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Research paper

Web GIS decision support system for increasing community participation in urban spatial planning using hybrid AHP-TOPSIS

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Abstract

The implementation of the GIS Decision Support System in spatial land management is believed to increase community participation to contribute to solving land management problems. The objective of the study was to analyze weighting parameters and prioritize the location of urban forest as Green Open Space (GOS) in Balikpapan City-Indonesia. Weighting and priority ranking analysis uses a combination of 2 methods on Multicriteria Decision Analysis - MCDA i.e. hybrid AHP-TOPSIS. The research phases were conducted by in-depth survey method to explore the preference of respondent key-person to the comparison value of each parameter. There has been a description of the existence of urban GOS, parameter weighting value and priority order of urban forest as an alternative location of Balikpapan City GOS. Weight analysis yields land area as the main factor in determining GOS location, followed by land price and location distance to downtown. The forest city location of Bendali III Gunung Bahagia Village in South Balikpapan is the highest priority that can be used as development area GOS Balikpapan City. Web GIS prototype software has been created as a decision support system that can give priority recommendations for urban forest as GOS Balikpapan City.

Keywords:*Urban Green Open Space; Weighting Analysis; MCDA; AHP-TOPSIS; Balikpapan City.*

1. Introduction

The ecological balance of urban environment is as important as the development of economic value in urban areas. These conditions cause the disruption of the balance of urban ecosystems that rise temperatures and due to global warming, climate change, air pollution, heat island, and the depletion of the ozone layer. Vegetation in urban GOS also offers citizens aesthetic enjoyments, recreational opportunities and physical and psychological well-being [1-4].

Rapid and high innovation in software Geographic Information Systems (GIS) has helped many aspects of environmental management. The progress in the application of GIS to enhance public cooperation in the spatial decision-making still has many limitations. Integration Web GIS and Decision Support System (DSS) can help urban living can increase the rate of community participation in spatial land management issues [5], [6].

There are many computational techniques in the Multicriteria Decision Analysis (MCDA) and DSS, among them are Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Several studies have used both methods either singly or in combination. For individual decision modeling in urban land planning problem, the Analytical Hierarchical Process - AHP technique can select the best location of urban GOS [5]. Research by [7] and [8] has applied AHP techniques singly to land suitability issues and by [9] has integrated AHP-TOPSIS for the commercial off-the-shelf (COTS) components in development projects of large systems. The both techniques have effectively accommodated the changing business landscape in addition to providing better software reuse functionalities.

The utilization of these two computational techniques in the management of natural resources, especially in spatial management is a very appropriate choice. The ability of decision analysis in space management can improve accuracy in managing and managing urban land [10].

On the other hand, the problem of urban areas is generally more complicated. Along with the development of urban areas, development poses problems in land management, such as high and uneven population density, reduced public infrastructure such as clean water, garbage, transportation and reduced public space such as the urban GOS and water catchment areas [11].

Balikpapan city is one of the big cities in East Kalimantan Province-Indonesia with an area of 843.48 KM^2. Based on regional spatial planning (RTRW) 2012-2032, this city government has set 52% as a green area and 48% of the area built. Balikpapan City has 20 green areas with an area of 349,196 Ha. Besides, there are 25 GOS locations with total area of 14 Ha and more. Along with the high growth rate of occupied Balikpapan City of 5.01% per year, the city still needs to develop a new GOS location to maintain an ideal green environment ratio of 52% [12-15].

This paper aims to apply MCDA analysis especially AHP-TOPSIS composite techniques in the case of prioritizing urban

forests as alternative urban GOS locations. It is hoped that this analysis will assist stakeholders in land management in Balikpapan City area.

