrarchy

No	Weight	Value
1	Awful	1
2	Not Satisfied	2
3	Good Enough	3
4	Satisfied	4
5	Very Satisfied	5

Table 5. Cost Hyrarchy

No	Weight	Value
1	Very Expensive	1
2	Expensive	2
3	Moderate	3
4	Cheap	4
5	Very Cheap	5



(a) (b)

Fig. 2. Crowdsourcing Feature

3.2. Decision Support Feature

The average participant rating of a tourist attraction becomes the weighted value for that attraction in the DSS. Other users can submit the weight value of the criteria preference according to their personal taste into the DSS. After user submit his criteria preference, DSS will recommend the best tourist spot according his personal taste and the wisdom of the crowd. Fig. 3 show the display of decision support feature. Table 6 describe preference level of criteria and its weight value.

Table 6. Preference Level of Criteria

No	Weight	Value
1	Can be ignored	1
2	Not Important	2
3	Enough Important	3
4	Important	4
5	Very Important	5

5. Testing

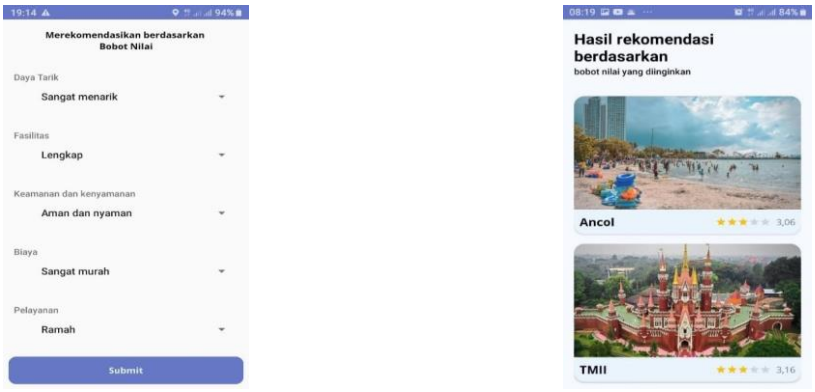
The author invite 25 participants who have visited 5 tourist sites in the application to fill in the rating. The matrix of the average value of the rating results of all participants for 5 tourist sites can be seen in table 7. Normalization results can be seen in table number 8.

Table 7. Average Rating for Participants

No	Alternatives	Attractiveness	Facility	Security	Service	Cost
1	Monumen Nasional	2.42	3.1	3.33	2.95	3.81
2	Museum Sejarah Jakarta	3.2	3.23	3.07	2.92	3.7
3	Taman Impian Jaya Ancol	3.04	3.43	3.29	3.05	2.48
4	TMII	3.21	3.26	3.11	2.63	3.58
5	Ragunan	3	3.25	3.2	2.7	4.1

Table 8. Normalization result of table 7

No	Alternatives	Attractiveness	Facility	Security	Service	Cost
1	Monumen Nasional	0.937895	1.148939	1.244574	1.1676731	1.347518
2	Museum Sejarah Jakarta	1.220814	1.19712	1.1474	1.1557985	1.305076
3	Taman Impian Jaya Ancol	1.178182	1.271246	1.229624	1.2072553	0.877124
4	TMII	1.244067	1.208239	1.16235	1.0410103	1.266171
5	Ragunan	1.162680	1.204533	1.195987	1.0687178	1.450085



(a) (b)

Fig. 3. Decision Support System

The author invites 2 participants to try out the use of DSS feature. The two participants had 2 very different criteria preferences. Table 9 describes the comparation of preferences between respondents. Table 10 describes TOPSIS matrix calculation for first respondents. The TOPSIS calculation in table 10 recommends Ragunan as the most suitable tourist spot for the tastes of the first respondents and Museum Sejarah Jakarta was the second. This is in accordance with the DSS application recommendations as shown in Fig. 4. Table 11 describes TOPSIS matrix calculation for second respondents.

The TOPSIS calculation in table 11 recommends Ancol as the most suitable tourist spot for the tastes of the second respondents and Ragunan was the second. This is in accordance with the DSS application recommendations as shown in Fig. 5.

Table 9. Preference Comparation between respondents

No	Criteria	First Respondent Preference	Second Respondent Preference
1	Attractiveness	4	1
2	Facility	5	5
3	Security	3	3
4	Service	3	3
5	Cost	5	1

Table 10. TOPSIS matrix calculation for first respondents

No	Alternatives	Attractiveness	Security	Facility	Service	Cost	Di+	Di-	Score	Order
1	Monas	3.7516	3.7337	5.7447	3.5030	6.7376	1.4666	2.4002334	0.620722	4
2	Museum Sejarah Jakarta	4.8833	3.4422	5.9856	3.4674	6.5254	0.8835	2.4568027	0.73551	2
3	Ancol	4.7127	3.6889	6.3562	3.6218	4.3856	2.8772	1.2678181	0.305862	5
4	TMII	4.9763	3.4871	6.0412	3.1230	6.3309	1.1200	2.3181304	0.674239	3
5	Ragunan	4.6507	3.5880	6.0227	3.2062	7.2504	0.6413	3.0200924	0.824855	1
Ideal Positive Solution		4.9763	3.7337	6.3562	3.6218	7.2504				
Ideal Negative Solution		3.7516	3.4422	5.7447	3.1230	4.3856				

