The Application of the AHP-TOPSIS Method for a Decision Support System in Determining the Areas for Enforcement of Restrictions on Community Activities at the District Level in West Java

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Abstract

Currently, the world has been hit by an outbreak of a virus called Covid-19, commonly called Coronavirus. Until now, the coronavirus is quite deadly, which causes severe symptoms to death for sufferers. Because the high number of deaths and positive patients requires countries to make policies to stop the spread of Covid19, each country has different policies. One of the policies of the Indonesian government is called the Implementation of Community Activity Restrictions (PPKM) which means limiting activities in a certain area that has the highest cases. To determine a PPKM area is not easy due to several factors. A Decision Support System (DSS) is a computer-based system that produces various alternatives for making decisions. The method used is the Analytic Hierarchy Process (AHP) and Technique for Others Preference by Similarity to Ideal Solution (TOPSIS); the AHP method is used for automatic weighting for each criterion to be used and reduces subjective weighting. In comparison, TOPSIS performs ranking by optimizing positive ideal solutions and negative ideal solutions. The conclusion of this research is that it can help the government to make decisions in the implementation of the Enforcement of Restrictions on Community Activities.

Keywords: Decision Support System, PPKM, AHP, TOPSIS

INTRODUCTION

Currently, the world is being hit by a pandemic, including Indonesia; this pandemic occurred at the end of 2019. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a new type of virus that has never been previously identified in humans(Susanto, 2020). This virus is also known as Corona, with a new type of coronavirus that can be transmitted to humans.

This virus has spread in 223 countries, with more than 221 million cases ("Worldometer," 2021). Covid19 virus infection was first discovered in Wuhan City, China, at the end of December 2019(Candra et al., 2020). This virus is different from other viruses, starting from the rapid transmission and the symptoms it causes. Transmission usually occurs by physical contact with the patient through shaking hands, touching objects splashed by the patient's saliva, and even splashes of saliva (droplets) when sneezing and coughing. There are many ways to prevent

transmission by maintaining a healthy lifestyle so that the body's immunity increases, washing hands frequently, and avoiding touching the nose, eyes, and mouth(Kesehatan, n.d.).

Because the Covid19 is deadly enough that it can make sufferers die, every country makes its policies. Of course, each country has its own policies to stop the spread of Covid19. In Indonesia, it is known as the Enforcement of Community Activity Restrictions (PPKM). The PPKM policy is carried out if an area has a high number of positive patients.

Determining PPKM in an area is not easy because the government must pay attention to several factors. A Decision Support System is part of a computer-based information system (including a knowledge-based system) that is used to support decision-making in an organization or company (Wikipedia, n.d.). This Decision Support System is useful for determining a district in Indonesia to apply the Enforcement of Restrictions on Community Activities so that it can reduce the number of cases and break the spread of Covid19.

The method used by the researcher is a combination of AHP and TOPSIS to determine the PPKM area through a Decision Support System. An interactive system that can provide information, model, and manipulate data (Hafidzi & Santoso, 2016). The AHP method is used to help select candidates or only sort priorities from several candidates, using a pairwise comparison matrix to generate relative weights between criteria and alternatives (Prihartono & Magdalena, 2016). And to maximize accuracy and effectiveness in the selection process, it is combined with the TOPSIS method so that a number of alternatives are obtained that may be in accordance with the proximity to the ideal solution (Ismail, 2018). By using the combined method of AHP and TOPSIS, accuracy is more accurate (Thelwall, 2016).

RESEARCH METHODOLOGY

Data Collection Method

The method of data collection is to obtain the information needed for problem-solving with a decision support system. The data collection methods carried out by the researchers were 1) Interviews, namely questions and answers about covid19 and PPKM 2) Library studies through data from the official website, pikobar.jabarprov.go.id, the number of cases in August 2021, and vaccine data are taken from the website, vaksin.kemkes.go.id, on September 21, 2021.

