Application of Mapping of the Raskin Aid using AHP Fuzzy Method based on Geographic Information System

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Abstract. The purpose of this study is to provide information about areas that get raskin aid according to the variables specified. The variables consist of income, housing, clothing, food and education. The supporting variables are indicators in determining the decision making received, considered or rejected. The Decision Making uses the FUZZY-AHP method which is implemented using Geographic Information System based applications. The map used is Maps Android API. The output produced is the mapping of the raskin aid area.

Keywords: FUZZY_AHP, Google Maps Android API

1. Introduction
A decision support tool has been used to support the selection of the location of location including geographic information system (GIS), fuzzy system, artificial neural genetic algorithms and various combinations of these approaches. GIS is specifically used to collect spatial for geographical data and support their spatial analysis [2]. Development of fuzzy sets in geographic information systems (GIS) emerge from the need to manage with the uncertainty and soft computing technology capabilities to support fuzzy information processing [6]. The important issue is that of combining Geographical Information Systems (GIS) to resolve more global processes [1].

Several application system have been proposed by researchers for integrate geographic information systems (GIS) and the Decision Support system process for distribution management. In paper Rikalovic et al. [2],[3],[4],[6], propose a framework by including GIS in decision support systems for application promote regional sustainability. They have combining GIS in the multi-criteria based methodology to produce an effective decision-making tools. The AHP method is the most widely used multi-criteria decision analysis models, this model has been used for the purpose of location distribution management.

The main aim of this paper is examine the capability of Fuzzy-AHP, geographical information system (GIS) and the Decision support process for potential mapping, and for this purpose of location distribution. Because the AHP fuzzy method is expected to help decision making on less-structured problems which are generally faced by top level management, especially the elements of regional leadership and in fuzzy AHP is a combination of a collection of qualitative models and datas.

The program of poor family rice or Indonesia called Beras Miskin (RASKIN) is essentially aimed to reducing the expenditure burden of poor households as a form of support in improving food security by providing cheap social protection for rice. The raskin dissemination evaluation based on GIS with fuzzy AHP method will be very beneficial for the authorized goverment in making decision of the rice aid distribution for poor families. Because in the use of geographic information system applications have the advantages of geographic information systems are very effective in helping the processes of
forming, developing and providing a complete illustration. It is comprehensive to a real problem related to spatial to all entities, modifying the colors, shapes and sizes of symbols needed for the representation of elements in the real world.

2. Description of study area

After conducting discussions and interviews with one of the experts at the Provincial Social Service on Technical Guidelines (Technical Guidance) for the provision of rice assistance to the poor, it was concluded that the final decision makers of rice assistance for the poor were assisted by the Head of the local RT. very aware of the conditions or conditions and in direct contact with every citizen / community living in their environment. From researching literature data and from the results of interviews and consultations from the Chairperson of RT 17, Bukit Lama Village, Ilir Barat District 1 and RT. 01 Kemuning sub-district of Palembang as a tool that helps the kelurahan in recording the poor who are sampled as determinants of the decision to give Rakin the following criteria are formulated:

1. Income is formulated as the first criteria (C1)
2. Housing is formulated as the second criteria (C2)
3. Clothing is formulated as the third criteria (C3)
4. Food is formulated as the fourth criteria (C4)
5. Education is formulated as the fifth criteria (C5)

While alternative is formulated as follows:

1. Rejected is formulated as alternative 1 (A1)
2. Considered is formulated as alternative 2 (A2)
3. Accepted is formulated as alternative 3 (A3)

2.1 Fuzzy-AHP

The ratio comparison between the relative preferences of indexed elements $i$ and $j$ in the criteria can be modeled through the fuzzy scale value associated with the level of fuzzyness. Then the elements $X, x_{ij}$ (i.e., a comparison of the decision alternatives $i$ and $j$ relating to the specific criteria) are fuzzy numbers identified as $x_{ij} = (l_{ij}, m_{ij}, u_{ij})$ where $l_{ij}, m_{ij},$ and $u_{ij}$ are the upper limits, respectively for $x_{ij}$ values [7].

