

# Fuzzy AHP Based Decision Support System for SKTM Recipient Selection

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**ABSTRACT**

Surat Keterangan Tidak Mampu (SKTM) is a letter issued by the City of Sukabumi government to help poor citizens with benefits in medical treatment. The applicants are assessed by the local Village to determine the eligibility and amount of benefit to be granted. This process had a problem that the decision made was mostly subjective and based on vaguely defined criteria's. This could result in the improper categorization and inappropriate distribution of benefits. A Decision Support System is designed to overcome this problem in the form of Recommendation System using Fuzzy AHP method. This method is used as the mathematical model for determining the weights of and refines the assessment of each criterion. The proposed system will calculate the scores of the applicants based on the model and show their poverty categories along with the amount of allowed benefits. The amount of funding is also become more evenly spread across 6 poverty categories compared to the previous 4 categories thus saving more funds to be used for other development programs.

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## 1. INTRODUCTION

One of the most important development since the Indonesia economic crisis (1999) with implications for poverty, is the implementation of social protection programs by the government. This program has been continued to evolve and expand, with new ones introduced over time. Jamkesmas (Jaminan Kesehatan Masyarakat) currently provides health service fee waivers for 18.2 million households, making it the largest permanent program in terms of coverage in the country. It is targeted to poor and vulnerable households. Overall expenditures on social assistance have increased significantly since 2005 and now account for about 0.5 percent of GDP, although this is still well below the average for developing countries (1.5%) and for other countries in East Asia and the Pacific (1%) [1]. Regardless of Jamkesmas being the largest permanent program in terms of coverage in the country, there are still a lot of citizen who are not recorded as poor nor being target as Jamkesmas recipient, even the reality show that they are eligible and need help. To overcome these problems, The Sukabumi city government made an alternative program named SKTM (Surat Keterangan Tidak Mampu). SKTM is a statement of poor condition from the village administration that could be used as a health-card that entitles its holders for benefits in health centers and hospitals. SKTM also could be used to plea for scholarship and other important social emergency. There are a number of criteria for decision maker to consider before making the final decision on determining the SKTM recipient.

This paper describes a fuzzy hierarchical analytic approach to determine the weighting of subjective judgments. Since assessment agents from the local officials (RT and RW) and the Central Bureau of Statistics (BPS – Biro Pusat Statistik) cannot clearly estimate each considered criterion in terms of numerical values for the anticipated alternatives, fuzziness is considered to be applicable. Consequently, this paper uses triangular fuzzy numbers to establish weights and anticipated achievement values. By ranking fuzzy weights and fuzzy synthetic performance values, the proposed system can determine the relative importance of criteria and decide the best candidate for the SKTM recipient.

## 2. RESEARCH METHOD

In this section we will discuss Research Method of the propose system. We will also illustrate the framework of proposed Decision Support System (DSS) to determine SKTM recipients with a detailed discussion of the design and analysis of system.

### 2.1. Poverty Concepts and SKTM Mechanism

SKTM (Surat Keterangan Tidak Mampu) is a statement of poor condition from the village/kelurahan administration. To obtain SKTM, poor people must file a plea to the village with a covering letter from RT and RW. Poor Certificate (SKTM) refers to Sukabumi Mayor Regulation No. 12 Year 2012 on Mechanism Provision of Health Services for the Poor outside the quota that set by the central government [2]. Benefits of SKTM Certificate are:

1. As the substitute JAMKESNAS, the letter to be given to Hospital or Regional Health Centre and Private Hospital who has worked with local government. SKTM can be used to get free access to medical treatment, because this letter states that the household is not able to pay the costs. If they show this letter in the health facility, they should be able to receive the care without charge (the health facility can declare the costs at the local government).
2. As for the letter of request of scholarships
3. As the letter to demand the release of administrative expenses in the trial manufacture of Birth Certificate.