2. Literature review

2.1. Analytical hierarchy process (AHP)

Decision-making issues can be complex because of the inclusion of multiple objectives and the complexity of the criteria. One suitable tool used for the selection of candidates or priority sorting in the MCDA problem is the Analytical Hierarchy Process (AHP). This method has been developed by [16] which are specifically suitable for candidate selection issues or priority sorting. AHP technique has characteristic traits such as:

- Involves qualitative criteria that are difficult to quantify appropriately.
- Each criterion can have sub-sub criteria that can be formed like a hierarchy.
- Assessment can be done by one or more decision makers at once.
- Selected candidates are certain and limited in number.

2.2. Technique for order preference by similarity to ideal solution (TOPSIS)

TOPSIS is a pretty ideal method because the chosen alternative has the closest distance to a positive ideal solution and has the furthest distance from the negative ideal solution [17]. Here are the steps in TOPSIS technique:

1) Normalization of the decision matrix: Let D is the criteria-weighting matrix of each alternative. Each element in the matrix D is normalized to obtain the normalized matrix R. Any normalization of the r_{ij} value can be calculated as in the following formula (1):

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Let i = 1, 2, 3, …, m and j = 1, 2, 3, …, n

2) Weighted in normalized matrix: Given the weight of W = (w_1, w_2, ..., w_n), so the weighted normalized matrix V can be generated as in the following formula (2):

$$V=\begin{bmatrix} w_1r_{11} & \cdots & w_1r_{1n} \\ \vdots & \ddots & \vdots \\ w_nr_{m1} & \cdots & w_nr_{mn} \end{bmatrix} \quad (2)$$

3) Determine the positive ideal solution and the negative ideal solution: The positive ideal solution is denoted by A^+ and the negative ideal solution denoted by A^-, as in the following formula (3):

$$A^+ = \left\{\left(\max v_{ij} \mid j \in J\right)\left(\min v_{ij} \mid j \in J'\right), i = 1,2,...,m\right\} = \left\{v_1^+, v_2^+, .., v_m^+\right\}$$

$$A- = \left\{\left(\max v_{ij} \mid j \in J\right)\left(\min v_{ij} \mid j \in J'\right), i = 1,2,...,m\right\} = \left\{v_1^-, v_2^-, .., v_m^-\right\} \quad (3)$$

4) Calculating Separation Measure: Separation measure is a measure of the distance from an alternative to a positive ideal solution and a negative ideal solution with the following formula (4) and (5):

$$S_i^+ = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2} \quad (4)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \quad (5)$$

5) Calculating relative proximity: The relative proximity of alternative A+ with ideal solution A- is represented in the following formula (6):

$$C_i = \frac{S_i^-}{S_i^- + S_i^+}, \text{ notice } 0 < C_i < 1 \quad (6)$$

6) Ranking alternative: Alternatives can be ranked based on a sequence of Ci values. The best alternative is one of the shortest distance to the positive ideal solution and furthest away with the ideal negative solution.

3. Research method

3.1. Location of the study

Balikpapan City is one of the big cities in East Kalimantan Province-Indonesia with an area of 843.48 KM^2. The city has a land area of 503.30 KM^2 and 340.18 KM^2 of water territory. The boundaries of this city include KutaiKertanegara Regency in the north, Makassar Strait on the South and East, and PenajamPaser Utara in the West. Astronomically, Balikpapan lies between 1.0 - 1.5 Latitude and 116.5 - 117.0 Longitude with an area of about 503.3 KM^2 and the area of marine reaches 160.10 KM^2. Figure 1 describes map of Balikpapan City.

