JURNAL INFOTEL
Informatics - Telecommunication - Electronics

Website Jurnal : http://ejournal.st3telkom.ac.id/index.php/infotel
ISSN : 2085-3688; e-ISSN : 2460-0997

The Geographic Information System Development for Selection of Green Open Space in Urban Densely Area

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Received 10 July 2018, Revised 18 July 2018, Accepted 25 August 2018

Abstract - Utilization of integrated Decision Support System and GIS as one of the intelligent computerized system can be used to help make decisions quickly, accurately, and consistently. This research aims to apply Simple Additive Weighting (SAW) and built application system with ArcGIS platform to determination of urban Green Open Space (GOS) location in densely populated area. The study was conducted in Samarinda City, used secondary data and obtained from the Sanitation and Gardening Agency. Data were collected by survey and interview with experts and using Waterfall Framework for software development method. The research has resulted the priority sequence of GOS location of densely area of Samarinda City. The first priority location is the location under Juanda Flyover Bridge. Research has also developed Web based GIS software application of GOS location determination using SAW technique.

Keywords - Green Open Space, Geographic Information System, Decision Support, Simple Additive Weighting

I. INTRODUCTION

Rapid urbanization has caused many environmental impacts associated with the reduction of urban green space [1]. 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. The existence of urban Green Open Space (GOS) have three benefits a) can improve the functions of Shading and Evapotranspiration b) the temperature of the different species of trees decreases with the increase of evaporation c) increasing urban GOS can improve the urban microclimate and the quality of life of its residents. The loss of green space may deprive the habitats for creatures, reduce biodiversity, and disrupt the structure and process of the urban ecosystem. Even, vegetation in urban GOS also offers citizens aesthetic enjoyments, recreational opportunities and physical and psychological well-being [2][3].

The existence of urban green spaces is important in high-density inner cities area as they enhance social well-being [4]. The importance of green open spaces for providing opportunities for social interaction, avoiding a sense of loneliness and promoting social life amongst the elderly. Based on the study from [5], They have found factors of important planning and design criteria of public open spaces for the elderly who are living in dense older districts in Hong Kong.

Rapid and high innovation in software Geographic Information Systems (GIS). The progress in the application of GIS to enhance public cooperation in the spatial decision-making still has many limitations. For individual decision modeling in urban land planning problem, the Analytical Hierarchical Process-AHP technique can select the best location of urban Green Open Spaces [6][7]. Simple Additive Weighting

(SAW) method is particularly applicable to electoral cases involving multiple attributes. The researchers combine AHP and SAW techniques in a GIS application. They have combined the AHP and SAW methods with GIS-based assessment for selecting suitable sites for landfill in Al-Musayiab Qadhaa, Babylon, Iraq. Meanwhile [8], GIS-based approach can apply to an optimal selection of meteo-hydrological station network on Vu Gia-Thu Bon river basin for developing an up-to-date real-time flood warning system. Image interpretation can be performed using GIS, and the use of GIS has evolved into a wide range of knowledge that can be integrated with spatial information [9]. A research on decision modeling for the management of GOS Samarinda has also been done by [10]. The researcher has applied a combination of the AHP-TOPSIS method in a software development of the Group Decision Support System.

This study aims to develop a geographic information system to select green open spaces in the densely populated areas of Samarinda using SAW method.

II. RESEARCH METHOD

This study includes engineering studies with survey methods for data collection. Data in the form of primary and secondary data obtained from the Department of Sanitation and Garden City of Samarinda. Software development uses the Waterfall framework that includes planning, model analysis, design, implementation and testing of software systems.

A. Decision Support Systems (DSS)

Decision support systems are a computer-assisted interactive system that supports the user in the ease of access to data and decision models in an effort to help the making decision process. It can be effective in solving problems that are semi-structured and unstructured. Decision support system (DSS) is an interactive information system that provide information, modeling, and data manipulation. This system is used to help making the decisions in semi structured and unstructured situations. From the above understanding, it can be concluded that the Decision Support System (DSS) is a computer-based information system approach to produce a variety of alternative decisions to assist the parties in addressing the issues particular to the use of data and models. A DSS only provide an alternative decision and subsequently handed over to the user to make the decision.