Since poverty is ubiquitous and complex, there are two sets of definitions of poverty namely absolute and relative poverty. Absolute poverty in one hand is broadly defined as an absence of means for the satisfaction of basic human needs. These basic needs can be translated in to financial requirement as "poverty line". Relative poverty, on the other hand refers to falling behind most other in the community [3]. The definition that being used to determine SKTM recipient is the absolute poverty. BPS (Central Bureau of Statistics), in measuring absolute poverty adopts a basic need approach, which is an individual would considered to be poor if and only if, his/her household level is below defined poverty line. Poverty line is described by using 14 indicators of poverty criteria to that has been set by the BPS. It describe as:

1. The floor area of residential buildings, which include poor criteria when floor space of less than 8 m<sup>2</sup>/ person.
2. Type of floor residential buildings, which include poor criterion if the floor is made of ground or low-quality cement
3. Residential wall types, which include poor criterion when the walls are made of wood or the wall is damaged.
4. Access to sanitation, which include poor criterion when the family used river or public sanitation (used by all households)
5. Household lighting sources, which include poor criterion when the family's using oil lamps or joined electric use(with other families)
6. Access to clean water (for drinking and cooking), which include poor criterion when the source of clean water comes from wells
7. Fuel for daily cooking, which include poor criterion when using firewood or subsidized gas.
8. Consumption of meat / dairy / chicken per week, which include poor criterion when the family did not eat any of that type of food in a week.
9. Purchase new clothes for household members in a year, which includes poor criterion when the family only buying one or even none at all in a year
10. Frequency of eating in a day for each member of the household, which included poor criterion if members of the household eat 2 times a day.
11. Ability to pay for treatment to public health centre, which includes poor criterion when the family cannot afford to go to public health center.
12. Heads of household income per month, which includes poor criterion is if the head of the household income less than Rp 500.000, -.
13. Educational attainment of household head, which includes a poor criterion if the highestlevel of educated only to primary school (SD)
14. Ownership of assets or savings, which include poor criterion are household members who do not have assets / savings.

In this study, because to determine of SKTM recipient is has multi criteria of poor indicator and also explores which criteria that have the highest factor on determining the citizen poverty condition. The model used in the proposed decision-making system for the determination of the SKTM recipient is FAHP.

## 2.2. F-AHP Method To Determine SKTM Recipient

Analytic Hierarchical Process (AHP) is well-known, practically applied procedures for solving multi criteria decision problems. The Analytic Hierarchy Process is aimed at facilitating decision-making in problems which involve multiple criteria]. AHP method set the decision problems in form of structured hierarchically at different levels, each level consisting of a finite number of elements. The priorities represent the relative importance of the decision elements at that level. For all levels of the hierarchy the prioritization of the elements is carried out with respect to the elements of the upper level [4]. According to empirical researches it is difficult for people to arrange alternatives consistently if more than two attributes have to be taken into account. Consequently in AHP various attributes are ordered by a hierarchical constructed decision system, in which only few, in most cases two or three attributes are gradually aggregated to a higher level. However, in real life the decision maker is quite often not in the position to define exactly all substitution rates of a pairwise comparison and deduct from this a consistent pairwise comparison matrix. In case of some pairwise comparisons he has only a vague idea, how much more important one goal seems to be compared with the other one. Such roughly defined data can be mathematically described by fuzzy sets.

Fuzzy Analytic Hierarchy Process (FAHP) is a combination of fuzzy logic techniques that aim to facilitate the assessment criteria that is not definitive [5]. The fuzzy set theory is designed to deal with the extraction of the possible outcome from a variety of information expressed in vague and imprecise terms [8]. Fuzzy set theory treats to express vague data as a certain distribution which can be effectively implemented for logical reasoning, in terms of each functions or benefit. In this study, FAHP used to evaluate each poor criterion in order to determine SKTM recipient and classification of citizen poverty condition.

## 2.3. The Selection Process on SKTM Receiver

An objective of assessment of the citizen condition is to gain information about the real condition of the citizen pleading for SKTM, based on BPS poverty criteria. Within a dynamic and diversified decision-making environment, this approach may neglect due to too much valuable information of poor criteria in the process. Hence, this research proposes a FAHP method to evaluate the hierarchy system for selecting the most informative poor criteria from all poverty indicators. In addition, the issues in the assessment of citizen household condition process are sometimes vague. When this occurs, the process becomes ambiguous and subjective for the assessor. An assessor has the tendency to perceive the weight of a hierarchy subjectively. Therefore, to consider the uncertain, interactive effects coming from other criteria when calculating the weight of a specified criterion, thus this research used fuzzy weights of criteria. The evaluation is conducted in an uncertain, fuzzy situation and to what extent vague criteria are realized by research is unknown [6]. Thus, the proposed system used fuzzy AHP for selecting and prioritizing the poor criteria to optimize the real scenarios faced by assessor. The FAHP model provides priority weights for the SKM Receiver, based on the BPS guidance and priority on multiple criteria on defining poverty. The alternative with the highest priority weight is then selected for the recommendation (Fig. 1).