Enforcement of Restrictions on Community Activities

PPKM was first effective on January 11 to January 25, 2021, covering the DKI Jakarta area and 23 regencies/cities in six provinces that have a high risk of Covid-19 (Rizal et al., 2021). The spread of Covid-19 in Indonesia has quite a lot of cases and a number of deaths. This virus can spread across regions, which has an impact on the political, social, cultural, security, and welfare of the Indonesian people (Hasrul, n.d.). The government itself issued a regulation from the Minister of Health regarding guidelines for handling the acceleration of Covid-19; this is one of the policies to suppress the transmission of COVID-19. PPKM is almost the same as self-quarantine, but it covers an area. This implementation includes restrictions on social and religious activities, closing schools or offices, and even restrictions on public facilities.

Covid-19

In 2019 the temporary name of this virus was novel coronavirus (2019nCoV) until the WHO changed the name of this virus to Corona Virus Disease (COVID-19). The coronavirus in Indonesia was first reported on March 2, 2020, where the number of people exposed to COVID-19 was two people (Susilo et al., 2020). Virus outbreaks like this did not only occur in 2019 but in 2012. The symptoms caused by Covid-19 are very severe, such as fever of 38 degrees Celsius, dry cough, and shortness of breath; these Covid-19 symptoms generally appear within two days to two weeks after the patient is exposed to the coronavirus (Wahyono, 2021; Widyawat, 2020). This becomes serious if the infected is an elderly person, pregnant woman, and for people who have a weak immune system (cancer sufferers). Currently, there are many ways to find out if someone is infected with Covid-19, by means of a rapid test to detect antibodies (IgM and IgG) produced by the body to fight the coronavirus, a swab test, or a PCR (polymerase chain reaction) test to detect the coronavirus in sputum and CT scan or chest X-ray to detect infiltrates or fluid in the lungs.

Analytical Hierarchy Process Method

AHP is one of the methods used to support decisions. This method can solve many problems multi-criteria that have uncertainty and are not yet clearly divided into components in a hierarchical arrangement (Suryadi, 2015). AHP is a method for ranking decision alternatives and choosing the best one with several criteria. AHP develops a numerical value to rank each decision alternative based on the extent to which each alternative meets the decision maker's criteria (Permatasari, 2020). The AHP method uses the following steps (Saaty, 1987):

1. Identifying the problem and determining the desired solution, then compiling a hierarchy of the problems encountered. Writing a hierarchy is to set goals that are the goals of the system as a whole at the top level.

2. Determine the priority of elements

   a. The first step in determining the priority of elements is to make pair comparisons, which is to compare elements in pairs according to the given criteria.
   b. Comparison matrix Pairs are filled in using numbers to represent the relative importance of an element to other elements.

3. Considerations for pairwise comparisons are synthesized to obtain overall priorities. The things to do in this step are:

   a. Sum the values of each column in the matrix
   b. Adding up the values of each column in the matrix. Dividing each value from the column by the total of the respective columns to obtain the normalization of the matrix.
   c. Add up the values of each row and divide by the number of elements to get the average value.

4. Measuring consistency

   a. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element, and so on
   b. Sum each row
   c. The result of the sum of the rows divided by the corresponding elements of the same relative priority
   d. Add the quotient above with the number of elements, and the result is called λmax

e. Calculating the Consistency Index CI with the formula: CI = (λmax – n) / (n – 1) where n = many elements

f. Calculate the Consistency Ratio (CR) with the formula: CR = CI / IR where:
   CR = Consistency Ratio
   CI = Consistency Index
   IR = Index Random Consistency

g. Check the consistency of the hierarchy. If the value is more than 10%, then the data judgment assessment must be corrected. However, if the consistency ratio (CI/IR) is less or with 0.1, then the calculation results can be declared correct.

Technique for Order Preference Method by Similarity to Ideal Solution (TOPSIS)

TOPSIS is a method of decision-making where the best decision is not only based on proximity to a positive solution but also comes from the lowest closeness to a negative solution. The positive ideal solution is the best value of all criteria, while the negative ideal solution is the worst value of each criterion and alternative. TOPSIS method uses the following steps (Hwang & Yoon, 1981):

a. Calculating the normalized matrix

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{n} X_{ij}^2}}$$

R_i = normalized value of decision matrix

X_i = original value of decision matrix

b. Calculating the weighted normalized matrix with weight W = (W1, W2, .. Wn), then the normalized weight matrix V is

$$Vij = Wirij$$

Explanation:

V_{ij} = weighted normalized decision matrix

W_i = weight against criterion i

c. Calculate the positive ideal solution matrix (A+) and negative ideal matrix (A-)

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+);$$
$$A^- = (y_1^-, y_2^-, \dots, y_n^-);$$

Explanation:

y_1^+ = max, if j is a benefit attribute

A^- = min, if j is attribute cost

d. Determine the distance between the value of each alternative with the positive ideal solution matrix and the negative ideal solution matrix. The distance between D+ alternatives and the positive ideal solution:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}\left(y_1^+ - y_{ij}\right)^2}$$

The alternative distance D- with a negative solution is formulated as:

$$D_i^- = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_i^-\right)^2}$$

e. Calculating preference values for each alternative

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}$$

f. Ranking alternated according to value (V_i)

Alternatives that have a value of Vi will be sorted from the largest to the smallest, and then a city will be selected that must implement the Enforcement of Community Activity Restrictions (PPKM).

RESULTS AND DISCUSSION

Data Analysis

The decision support system using the AHP and TOPSIS methods is carried out in several steps as follows:

a. Determine alternatives to determine the area to be carried out by PPKM in making decisions that will be carried out later. And determine the criteria that will be used as a reference in decision making. In this case, the author took 10 districts from the official website covid19.go.id

Table 1: Alternative Table

Code	Daerah
A1	Sukabumi, District
A2	Majalengka, District
A3	Purwakarta, District
A4	Cianjur, District
A5	Cirebon, District
A6	Karawang, District
A7	Subang, District
A8	Tasikmalaya, District
A9	Indramayu, District
A10	Bandung Barat, District
A11	Bogor, District

A12	Bekasi, District
A13	Ciamis, District
A14	Garut, District
A15	Kuningan, District
A16	Sumedang, District
A17	Bandung, District

Table 2 below is the criteria based on the results of interviews and literature study

Table 2: Criteria Table

Code	Criteria
C1	Confirmed
C2	Suspect
C3	Close Contact
C4	Probable
C5	Die
C6	Vaccine

b. Determining Pairwise Comparison

Table 3: Pairwise Comparison Table

Criteria	C1	C2	C3	C4	C5	C6
C1	1	1	3	3	3	7
C2	1	1	1	1	3	1
C3	0.333	1	1	1	1	3
C4	0.333	1	1	1	1	1
C5	0.333	0.333	1	1	1	1
C6	0.143	1	0.333	1	1	1
Total	**3.142**	**5.333**	**7.333**	**8.000**	**10.000**	**14.000**

c. Counting Consistency

Table 4: Multiply each column of the Pairwise Comparison Table

Criteria	Multiplied by Weight (0.3483)	Multiplied by Weight (0.1898)	Multiplied by Weight (0.1449)	Multiplied by Weight (0.1210)	Multiplied by Weight (0.1002)	Multiplied by Weight (0.0958)
C1	1	1	3	3	3	7
C2	1	1	1	1	3	1
C3	0.333	1	1	1	1	3
C4	0.333	1	1	1	1	1
C5	0.333	0.333	1	1	1	1
C6	0.143	1	0.333	1	1	1

Table 5: Calculating the total for each row

Criteria	C1	C2	C3	C4	C5	C6
C1	0.3483	0.1898	0.4346	0.3631	0.3006	0.6707
C2	0.3483	0.1898	0.1449	0.1210	0.3006	0.0958
C3	0.1160	0.1898	0.1449	0.1210	0.1002	0.2874
C4	0.1160	0.1898	0.1449	0.1210	0.1002	0.0958
C5	0.1160	0.0632	0.1449	0.1210	0.1002	0.0958
C6	0.0498	0.1898	0.0482	0.1210	0.1002	0.0958

Table 6: Calculating the values of Cl and CR

Value Total	Value Eigen	Value Lambda (λ)
2.3071	0.3483	6.6236
1.2004	0.1898	6.3258
0.9593	0.1449	6.6223
0.7677	0.1210	6.3418
0.6411	0.1002	6.3980
0.6049	0.0958	6.3132
Lamda(λ) Max		6.4375
Value CI		0.0875
Value CR		0.0706