B. Simple Additive Weighting Method (SAW)

One method of solving MADM (Multiple Attribute Decision Making) is to use the Simple Additive Weighting method (SAW). SAW method also commonly known as weighted summation method. The basic concept of SAW method is to find a weighted summation of the performance rating of all the attributes of each alternative [11]. Combined with SAW and GIS can optimal site selection for sitting a solar park in the southern part of the island of Cyprus [12].

SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all the rating alternatives. This method is the most famous and most widely used method of dealing with situations of Multiple Attribute Decision Making (MADM). MADM itself is a method used to find the optimal alternative of a number of alternatives to certain criteria.

SAW method requires decision-makers determining the weights for each attribute. The total score for alternatives is obtained by adding up all the multiplication of rating (which can be compared cross-attribute) and the weight of each attribute. The rating for each attribute dimension must be free in the sense that has gone through the process of normalization toward previous matrix. Given equation (1):

$$R_{ij} = \begin{cases} \dfrac{X_{ij}}{Max\, X_{ij}} & ; \text{If j is benefit attribute} \\ \dfrac{Min\, X_{ij}}{X_{ij}} & ; \text{If j is cost attribute} \end{cases} \quad (1)$$

R_{ij} is the normalized performance rating of alternative A_i on attribute C_j,i = 1, 2, ..., m and j = 1, 2, ..., n. Preference value for each alternative V_i given equation (2):

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (2)$$

V_i = the value of preferences will; The greater V_i value indicates that alternative A_i is selected, w_j = weighting rankings, r_{ij}= normalized performance rating.

C. Research for Geographic Information Systems (GIS)

There were many researches that applies the concept of Geographic Information Systems. Many applications were related to spatial data on the surface of the earth. According to [13], GIS is a computer-based system used to store and manipulate spatial information. This system was designed to collect, store, and analyze the objects and phenomena of geographical location on the surface of the earth.

GIS concepts and theories have been applied to virtual of flight route simulation software systems [14]. They have also implemented a location-based services application for Tegal district tourist places. Location Based Service (LBS) is a service offered through the mobile phone by considering geographical location of the device [15].

Many researchers stated interest of urban green space. The existence of urban green spaces are important in high density inner city areas as they enhance social well-being [16]. Based on study from [17], They have found factors of important planning and design criteria of public open spaces for the elderly who are living in dense older districts in Hong Kong.

D. Green Open Space (GOS)

Green Open Space (GOS) is an elongated area or line in groups that's more open, where the plants grow, both of which grow naturally or deliberately planted.GOS can be a region with a certain area and overgrown with green plants. They can be parks, gardens, road borders, river borders, urban forests or even conservation forests.

GOS in Samarinda is consists of public GOS and private GOS. Public GOS is managed by the local government, in this case, the government of Samarinda through regional work units and Sanitation and Gardening Department that is constructed and used for the public interest. While private GOS is the property of a particular institution or individual can use for a limited circle.

III. RESULT

A. GOS Modeling

Determination of GOS System in the densely populated area uses SAW method and ArcGIS Platform has the three-stage process to get the best alternative candidate recommendations GOS. The first stage, admin entry candidate data for the location of green space, here the system uses four criteria: land use area (C1), land ownership (C2), the number of residents around the site (C3) and the distance to the settlement (C4). The system will make improvements by changing the input into the rating value match.

The second phase after the match got value for value rating criteria, the system will have normalized criteria values by looking for the greatest value to each criterion of all the alternatives and then after getting the greatest value then the value of the criteria will be shared with the greatest value for each of the same criteria.

The third stage is to find the value of V is the final value by adding the product of value criteria in normalization and weighting each alternative. Having obtained the value of V, the system will do the ranking. The highest value of V is the best alternative that is generated.

Data names of candidates for the location of the green space in the district of Samarinda Ulu existing in the system can be seen in Table 1 below.