Figure 1 shows that the hierarchy is based on the level of interest that has been determined and discussions with village officials. The importance level is based on a scale TFN (Triangular Fuzzy Number). The goal is to select the poor from all of citizen data, based on criteria that has been established by BPS. When the hierarchy structure has been drafted, the next step is to conduct fuzzy pairwise comparisons. All criteria at the same level compared. To perform pairwise comparisons using the TFN scale linguistic variables as in Table 2. TFN used in this study is from Tolga et.al. [7]. The Value that gains from TFN will be used to determine the weight of each criterion. Each criterion will be compared in pairs and are determined based on its closeness level, this are been done in order to determine the value to be calculated. After knowing the level of closeness between the main criteria, the next step is to do pairwise comparison matrix with Fuzzy Evaluation Matrix. Then the next step is to find *fuzzy synthetic extent value ( $S_i$ ) based on each criteria*. After  $S_i$  value is gain, the next step is to compare each fuzzy numbers. The weight of the different criteria and the fuzzy performance value needs to be operated to generate the synthetic performance of each criterion within the same dimension. the fuzzy synthetic performance is conducted by a simple additive weight method assuming the criteria are independent in a fuzzy environment. The result of fuzzy synthetic decisions reached by each alternative is a fuzzy number. It is therefore the non-fuzzy ranking method for fuzzy numbers that must be employed in order to compare the various criteria that resulting the synthetic performance (weight) of main criteria as shown in table 2.

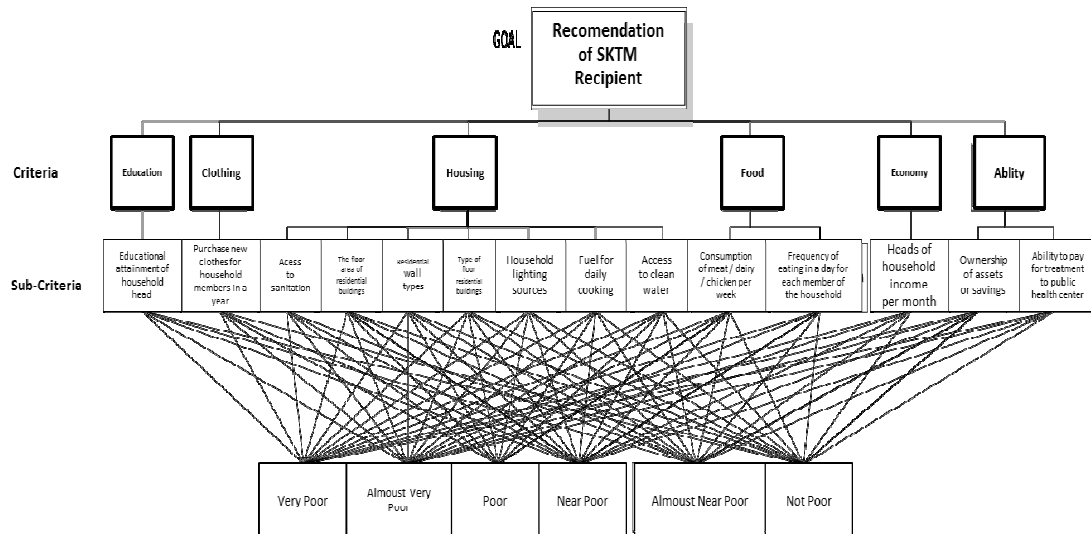


Figure 1. Hierarchy tree for Recommendation of SKTM Recipient

Table 2. The synthetic performance of main criteria

Criteria	Weight
Housing	0,284
Food	0,198
Economic	0,198
Education	0,131
Clothing	0,094
Ability	0,094

The empirical evidence in this paper indicates that the weight of housing (0.248) was the most important factor to influence in the poverty indicator, tied in seconds place were food (0,198) and economic (0,198) criterias.