Referring to the research [7] and [5], there are several steps of the AHP fuzzy approach that are applied in this study as follows:

1. The criteria pair pairing matrix is made with the concept of fuzzy Synthetic extend boundary which is an aggregation of $l_{ij}, m_{ij},$ and $u_{ij}$ for an assessment between criteria, based on $\delta = 0.5$ (the specified delta) then the transfer variable value is then added in line and the column and continued with look for the $S_i$ set value which corresponds to the multiplication of the number of rows with the seper_total of the column sum using the equation formula below:

$$S_i = \sum_{j=1}^{m} M_{ji}^{l} \otimes \left( \sum_{l=1}^{n} \sum_{j=1}^{m} M_{ji}^{l} \right)$$

$$V(M_{ji} \geq M_{ji}) = \sup_{y \in a} \min(\mu_{M_{ji}}(x), \mu_{M_{ji}}(y))$$
3. **W' weight value obtained by calculation refers to the equation:**

\[
d'\left(A_i\right) = \min_{i=1,2,...,k} V\left(S_i \geq S_k\right)
\]

(5)

\[
W' = (d'(A_1), d'(A_2),..., d'(A_n))
\]

(6)

Finally, the normalization value of W' weight is obtained by using the equation:

\[
W = \frac{d'(A_i)}{\sum_{i=1}^{n} d'(A_i)}
\]

(7)

\[
W = (d(A_1), d(A_2),..., d(A_n))
\]

(8)

Steps 1 and 3 are carried out for AHP fuzzy pair comparisons of criteria sets. Then repeat the step 1 and step 3 by using the same equations in the alternative comparisons (A1, A2 and A3) for each criteria.

4. The final step is using the equation:

\[
\mu_{ij}(c) = \begin{cases} 
1, & \text{if } m_j \geq m_i \\
\frac{l_i - u_j}{(m_j - u_j) - (m_i - l_i)}, & \text{otherwise}
\end{cases}
\]

(3)

\[
V(M \geq M_1, M_2,...,M_k) = \min_{i=1,2,...,k} V(M \geq M_i) \text{ and } (M \geq M_i) \text{ and } ... \text{ and } (M \geq M_k)
\]

(4)

**Research Methodology**

**3.1 Problem Formulation Stage**

This stage is the process of formulating the problem and limiting the problem to be examined. This is needed in order to direct the researcher better in making the application so that what is done is not out of the predetermined limits.

**3.2 Data Collecting Stage**

From the literature data search and from the results of interviews and consultations from the Chairperson of RT 17 Bukit Lama Village, Ilir Barat 1 Subdistrict, Palembang as a tool to assist the village in recording the poor as the sample for determining decision of distributing raskin were obtained as follows:

1. Income is formulated as the first criteria (C1)
2. Housing is formulated as the second criteria (C2)
3. Clothing is formulated as the third criteria (C3)
4. Food is formulated as the fourth criteria (C4)
5. Education is formulated as the fifth criteria (C5)
While alternative is formulated as follows:

6. Rejected is formulated as alternative 1 (A1)
7. Considered is formulated as alternative 2 (A2)
8. Accepted is formulated as alternative 3 (A3)

![Figure 1. Case Hierarchy Structure](image)

4. Result and Discussion

4.1 The Calculation of FUZZY-AHP Algorithm

Fuzzy AHP Pairwise Comparison Matrix on value criteria of the fuzzy AHP pairwise comparison matrix is taken from the AHP pairwise comparison matrix that has previously been determined (see table 1)

|      | C1   | C2   | C3   | C4   | C5   |
|------|------|------|------|------|------|
| C1   | 1    | 1/3  | 1/5  | 1/7  | 1/9  |
| C2   | 3    | 1    | 1/3  | 1/3  | 1/3  |
| C3   | 5    | 3    | 1    | 1/2  | 1/3  |
| C4   | 7    | 3    | 2    | 1    | 1/3  |
| C5   | 9    | 3    | 3    | 3    | 1    |

Table 1. Fuzzy AHP Pairwise Comparison Matrix on value criteria

aggregated into lij, mij, and uij from the concept of Fuzzy Synthetic extent limit. The pairwise comparison matrix of the AHP Fuzzy Criteria is shown in table 2.