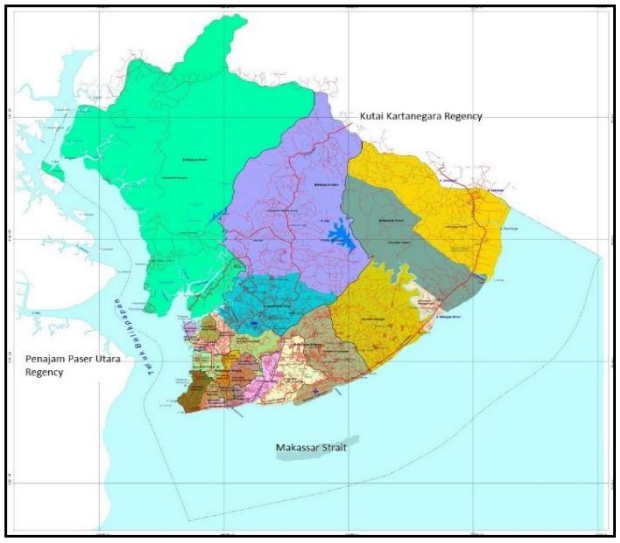

Fig. 1: Boundary Map of the Balikpapan City as Research Location.

Based on the amendment of the Local Regulation Balikpapan City number 7/2012 concerning the establishment of 7 (seven) sub-district in Balikpapan City, and Local Regulation number 8/2012 on the Formation of district of Balikpapan City. This site consists of 6 district and 34 sub-districts. Table 1 explained about the division of Balikpapan City region consists of [6] districts.

Table 1: List of District of Balikpapan City

Number	District Name
1.	East Balikpapan District
2.	South Balikpapan District
3.	Center Balikpapan District
4.	North Balikpapan District
5.	West Balikpapan District
6.	Town Balikpapan District

3.2. Stages and variable research

This research applies several stages: (1) Determination of research objectives, variables and alternatives model (2) In-depth survey to

respondent key-person (3) Analyse the model using AHP-TOPSIS technique and (4) Software development Web GIS DSS of GOS location Balikpapan City.

Decision analysis is conducted to produce recommendations on the case of prioritization of Balikpapan City Forest location. In other words, decision analysis is aimed at obtaining an appropriate decision recommendation on site or place selection based on individual preferences and considerations. The exact location of the Kota Balikpapan Forest involves the various variables (criteria) that determine the choice. In this research has determined 7 (seven) main factors that are assumed can influence City Forest location selection. The selection of these seven factors is based on guidance on determining the location of green space emitted by the Ministry of Forestry in 2004 and refers to the research reference by [18]. The following table describes the criteria used in decision model analysis for the selection of the GOS urban forest selection of Balikpapan City.

Table 2: Multi Criteria Used for Analysis of Decision Model of Urban Forest Selection, GOS Balikpapan City

No.	Criteria name	Type	Unit	Adding information	Decision Rule
1	C1	Interval	M^2	Land area	The widest is the best
2	C2	Interval	Rp/M^2	Land price	Cheapest is selected
3	C3	Interval	Person	Total population within radius 100M	The largest population is selected
4	C4	Ordinal	ISPU	Pollution levels	The highest pollution is selected
5	C5	Interval	M	Average distance to settlement	Closest distance is the best
6	C6	Interval	M	Average distance to city center	Closest distance to city center is the best
7	C7	Interval	M	Average distance to main street	Closest distance to main road is the best

4. Result and discussion

4.1. Profile of GOS balikpapan city

Balikpapan city has many GOS in urban forest, City Park, green line, cemetery, conservation forest and others. One of the green spaces that still survive is the conservation forest of Wain River, this area is Wain River Basin with Bugis Sub River Basin. This area is defined by the status of a protected area based on Kutai Kingdom Decree No. 48 / 23-2B-1934 - July 9, 1934. Then the determination was also reinforced by the Decree of the Minister of Forestry no. 118 / Kpts-II / 1988 - February 29, 1988 on the boundaries of Wain River conservation forest. The Wain River conservation forest area covers a total area of 100.25 KM^2 based on measurement in 1990 and reduced to 978.28 KM^2 in 1993 measurements.

Based on the Regulation of Public Works and People's Housing number 5 / PRT / M / 2008 on Guidelines for the Supply and Utilization of GOS in urban areas, GOS types of Balikpapan City are divided into 2, namely public and private GOS. The GOS management of Balikpapan City also refers to Balikpapan City Local Regulation number 12 years of 2012 on Regional Spatial Plans in 2012 – 2032 and refers to the local regulation number 5 years of 2013 on the Provision and Supply of Infrastructure, Facilities and Utilities in the Housing Area. Map of Regional Spatial Plans in 2012 - 2032 Balikpapan City as described in Figure 2.