### 3. RESULTS AND ANALYSIS

The proposed DSS is intended to use by the assessor from village council, in order to assist them on citizen condition evaluation and also classify the result so it can give recommendation of SKTM recipient. The main function of the proposed system is a function of assessment citizen poverty condition. This function consists of the calculation of weight of poverty criteria and classifies the result by using F-AHP method. The system will consist of several functions which are: historical data management, input indexes of data assessment and classifying the assessment result. Figure 2 shows the architecture of our proposed system that can be deployed as an online hybrid application. The system is developed in the form of a web-based application using PHP and MySQL database. The user interacts with the interface which is basically a graphical user interface (GUI). Using the GUI the user can key in data and also retrieve citizen data to be edited or reused. The process in this system is divided into three phases.

In the first phase, the proposed system that already being embedded with poor criteria and factor, will start collecting data of Sukabumi's citizens. These data's are stored in the supplier's database. Figure 3 shows the interface of the developed DSS system on which an assessor will input the applicant's data. The second phase is the processing those input data to get recommendation of SKTM recipient with F-AHP method. SKTM recipient selection process is initiated with the screening of citizen household condition based on the poor criteria. First, the classification of citizen household is being done by using poor criteria and indicator. Then the system will use the result of these classifications as an input on the filtering process in order to get the information list of the most needed SKTM among those citizens. Then on the third or the last phase the system will show the result, which is the list of recommendation of SKTM recipient. Then the system will generate the result which shows the poverty categories of the applicant as follows: Sangat Miskin (Very Poor), Hampir Sangat Miskin (Almost Very Poor), Miskin (Poor), Mendekati Miskin (Rather Poor), Hampir Mendekati Miskin (Almost Rather Poor), and Tidak Miskin (Not Poor). These categories will determine the maximum amount of benefit that will be given to the applicant for medical treatment. This recommendation then will be used by the village council/ authorities to support their decision. The results of the SKTM Recipient Selection process are used to rank the citizen's condition as shown in Figure 4.