The CR value is 0.0706, so the comparison criteria value is consistent.

    d.   Normalizing the Decision Matrix

Table 7: Normalization Results

Alternative	C1	C2	C3	C4	C5	C6
A1	2447	458	0	0	248	471573
A2	1144	0	1	1	26	248823
A3	512	0	93	0	34	298236
A4	1972	0	1	0	180	354260
A5	2134	0	1128	0	212	179322
A6	2883	5	0	0	182	1856867
A7	844	0	1	0	51	341896
A8	1123	31	56	0	59	241679
A9	1681	1	0	0	222	341424
A10	2071	19	248	0	48	451586
A11	6656	1	0	0	1	1261201
A12	4671	0	715	8	201	1192231
A13	3039	0	1	0	45	201195
A14	1158	149	48	0	53	448709
A15	979	0	1	0	144	266612
A16	599	0	0	1	9	404316
A17	2933	1	0	0	49	714020

    e.   Calculating a Weighted Normalized Matrix

Table 8: Results of Weighted Normalization Matrix

Alternative	C1	C2	C3	C4	C5	C6
A1	0.0778	0.1799	0.0000	0.0000	0.0454	0.0155
A2	0.0364	0.0000	0.0001	0.0149	0.0048	0.0082
A3	0.0163	0.0000	0.0099	0.0000	0.0062	0.0098
A4	0.0627	0.0000	0.0001	0.0000	0.0329	0.0117
A5	0.0678	0.0000	0.1198	0.0000	0.0388	0.0059

A6	0.0917	0.0020	0.0000	0.0000	0.0333	0.0611
A7	0.0268	0.0000	0.0001	0.0000	0.0093	0.0113
A8	0.0357	0.0122	0.0059	0.0000	0.0108	0.0080
A9	0.0534	0.0004	0.0000	0.0000	0.0406	0.0112
A10	0.0658	0.0075	0.0263	0.0000	0.0088	0.0149
A11	0.2116	0.0004	0.0000	0.0000	0.0002	0.0415
A12	0.1485	0.0000	0.0760	0.1192	0.0368	0.0392
A13	0.0966	0.0000	0.0001	0.0000	0.0082	0.0066
A14	0.0368	0.0585	0.0051	0.0000	0.0097	0.0148
A15	0.0311	0.0000	0.0001	0.0000	0.0263	0.0088
A16	0.0190	0.0000	0.0000	0.0149	0.0016	0.0133
A17	0.0933	0.0004	0.0000	0.0000	0.0090	0.0235

f. Calculating Positive and Negative Ideal Distance

Table 9: Positive and Negative Ideal Table for Each Criteria

Criteria	Positive Ideal Solution	Negative Ideal Solution
C1	0.2116	0.0163
C2	0.1799	0.0000
C3	0.1198	0.0000
C4	0.1192	0.0000
C5	0.0454	0.0002
C6	0.0059	0.0611

Table 10: Positive and Negative Ideal Table for Each Alternative

Alternative	Positive Ideal Solution	Negative Ideal Solution
A1	0.2158	0.2007
A2	0.2999	0.0587
A3	0.3137	0.0526
A4	0.2886	0.0753
A5	0.2594	0.1468

A6	0.2790	0.0824
A7	0.3105	0.0518
A8	0.2957	0.0592
A9	0.2930	0.0742
A10	0.2745	0.0736
A11	0.2532	0.1963
A12	0.1987	0.1982
A13	0.2748	0.0974
A14	0.2721	0.0782
A15	0.3064	0.0604
A16	0.3109	0.0502
A17	0.2765	0.0861

g. Calculating Final Score and Determining Rank

Table 11: Ranking Table

Alternative	District	Final Score	Ranking
A1	Sukabumi, District	0.4819	2
A2	Majalengka, District	0.1637	14
A3	Purwakarta, District	0.1436	15
A4	Cianjur, District	0.2070	10
A5	Cirebon, District	0.3614	4
A6	Karawang, District	0.2279	7
A7	Subang, District	0.1430	16
A8	Tasikmalaya, District	0.1667	12
A9	Indramayu, District	0.2020	11
A10	Bandung Barat, District	0.2115	9
A11	Bogor, District	0.4367	3
A12	Bekasi, District	0.4994	1
A13	Ciamis, District	0.2617	5