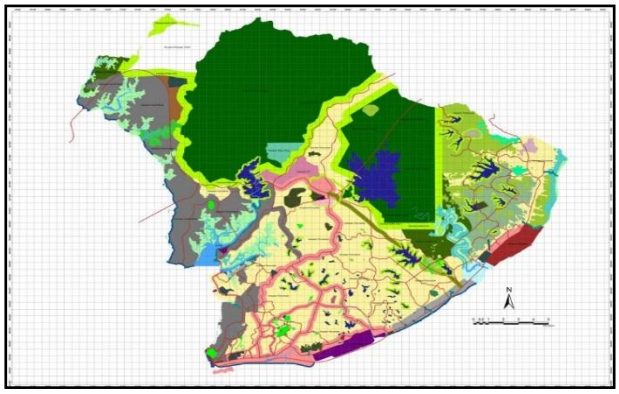

Fig. 2: Map of Regional Spatial Plans in 2012 - 2032 Balikpapan City. The Intensity of Green Colour Shows the Change of Land Function from Green Area to Building Area.

Balikpapan Green Book [13] issued by the Balikpapan City Government Environmental Agency, the GOS of the city is classified into [4] types:

1) GOS yard
2) GOS park and urban forest
3) GOS border road, and
4) GOS certain function

The four types of green space above, GOS type of urban forest is the largest contributor percentage of total green space Balikpapan City.

GOS of urban forest is a land that grows compact and densely populated trees within urban areas both on state and private lands, designated as urban forest by authorized officials. The state of urban forest is illustrated in the table below [Table 3]:

Table 3: Data Area of Urban Forest Balikpapan City, Determination of the Year 1996 – 2004

No.	Location	Wide (M^2)	Unit Private	Public
1	Kariangau forest region	0.030	Owned by the community	
2	Karang Rejo forest region	0.017	Owned by the community	
3	Prapatan forest region	0.073	Owned by the community	
4	Daksa region	0.010	Owned by PT. Daksa	
5	Buffer Zone Pertamina Kr. Jati region	0.025		Owned by PT. Pertamina
6	Navy Kr. Jati region	0.026		Owned by NAVI
7	Bendali I Sepinggan region	0.016		Owned by Regional Gov.
8	Bendali II Sepinggan region	0.220		Owned by Regional Gov.
9	Bendali Kampung Timur region	0.150		Owned by Regional Gov.
10	Bendali III Gn. Bahagia forest region	0.200		Owned by Regional Gov.
11	Teritip market region	0.030		Owned by Regional Gov.
12	A. Yani Street Kr. Jati river banks	0.004		Owned by Regional Gov.
13	Batu Ampar RT42 region	0.040		Owned by Regional Gov.
14	Batu Ampar RT55 region	0.055		Owned by Regional Gov.
Wide Total		0.896		

In addition to urban forests, Balikpapan City also has forest areas and conservation forests that provide protection of crops and biological resources. The existing forest areas are the Karang Rejo Forest and Prapatan Forest Area. Both of these forest areas are GOS private managed by local people. Conservation forest in the city of Balikpapan is Wain River Forest and Manggar River Forest. Wain River Forest is partly located in Karang Joang sub-district, North Balikpapan District and partly located in Kariangau sub-

district, West Balikpapan District. Meanwhile, Manggar River Forest covers District of North Balikpapan (Karang Joang sub-district) and East Balikpapan (Manggar sub-district, Lamaru sub-district and Teritip sub-district).

4.2. Analysis with AHP technique

After establishing criteria on urban forest determination, factor analysis is used to obtain the weight of each criterion. Through this analysis, we will know which criteria have the greatest weight and which have the smallest. To determine the weight of each criterion is done by using expert judgment. Expert justification value obtained through the field survey process by visiting respondents who act as key-person.