|      | a).C1 A1 | A2 | A3 |
|------|----------|----|----|
| A1   | 1        | 4  | 8  |
| A2   | 1/3      | 1  | 8  |
| A3   | 1/8      | 1/8| 1  |

|      | b).C2 A1 | A2 | A3 |
|------|----------|----|----|
| A1   | 1        | 4  | 8  |
| A2   | 1/4      | 1  | 8  |
| A3   | 1/8      | 1/8| 1  |

|      | c).C3 A1 | A2 | A3 |
|------|----------|----|----|
| A1   | 1        | 4  | 8  |
| A2   | 1/2      | 1  | 8  |
| A3   | 1/8      | 1/8| 1  |

|      | d).C4 A1 | A2 | A3 |
|------|----------|----|----|
| A1   | 1        | 2  | 4  |
| A2   | 1/2      | 1  | 4  |
| A3   | 1/4      | 1/4| 1  |

|      | e).C5 A1 | A2 | A3 |
|------|----------|----|----|
| A1   | 1        | 2  | 4  |
| A2   | 1/2      | 1  | 4  |
| A3   | 1/4      | 1  | 1  |
Table 3. Pairwise Comparison Matrix Criteria is different when δ = 0.5

| C1 | C2 | C3 | C4 | C5 |
|----|----|----|----|----|
| C1 | 1,1 | 0.2857,1/3,0.4 | 0.1818,1/5,0.2222 | 0.1333,1/7,0.1538 | 0.1053,1/9,0.1176 |
| C2 | 2.5,3,3.5 | 1,1 | 0.2857,1/3,0.4 | 0.2857,1/3,0.4 | 0.2857,1/3,0.4 |
| C3 | 4.5,5,5.5 | 2.5,3,3.5 | 1,1 | 0.41/2,0.6666 | 0.2857,1/3,0.4 |
| C4 | 6.5,7,7.5 | 2.5,3,3.5 | 1.5,2,2.5 | 1,1 | 0.2857,1/3,0.4 |
| C5 | 8.5,9,9.5 | 2.5,3,3.5 | 2.5,3,3.5 | 2.5,3,3.5 | 1,1 |

Next, do the summation in a row and column on the pairwise comparison matrix criteria and summarize the number of columns as shown in table 4.

Table 4. Summation in a row and column on the pairwise comparison matrix criteria

| Jumlah Baris | Jumlah Kolom |
|--------------|--------------|
| C1 | (1.7061,1.7873,1.8937) | (23,25,27) |
| C2 | (4.3571,5,5.7) | (8.7857,10,3333,11.9) |
| C3 | (8.6857,9.8333,11.0667) | (5.4675,6.5333,7.6222) |
| C4 | (11.7857,13,3333,14.9) | (4.3190,4.976,5.7205) |
| C5 | (17,19,21) | (1.9624,2.1111,2.3176) |

| Jumlah dari Penjumlahan Perkolom | (43.5347,48.9540,54.5604) |

Then using equations (6) and (7) are obtained as follows:

\[
\begin{align*}
S_1 &= (1.7061,1.7873,1.8937) \\
&= (0.03127,0.03651,0.043499) \\
S_2 &= (4.3571,5,5.7) \\
&= (0.079859,0.102137,0.13093) \\
S_3 &= (8.6857,9.8333,11.0667) \\
&= (0.159195,0.200869,0.254203) \\
S_4 &= (11.7857,13,3333,14.9) \\
&= (0.216012,0.272365,0.342256) \\
S_5 &= (17,19,21) \\
&= (0.311581,0.38812,0.482374)
\end{align*}
\]

Then, the related S1 calculation uses equation (2) as follows:

\[
S_1 = (1.7061,1.7873,1.8937) \times \frac{1}{54.5604} \times \frac{1}{48.9540} \times \frac{1}{43.5347}
\]
The alternatives in each criteria are weighted by taking the same steps as the weighting step on the criteria. The alternative variable value takes the example of the assessment data criteria for a citizen who will be given rice aid for the poor (raskin) who get the overall criteria value is not fulfilling as a sample in this study. In summary, the alternative weight values for each normalized criteria can be shown in table 5. as follows:

**Table 5.** the alternative weight values for each normalized criteria

| No | C1   | A1     | A2     | A3     |
|----|------|--------|--------|--------|
| 1  |      |        |        |        |
|    | A1   | 1      | 3.5, 4.4.5 | 7.5,8,8.5 |
|    | A2   | 0.2222,1/4,0.2857 | 1      | 7.5,8,8.5 |
|    | A3   | 0.1176,1/8,0.1333 | 0.1176,1/8,0.1333 | 1 |
| 2  | C2   | A1     | A2     | A3     |
|    |      |        |        |        |
|    | A1   | 1      | 3.5,4,4.5 | 1      |
|    | A2   | 0.2222,1/4,0.2857 | 1      | 7.5,8,8.5 |
|    | A3   | 0.1176,1/8,0.1333 | 0.1176,1/8,0.1333 | 1 |
| 3  | C3   | A1     | A2     | A3     |
|    |      |        |        |        |
|    | A1   | 1      | 3.5,4,4.5 | 7.5,8,8.5 |
|    | A2   | 0.2222,1/4,0.2857 | 1      | 7.5,8,8.5 |
|    | A3   | 0.1176,1/8,0.1333 | 0.1176,1/8,0.1333 | 1 |
| 4  | C4   | A1     | A2     | A3     |
|    |      |        |        |        |
|    | A1   | 1      | 1.5,2,2.5 | 3.5,4,4.5 |
|    | A2   | 0.4,1/2,0.6667 | 1      | 3.5,4,4.5 |
|    | A3   | 0.2222,1/4,0.2857 | 0.2222,1/4,0.2857 | 1 |
| 5  | C5   | A1     | A2     | A3     |
|    |      |        |        |        |
|    | A1   | 1      | 1.5,2,2.5 | 3.5,4,4.5 |
|    | A2   | 0.4,1/2,0.6667 | 1      | 3.5,4,4.5 |
|    | A3   | 0.2222,1/4,0.2857 | 0.2222,1/4,0.2857 | 1 |

**Table 6.** Weight Values for All AHP Fuzzy Pairing Comparison Matrix and Final Results Obtained When Delta (δ) = 0.5 which is based on the Decision Maker Opinion

| C1  | C2  | C3  | C4  | C5  | Hasil akhir |
|-----|-----|-----|-----|-----|-------------|
| W(Ci,j) | 0   | 0   | 0   | 0.1732 | 0.8268 | [A3, A2, A1] |
| A3  | 0.9022 | 0.9022 | 0.9022 | 0.6558 | 0.6558 |
| A2  | 0.9776 | 0.9776 | 0.9776 | 0.3442 | 0.3442 |
| A1  | 0    | 0    | 0    | 0    | 0    |
The final result is the sum of the results of the multiplication $W(C1-5)$ with $W(A1-3)$, show alternative values A3, A2 and A1. In table 5.4 shows the results of the decisions obtained are the maximum final results, namely A3.

4.2 System Design

4.2.1 Usecase Diagram

![Usecase Diagram](image)

Figure 2. Usecase Diagram

4.2.2 Class Diagram

![Class Diagram](image)

Figure 3. Class Diagram

4.3 Implementation

Here are some interface views of the Application of Mapping of the Raskin Aid Using AHP Fuzzy Method Based On Geographic Information System. The Application of The Aid Mapping Provides information about raskin aid in the Palembang region with 4 main menus, the master menu consists of criteria, sub-discricts, and alternatives; seconds menu consists of criteria input of input data (pairwise criteria, pairwise alternatives and statistic); The third menu is about calculation that that is FAHP weighting and FAHP ranking. While The last menu consists of mapping obtained from FAHP ranking. The mapping of raskin of five variabel; they are income, housing, clothing, food and education.
Figure 4. Main Page

Figure 5. List of Criteria

Figure 6. List of Sub-district

Figure 7. List of Population Data
5 Conclusions

Based on the results and discussion that have been stated in the previous chapters, then in general the writer can conclude some of the following:

1. In this research, Fuzzy-AHP based GIS approach for various multi-criteria techniques was chosen to obtain spatially distributed location potential zones the area.

2. In resume, there are results from the root of the Fuzzy-AHP based GIS approach that could have successfully applied for the Aid Mapping provides information about raskin aid mapping. Hence, the result of location distribution management potential map evaluation can be useful for the planner the raskin aid.

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