A14	Garut, District	0.2232	8
A15	Kuningan, District	0.1646	13
A16	Sumedang, District	0.1390	17
A17	Bandung, District	0.2375	6

System Implementation

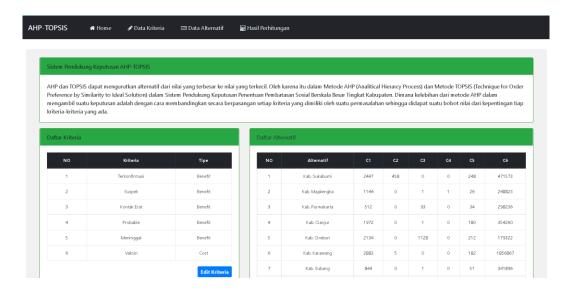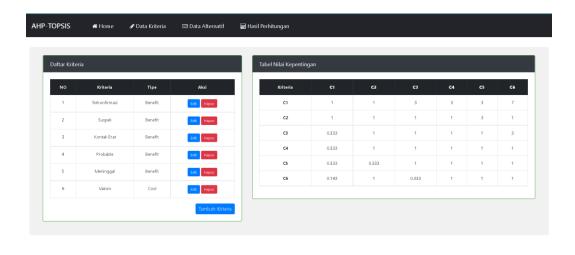a. Main Page View

Figure 1: Main Page

Figure 1 displays the main page of the Decision Support System, where there is an explanation of the method, a list of criteria, and a list of alternatives.

b. Criteria Page View

Figure 2: Criteria List page

In Figure 2, there is a list of criteria and their importance. And can add criteria, edit, and delete criteria.

c. Alternative Page View

In Figure 3, there is an alternative table that can be edited and deleted.
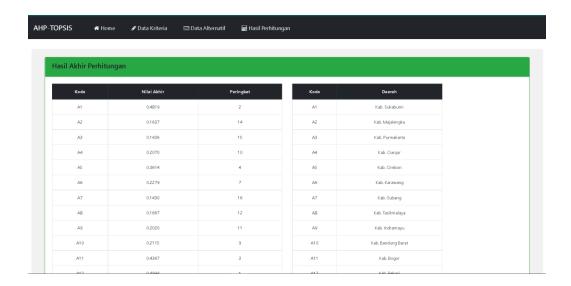
Figure 3: Alternative Picture View

d. Calculation Result Display

In Figure 4, there are calculation results from AHP to TOPSIS and ranking results at the end of the page.

Figure 4: Display of Calculation Results Page

Kode	Nilai Akhir	Peringkat		Kode	Daerah
A1	0.4819	2		A1	Kab. Sukabumi
A2	0.1637	14		A2	Kab. Majalengka
A3	0.1436	15		A3	Kab. Purwakarta
A4	0.2070	10		A4	Kab. Cianjur
A5	0.3614	4		A5	Kab. Cirebon
A6	0.2279	7		A6	Kab. Karawang
A7	0.1430	16		A7	Kab. Subang
A8	0.1667	12		A8	Kab. Tasikmalaya
A9	0.2020	11		A9	Kab. Indramayu
A10	0.2115	9		A10	Kab. Bandung Barat
A11	0.4367	3		A11	Kab. Bogor
A12	0.4994	1		A12	Kab. Bekasi

CONCLUSION AND DISCUSSION

Based on the results of the discussion and analysis of the decision support system for determining large-scale social border areas using the AHP and TOPSIS methods, the conclusions are as follows:

a. By using the combined method of AHP and TOPSIS, accuracy is higher, and the calculations carried out are in line with expectations
b. With this system, it can help local governments determine the implementation of restrictions on community activities based on the available rankings
c. The use of this system can save time and is efficient because of the easy-to-understand display and fast calculations.

Based on our findings in this research, there are some improvements that can be added to future works. It is hoped that someday the development of this system can run on smartphones and run online so that it can be used anywhere. It is hoped that further research can determine the PPKM area based on levels 1-4.

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