Prior to field surveys of key personnel, it is necessary to design a questionnaire format to extract expert justification scores. The questionnaire is designed as complete as possible with reference to the AHP technique so that expert value can be obtained about the weight ratio of each criterion.

The selection of respondents as experts is done through sampling method with purposive sampling technique non-probabilities. That is a sampling procedure based on a specific purpose. The number of respondents is determined by quota sampling technique as much as 2 (two) people. Determination of the number of respondents as much as 2 people related to real conditions in the field.

During the field survey, urban forest management was conducted by 3 departments, namely the Land and Spatial Planning Department, the Environment Department and the Housing and Settlement Department. Especially with regard to the management and policy of the urban forest, its coordinator is at the Environment Department. As for the management and policy of other types of GOS, there is the Department of Housing and Settlements. While the Land and Spatial Planning Office is policy in determining Regional Spatial Plans Balikpapan City.

Based on these data, this research explores one expert's point of view and preferences from the Environment Department, and 1 expert from the Housing and Settlement Department. The data of expert respondents used as the basis of the decision model is Mr. Rizal who served as Head Section of Urban Forest Management, Protection Forest and Ground Water Land, Environment Department of Balikpapan City.

This research explored in depth information about the policy of GOS development plan in Balikpapan City. Specific to the development of the new GOS, policy patterns have been set by the Environment Department, that the location of the new GOS is addressed to urban forests in Balikpapan. The urban forest is considered highly potential and has a long-term strategic aspect. The location of urban forest development in Balikpapan refers to the alternative table as shown in the Table 4.

Table 4: Alternative Location and Code on Decision Analysis GOS Balikpapan City

Alternative Code	Location
A1	Kariangau forest region
A2	Buffer Zone Pertamina Kr. Jati region
A3	Navy Kr. Jati region
A4	A. Yani Street Kr. Jati riverbanks
A5	KarangRejo forest region
A6	Prapatan forest region
A7	BatuAmpar RT42 region
A8	BatuAmpar RT55 region
A9	Daksa region
A10	Bendali I Sepinggan region
A11	Bendali II Sepinggan region
A12	Bendali Kampung Timur region
A13	Bendali III Gn. Bahagia forest region
A14	Teritip market region

Furthermore, row and column manipulation of paired matrices and AHP techniques is performed. The results of AHP technique analysis are described in accordance with the phasing as described Table 5.

Table 5: Matrix Comparison Pairs with AHP Technique

Criteria	C1	C2	C3	C4	C5	C6	C7	Sum of row
C1	1	1	5	7	5	1	5	25.00
C2	1	1	5	5	5	1	5	23.00
C3	0.2	0.2	1	1	1	0.2	0.2	3.80
C4	0.14	0.2	1	1	0.2	0.2	1	3.74
C5	0.2	0.2	1	5	1	0.2	1	8.60
C6	1	1	1	5	5	1	5	19.00
C7	0.2	0.2	5	1	1	5	1	13.40
Sum of column	3.7	3.8	19.0	25.0	18.2	8.6	18.2	

Priority vector calculation is performed by normalizing the value of each matched column matrix by dividing each value in the matrix column by the corresponding sum of column, and then calculated the average value of the sum of each row matrix. After repeatedly doing the normalization process matrix pair, then obtained matrix normalized and Eigen vector as weighting criteria (W) as follows:

Table 6: Normalized Matrix and Eigen Vector Value

Criteria	C1	C2	C3	C4	C5	C6	C7	Eigen vector
C1	0.27	0.26	0.22	0.28	0.27	0.12	0.27	0.24
C2	0.27	0.26	0.22	0.20	0.27	0.12	0.27	0.23
C3	0.05	0.05	0.04	0.04	0.05	0.02	0.01	0.04
C4	0.04	0.05	0.04	0.04	0.01	0.02	0.05	0.04
C5	0.05	0.05	0.04	0.20	0.05	0.02	0.05	0.07
C6	0.27	0.26	0.22	0.20	0.27	0.12	0.27	0.23
C7	0.05	0.05	0.22	0.04	0.05	0.58	0.05	0.15
Total	1	1	1	1	1	1	1	1.00

$$W = \begin{bmatrix} 0{,}242 \\ 0{,}231 \\ 0{,}04 \\ 0{,}038 \\ 0{,}069 \\ 0{,}231 \\ 0{,}151 \end{bmatrix}$$

The analysis explains that the land area (C1) is the highest factor in determining the location of urban forest, followed by price (C2), the distance to the city center (C6), the distance to the main road (C7), the distance to the settlement (C5), population around the site (C3) and pollution level (C4). So the wide criteria, price and distance are the main factors that influence the selection of urban forest location of GOS Balikpapan City.

4.3. AHP-topsis hybrid analysis

After obtaining the criteria weight (W) of pair's matrix analysis using AHP technique, the analysis was continued with TOPSIS technique. Namely an analysis aimed to obtain individual decision preferences / recommendations.

Suppose D_{ij} is an alternative preference value matrix of each criterion, then R_{ij} can be calculated using equation (1). Furthermore, Y_{ij} is calculated as the result of multiplication of R_{ij} matrix with W obtained from previous AHP technique. Then we get the V_{ij}, the normalized matrix according to equation 2. The results of this treatment are shown in tables 7 and 8.

Table 7: Alternative Preference Value of Each Criterion, Data for D_{ij} Matrix

Alternative	Criteria						
	C1	C2	C3	C4	C5	C6	C7
A1	1	1	1	1	2	1	1
A2	1	1	1	2	3	3	3
A3	1	1	2	2	3	3	3
A4	1	2	2	3	3	2	3
A5	1	1	2	1	3	3	3
A6	2	1	2	1	2	1	3

A7	2	2	3	3	3	2	3
A8	2	2	3	3	3	2	3
A9	2	1	2	2	2	1	2
A10	3	2	3	2	2	2	2
A11	3	2	3	2	2	2	2
A12	3	2	3	2	2	2	2
A13	3	2	3	2	3	3	3
A14	1	2	2	1	2	1	3

Table 8: The Normalized Matrix RijX W Produce Vij

Alternative	Criteria						
	C1	C2	C3	C4	C5	C6	C7
A1	0,032	0,037	0,004	0,005	0,007	0,029	0,015
A2	0,032	0,037	0,004	0,01	0,011	0,087	0,046
A3	0,032	0,037	0,009	0,01	0,011	0,087	0,046
A4	0,032	0,081	0,009	0,015	0,011	0,058	0,046
A5	0,032	0,037	0,009	0,005	0,011	0,087	0,046
A6	0,064	0,037	0,009	0,005	0,011	0,029	0,046
A7	0,064	0,081	0,013	0,015	0,011	0,058	0,046
A8	0,064	0,081	0,013	0,015	0,011	0,058	0,046
A9	0,064	0,037	0,009	0,01	0,007	0,029	0,031
A10	0,095	0,081	0,013	0,01	0,007	0,058	0,031
A11	0,095	0,081	0,013	0,01	0,007	0,058	0,031
A12	0,095	0,081	0,013	0,01	0,007	0,058	0,031
A13	0,095	0,081	0,013	0,01	0,011	0,087	0,046
A14	0,032	0,081	0,009	0,005	0,007	0,029	0,046

The next step determines the positive ideal solution (A^+) and the negative ideal solution (A^-). Then measure the distance of each alternative to A^+ and A^- which yields S^+ and S^- using equations 3, 4 and 5. Then it is calculated the relative proximity of S^+ and S^- using equation 6 that yields the C_i matrix. Rating Matrix C_i this is the result of recommendation of the final decision of TOPSIS technique. Table 9 describes the value of the C_i matrix and its ranking.