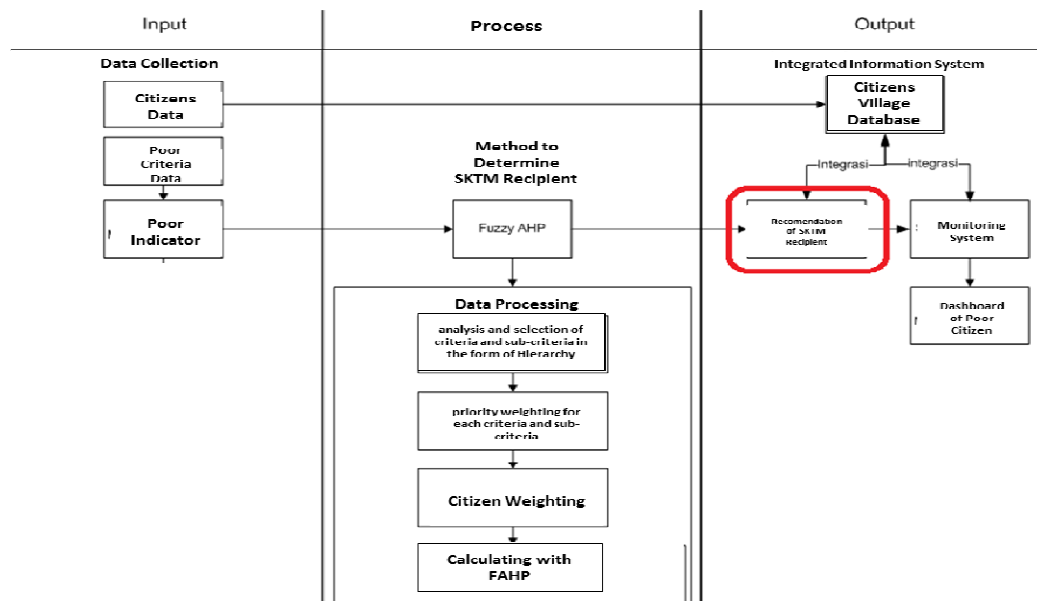


Figure 2. Scheme of Proposed System

Kriteria	Subkriteria	Nilai
Papan	Luas Lantai Bangunan Tempat Tinggal Anggota Rumah Tangga	<2m <sup>2</sup>
	Jenis Lantai Bangunan Tempat Tinggal	tanah
	Jenis Dinding Tempat Tinggal	bambu
	Fasilitas Tempat Buang Air Besar	tidak ada
	Sumber Air Minum	sungai
	Sumber Penerangan Rumah Tangga	bukan listrik
	Bahan Bakar Untuk Masak Sehari-Hari	kayu bakar
Pangan	Makan Dalam Sehari Untuk Setiap Anggota Rumah Tangga	1 kali
	Konsumsi Daging/Ayam/Susu Perminggu	tidak sama sekali
Sandang	Pembelian Pakaian Baru Bagi ART dalam Setahun	tidak sama sekali
Ekonomi	Penghasilan Kepala Rumah Tangga Per Bulan	< Rp. 500.000
Kemampuan	Kemampuan Membayar Untuk Berobat ke Puskesmas	tidak
	Kepemilikan Aset/Tabungan	tidak ada
Pendidikan	Pendidikan Tertinggi Kepala Rumah Tangga	tidak sekolah

proses

Figure 3. Poor Certificate Receiver (SKTM) Assessment Form

Form Hasil Kategori	
Nomor Kk	12
Nama Masyarakat	asi testan
Kategori	Sangat Miskin
Jenis Bantuan	Rp 2.000.000

Print

**Kategori**

SM : Sangat Miskin  
 HSM : Hampir Sangat Miskin  
 M : Miskin  
 MM : Mendekati Miskin  
 HMM : Hampir Mendekati Miskin  
 TM : Tidak Miskin

Figure 4. Example of Assessment Result

As seen on the figure 4, this form showing the results of the assessment per household in 14 assessment criteria and also show the conditions of the current state of the family condition. The proposed DSS already being tested and validated with sample data gathered from Babakan Village, Sukabumi. Unlike a standalone model which relies on the accuracy of available data for its efficiency, the proposed DSS allows for interfaces between databases and models and subsequently handles what-if scenarios in the case that citizen data changes over time.

#### 4. CONCLUSION




This research used the fuzzy AHP to solve the problem of evaluating and selecting SKTM recipient based on poverty indicator that has been establish by BPS. It is utilized due to its ability for taking into account both the qualitative and quantitative measures. 14 decision criteria have been used for assessing the

condition of the citizen. In this research, the triangular fuzzy numbers are utilized in establishing the pairwise comparisons of criteria and alternatives through linguistic scales. Further, group-based fuzzy analytical hierarchy process was used in generating criteria weights for the evaluation of the most influence criteria to determine the poor citizen among the others. By using fuzzy AHP, the qualitative judgment can be qualified to make comparison more perception and reduce assessment bias in assesment proces. This finding result will help the decicion maker to select the best candidate to receive SKTM.

## REFERENCES

- [1] African Development Bank Indonesia. "ADB Completion Report September 2011", Neighborhood Upgrading and Shelter Sector Project, adb, 2011.
- [2] Sukabumi Mayor Regulation No. 12 Year 2012 on Mechanism Provision of Health Services for the Poor outside the quota that set by the central government, June 2012, Sukabumi.
- [3] S. Sumarto, A. Suryahadi, and W. Widyanti, "Assessing the Impact of Indonesian Social Safety Net Programmes on Household Welfare and Poverty Dynamics," *European Journal of Development Research*, vol. 17, pp. 155-177, 2005.
- [4] R.W. Saaty, "Decision Makin in Complex Environments: The Analytic Hierarchy Process (AHP) for Decision Making and The Analytic Network Process (ANP) for Decision Making with Dependence and Feedback. The Handbook of SuperDecision," Pittsburgh: Creative Decisions Foundation. 2003.
- [5] Kabir, Golam and A.A Hasin."Comparative Analysis of AHP and Fuzzy AHP models for multi-criteria inventory classification," *International Journal of Fuzzy Logic Systems (IJFLS)*, Vol.1, No.1, October 2011.
- [6] G. Ozdagoglu and A. Ozdagoglu."Comparison of AHP and Fuzzy AHP For The Multi-Criteria Decision Making Processes With Linguistic Evaluations," *Istanbul Commerce University Journal Of Science* ISSN:1305-7820, 2007
- [7] M.T. Tang, G. H. Tzeng, S.W. Wang, "A hierarchy fuzzy MCDM method for studying electronic marketing strategies in the information service industry", *Journal of International Information Management*, 8(1):pp. 1-22, 1999
- [8] T. Wang and Y. Chen, "Applying fuzzy linguistic preference relations to the improvement of consistency of fuzzy AHP," *Information Sciences*, vol. 178, no. 19, pp. 3755-3765, 2008.

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