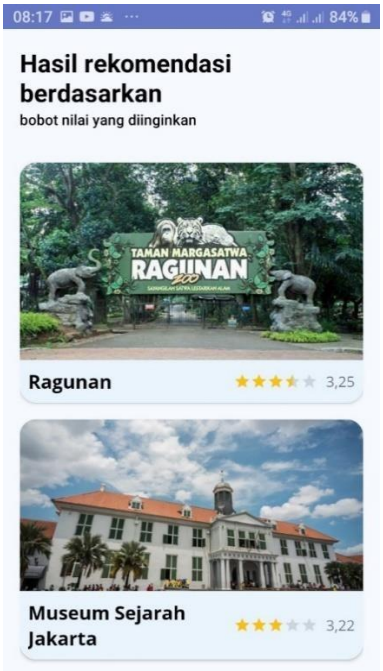


Fig. 4. DSS Recomendation for First Respondent

Table 11. TOPSIS matrix calculation for second respondents

No	Alternatives	Attractiveness	Security	Facility	Service	Cost	Di+	Di-	Skor	Order
1	Monas	0.9379	3.7337	5.7447	3.5030	1.3475	0.7017	0.6713024	0.4889428	4
2	Museum Sejarah Jakarta	1.2208	3.4422	5.9856	3.4674	1.3051	0.5174	0.6631808	0.5617207	3
3	Ancol	1.1782	3.6889	6.3562	3.6218	0.8771	0.5785	0.8609839	0.5981291	1
4	TMII	1.2441	3.4871	6.0412	3.1230	1.2662	0.6653	0.5788114	0.4652327	5
5	Ragunan	1.1627	3.5880	6.0227	3.2062	1.4501	0.5585	0.69587	0.554778	2
Ideal Positive Solution		1.2441	3.7337	6.3562	3.6218	1.4501				
Ideal Negative Solution		0.9379	3.4422	5.7447	3.1230	0.8771				

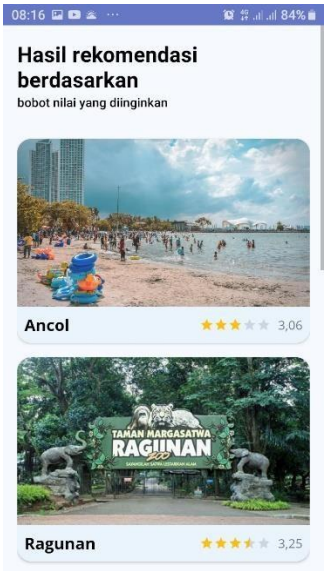


Fig. 5. DSS Recomendation for Second Respondent

6. Conclusion

Through the use of multi-criteria decision-making methods such as TOPSIS, DSS application recommendations can be more in line with the characteristics of user preferences. Through the use of crowdsourcing technology, Decision Support Systems can capture the wisdom of the crowd. Decision support systems can use the wisdom of the crowd as a source of weighting for alternative solutions at its decision-making methods. The recommendation given by the DSS can be more balanced because it is based on crowd assessments and are also updated automatically as long as there is user participation. In this study, the topsis method and crowdsourcing technology can be used to build a decision support system for choosing tourist sites based on user preferences and the wisdom of the crowd.

We have some recommendations for further research. We suggest further research to no longer use a static number of alternative solutions, but to use dynamic alternative solutions. Users can recommend new tourist attractions that are not in the list of alternative solutions in the system. Future research can also use a more detailed multi-criteria hierarchy in DSS, no longer using a single hierarchy.

References

[1] Ciptayani, P. I., Saptarini, N. G. A. P. H., Santiary, P. A. W., & Astawa, I. N. G. A. (2018). Decision Support System for Tourist Destination using the Combination of AHP and SAW. 2018 2nd East Indonesia Conference on Computer and Information Technology (EIConCIT), 271–275. https://doi.org/10.1109/EIConCIT.2018.8878638

[2] Hendrikx, R. J. P., Spreeuwenberg, M. D., Drewes, H. W., Struijs, J. N., Ruwaard, D., & Baan, C. A. (2018). Harvesting the wisdom of the crowd: using online ratings to explore care experiences in regions. BMC Health Services Research, 18(1), 801. https://doi.org/10.1186/s12913-018-3566-z

[3] Hwang, C.-L., Lai, Y.-J., & Liu, T.-Y. (1993). A new approach for multiple objective decision making. Computers & Operations Research, 20(8), 889–899. https://doi.org/10.1016/0305-0548(93)90109-V

[4] Hwang, C.-L., & Yoon, K. (1981). Multiple Attributes Decision Making Methods and Applications. In Springer-Verlag.

[5] Modaresnezhad, M., Iyer, L., Palvia, P., & Taras, V. (2020). Information Technology (IT) enabled crowdsourcing: A conceptual framework. Information Processing & Management, 57(2), 102135. https://doi.org/10.1016/j.ipm.2019.102135

[6] Mumtaz, Y. (2020). Decision Support System for Tourist Attractions Recommendation in Sidoarjo Using Profile Matching Method and Analitycal Hierarchy Process Method. International Journal of Science, Engineering, and Information Technology, 4(2), 215–217. https://doi.org/10.21107/ijseit.v4i2.6139

[7] Phuttharak, J., & Loke, S. W. (2019). A Review of Mobile Crowdsourcing Architectures and Challenges:

[8] Toward Crowd-Empowered Internet-of-Things. IEEE Access, 7, 304–324. https://doi.org/10.1109/ACCESS.2018.2885353 Santiary, P. A. W., Ciptayani, P. I., Saptarini, N. G. A. P. H., & Swardika, I. K. (2018). Sistem Pendukung Keputusan Penentuan Lokasi Wisata dengan Metode Topsis. Jurnal Teknologi Informasi Dan Ilmu Komputer, 5(5), 621. https://doi.org/10.25126/jtiik.2018551120