Table 9: Relative Proximity Value (C_iMatrix) and Its Ranking

Alternative	Relative Proximity Value	Ranking
A1	0.000	14
A2	0.460	10
A3	0.462	8
A4	0.473	7
A5	0.460	9
A6	0.360	13
A7	0.624	5
A8	0.624	6
A9	0.366	12
A10	0.717	2
A11	0.717	3
A12	0.717	4
A13	0.953	1
A14	0.385	11

Accordance to Relative Proximity Ranking, the location of urban forest in Bendali III area of Gunung Bahagia Village in South Balikpapan is the highest priority that can be used as development area of GOS urban Forest. The 2nd, 3rd and 4th priorities have the same preferences vector value, which is the location of Bendali (Bendali I and II) in Sepinggan and Bendali in Kampung Timur. Meanwhile the area in Batu Ampar area in RT42 and RT55 also has the same vector, followed by the area in riverbanks of Karang-Jati, Navy region, Karang Rejo region as described in detail in accordance with those in Table 8.

4.4. Web GIS DSS software prototyping

There are many studies that integrate GIS with decision analysis. Rapid innovation of GIS software and supported by the development of computing hardware has made GIS the ultimate tool for spatial planning and decision making. Application of GIS in the World Wide Web environment and integrating it with multi-criteria decision analysis capabilities can provide a mechanism that bridges the gap between the general public and the experts. Web-based GIS can also be a solution to improve people's access to information.

This study develops software that has the ability to perform collaborative and participatory decision analysis in accordance with the predefined model in the best GOS location selection case in Balikpapan City. The software operates in a World Wide Web environment and is distributed on a global Internet network with copyright of the GreenSpaceBpn domain name. Currently GreenSpaceBpn application is still in Indonesian version.

GreenSpaceBpn is Web GIS-based multicriteria decision analysis software (GIS-MDCA) that can transform and combine geographic data and decision maker preference values. GreenSpaceBpn was created to obtain appropriate information for decision making on the selection of GOS. GreenSpaceBpn integrates 2 (two) different and complementary research areas. GIS-MCDA is an area that will provide powerful and integrated tools for storage, analysis and visualization of spatial data for decision making [17]. MCDA AHP-TOPSIS is a mechanism that provides procedures and algorithms for structured decision analysis, can be evaluated and prioritize the order of decisions.

GreenSpaceBpn application users are expected from the general public who are focused and have concern for the presence of green open space. Application users are expected to come from all walks of life, either expert or lay users, from bureaucrats, academics, industry, and other professions as well as to the general public without unrestricted religion and ethnicity. In accordance with Internet-based distribution patterns, the user is not limited by time and place.

GreenSpaceBpn is built using a client-server architecture that is distributed across the global network of World Wide Web networks. End users access GreenSpaceBpn applications from client computers via browser applications such as Firefox, Internet Explorer or Chrome Web Browser. When the computer is connected to the application, the user's computer is actually accessing the GreenSpaceBpn server machine. GreenSpaceBpn application development was using free open source software programming tools such as HTML, CSS, PHP and MySQL database.

Fig. 3: GreenSpaceBPN aboutDesign.

The GreenSpaceBpn application prototype can be accessed with the domain name greenspacebpn.com and can be accessed from any web browser. If the user's computer is connected to the Internet network, typing in the domain name, then the user will find the Home view, which contains the initial information about the application. A look at the Home page of the GreenSpaceBpn application is described in figures 4 and 5 below.

The application stores alternative urban forest data as an existing option for GOS Balikpapan City. Detail information about alternatives inputted by the admin consists of the location name, address, user preference value of each criterion, and location image. Figure 6 describes alternative information on the GreenSpaceBpn application.

The app displays the results of the computing process using the AHP-TOPSIS hybrid. Computational results are displayed starting from user preference data, AHP weighting value, and priority

order recommendation results from AHP-TOPSIS. The result view of the system computing process is described in Fig. 7.