Table 1. Data GOS Candidate in The District of Samarinda Ulu

No.	*GOS Candidate Name*
1.	Border Parks of Drs. H. Anang Hasyim
2.	Border Parks of intersection Suryanata
3.	Under of Juanda flyover
4.	Border Parks of RS SMC

B. Data Analysis

Data of value criteria and weighting criteria of GOS obtained from the results of interviews with experts, namely Section Chief and Section Head Nursery Landscape and Greening of Sanitation Department of Samarinda City Government.

a) Land Area: The land area with the widest measure is the best. The land area of GOS a densely populated area to adjust the available land. In this case, using a square meter (m^2).
b) Land ownership: State-owned land is the best alternative location. State-owned land which was built as a green open space referred to as public GOS is managed by the local government, in this case, the government of Samarinda through regional work units and Sanitation Department.
c) The population around the site: The population around the site with a population in a radius one hundred meters of the most widely is the best an alternative location.
D) The distance to human settlements: The distance to the nearest settlement is the best for GOS location.

TABLE 2. LAND SCALE (C1)

Weight Name	*Range*	*Compatibility Rating Value*
The land area is very narrow	1 m^2 -249 m^2	1
The land area is narrow	250m^2 -599 m^2	2
The land area is moderate	600m^2-24.999 m^2	3
The land area is large	25.000m^2-49.000 m^2	4
The land area is very large	50.000m^2 or more	5

TABLE 3. LAND OWNERSHIP SCALE (C2)

Weight Name	*Compatibility Rating Value*
Private properties	1

Weight Name	***Compatibility Rating Value***
Company properties	2
State properties	3

TABLE 4. TOTAL POPULATION SCALE (C3)

Weight Name	***Range***	***Compatibility Rating Value***
Sparcely populated	1 – 20 people	1
Moderately populated	21 – 45 people	2
Considerably populated	46 or more people	3

TABLE 5. DISTANCE SCALE (C4)

Weight Name	***Range***	***Compatibility Rating Value***
Far from the settlement	61 meter or more	1
Average distance to the settlement	31 – 60 meter	2
Close to the settlement	1 – 30 meter	3

For the four criteria above, we give priority number 1 to number 4. First priority is given weight 4 and so on. The weight values for each criterion are those described in the following table.

TABLE 6. WEIGHT OF CRITERIA

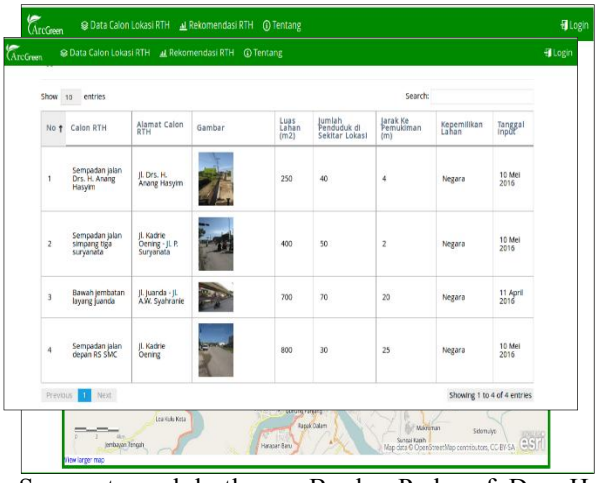
Criteria Name	***Weight***
Land Area	3
Land Ownership	4
The Population Around the Site	2
The Distance to Human Settlements	1

C. System Software Implementation

This study did the implementation of GOS determination software system using the SAW technique, ArcGIS platform and programming language with a PHP script. GOS determination application system of Samarinda City in the website and domain name Arcgreen and can be accessed freely on the web page at HTTP://arcgreen.web.id. The following pictures describe the system view. Currently the developed system is still using the Indonesian language.

System Arcgreen has 4 menu that is *Data Calon Lokasi RTH*, *Rekomendasi RTH*, *Tentang* and *Login* menu. Figure 1 describes the view of a user page as an index page. On this page is available the main menu of *Data Calon Lokasi RTH* and *Rekomendasi RTH*.

Figure 2 describes the admin page to input the GOS alternative location. Based on the results of recommendations with SAW computing, the best location as the top priority for the new location of GOS Kota Samarinda is the location on Under the Juanda flyover. Then second priority at Border Parks of RS SMC, then Border Parks of intersection



Suryanata and lastly on Border Parks of Drs. H. Anang Hasyim (Fig. 3 and Fig 4).