Fig. 4: GreenSpaceBPN Home View Information about AHP-TOPSIS.

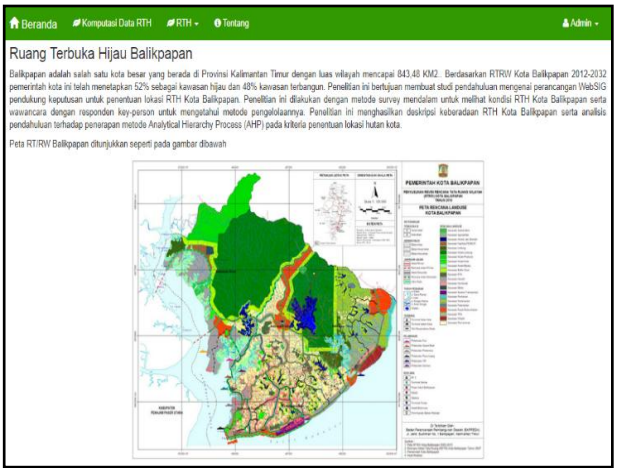

Fig. 5: GreenSpaceBPN, Home View Explanation about GOS Balikpapan City.

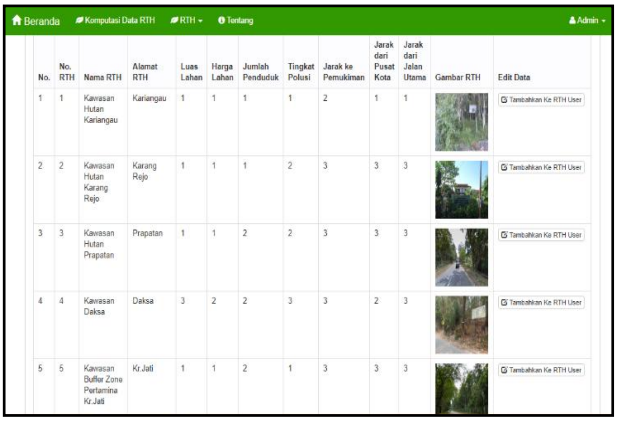

Fig. 6: Alternative Information on the GreenSpace BPN.

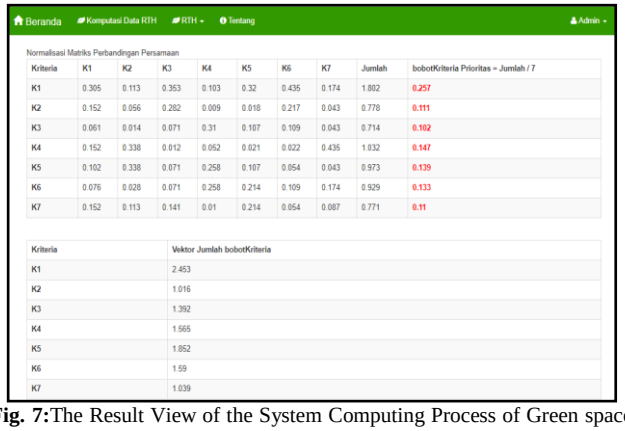

Fig. 7: The Result View of the System Computing Process of Green space BPN.

5. Conclusion

MCDA with AHP-TOPSIS technique is a model that can be applied well in case of GOS management of Balikpapan City. The weighted criteria analysis with AHP technique placed the criteria of land area as the main factor in the development of GOS location of urban forest, followed by the criteria of land price and location distance to the city center. Analysis of urban forest priority determination by AHP-TOPSIS technique resulted in Bendali III Kelurahan Gunung Bahagia location in South Balikpapan as the first priority that can be used as development area of GOS Balikpapan City. The GreenSpaceBpn application is a software prototype capable of providing recommendation of city forest selection decision as GOS of Balikpapan City.

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