Fig.1. Administrative Map

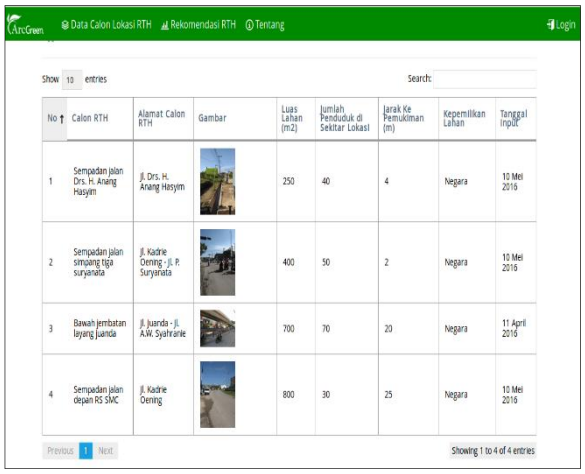


Fig.2. Admin Page for Input GOS Alternative

Calon RTH	C_1	C_2	C_3	C_4
Sempadan jalan Drs. H. Anang Hasyim	1	0.667	1	0.667
Sempadan jalan simpang tiga suryanata	1	1	1	0.667
Bawah jembatan layang juanda	1	1	1	1
Sempadan jalan depan RS SMC	1	0.667	1	1

Nilai Utilitas

Sempadan jalan Drs. H. Anang Hasyim

V1=(1*1)+(0.667*2)+(1*4)+(0.667*3)=8.335

Sempadan jalan simpang tiga suryanata

V2=(1*1)+(1*2)+(1*4)+(0.667*3)=9.001

Bawah jembatan layang juanda

V3=(1*1)+(1*2)+(1*4)+(1*3)=10

Sempadan jalan depan RS SMC

V4=(1*1)+(0.667*2)+(1*4)+(1*3)=9.334

Fig.3. Utility Value of Green Open Space Recommendation

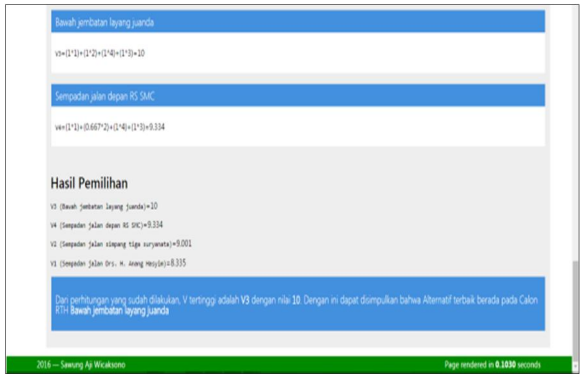


Fig.4. Green Open Space Recommendation

IV. DISCUSSION

Based on the result of analysis and testing conducted in the previous chapter, the discussion that can be drawn is: the four criteria of land use area (C1), land ownership (C2), the number of residents around the site (C3) and the distance to the settlement (C4) were used as the determining parameter for the selection of GOS locations in Samarinda City's densely populated areas.

In this research had applied the SAW method and provided the best alternative in the determination of the GOS candidate sites. The calculation process of decision support using the SAW in the GIS system are in accordance with the manual calculation that gives the best alternative is the prospective location of green space under Juanda flyovers.

Determination system of open green space can help provide recommendations GOS candidate location-based system in accordance with the data entered by the admin. The application software had provided in the website and domain name Arcgreen.

V. CONCLUSSION

In this research has produced the priority sequence of GOS location of densely area of Samarinda city that is location under Juanda Flyover bridge and developed a web-based GIS software application of GOS location determination using SAW computing technique at domain name Arcgreen. The system still has limitations on the platform used. In the future, this system will be developed with mobile system by applying other decision analysis method like TOPSIS and Artificial Neural Network.

ACKNOWLEDGMENT

The first author would like to thank the Faculty of Computer Science and Information Technology Mulawarman University who has supported this research, as well as to ESRI with Arcgis products that have provided stimulant funding of this research activity.

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