Implementation of the Fuzzy Analytical Network Process Method in Decision Making on the Granting of Non-occupied Building Permits

Muhammad Ali Syakur(✉), Eka Mala Sari Rochman, Aeri Rachmad, Wahyudi Setiawan, and Sigit Susanto Putro

Departement of Informatics, Faculty of Engineering, University of Trunojoyo Madura, Bangkalan, Indonesia
{alisyakur,wsetiawan,sigit.putro}@trunojoyo.ac.id

Abstract. Building Permit (BP) is one of the authorities that can be given by local governments to people who will construct buildings, both residential and non-residential buildings. The requirements for applying for BP for residential buildings are different from those for non-residential buildings. The criteria for selecting the BP granting authority are given to each region. One of the regions, namely Sampang Regency, in selecting the granting of a non-residential BP, considered several things including the completeness of the files, building layout, designation and intensity of buildings, building architecture, land suitability, environmental impact control, and community approval. The decision to grant a Non-residential BP which was taken into consideration in the assessment, as well as the involvement of two regional apparatus as admins and appraisers caused the decision-making process to be less efficient and lack transparency. Therefore, a decision support system is needed using the Fuzzy Analytical Network Process (FANP) method to assist the decision-making process for granting non-residential BP. The FANP method is used to determine the importance of the criteria used to determine the granting of a non-residential BP permit. Based on the results of the tests that have been carried out, the accuracy of the system obtained is 97.12%. With this decision support system, it can speed up the decision-making process for granting non-residential BP with fairly accurate results.

Keywords: BP · Non-Residential · Decision Support System · FANP

1 Introduction (Heading 1)

Indonesia, which is a developing country, holds the key to efficient economic and social infrastructure development [1]. The community's need for buildings with all kinds of functions is one of the most important needs. As population growth continues to grow, the need for infrastructure and facilities development also increases. The building is a physical form that is used by humans as a place to live, for busi-ness activities, social activities, religious activities, and other special activities. Based on its function, the

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building is divided into residential buildings and non-residential buildings. To carry out development must go through procedures set by the government. Building Permit (BP) is a licensing procedure that must be fulfilled before carrying out construction which aims to optimize the arrangement, control, and supervision of development carried out by the community. In addition, the existence of an BP can guarantee the quality of the building to be built [2]. In issuing an BP, there are several things that need to be considered, including conformity with provisions relating to land, planning, technical, health, comfort, and environmental aspects [3]. The criteria that need to be considered in granting BP authority are given to each region so that there is no conflict over affairs with the central government [4].

Services and issuance of BP in Sampang Regency are managed by the Investment and One-Stop Services Agency (DPMPTSP). Regulations regarding buildings have been explained in Sampang Regent Regulation Number 9 of 2016 concerning Buildings. The requirements for administering and issuing BP differ between residential buildings, namely residential houses, and non-residential buildings such as shops, warehouses, factories, etc. The requirements and criteria considered for issuing a non-residential BP are more than the requirements for issuing a residential BP. The criteria that need to be considered in granting non-residential permits in Sampang district include the completeness of documents, building layout, building designation and intensity, building architecture, land suitability, environmental im-pact control, and community approval.

Research on decision support systems to determine the best village rating uses the Simple Additive Weighting (SAW) method to determine alternative values based on existing criteria. The results of this study indicate that the system can assist in the process of determining which system can display the best village assessment recommendations based on the criteria in the system [5]. The next research analyzes the multi-criteria quantitative decision-making method and the use of sensitivity analysis methods in decision support systems. The method used in this research is the SAW and TOPSIS methods [6].

Other research on contractor selection decision support systems has been discussed uses the Analytical Hierarchy Process (AHP) method to determine contractors who can provide satisfaction to customers based on 6 predetermined criteria. The results of this study indicate that the AHP method can be implemented in a decision support system for selecting the best contractor [7].

In addition, research on decision support systems to determine MSME innovation strategies has been carried out [8]. In this study, the integration of the Fuzzy Analytical Network Process (FANP) and TOPSIS methods was used. The FANP method is used to weight the criteria, while the TOPSIS method is used to rank alternatives [8]. Based on the results of this study, it shows that the FANP and TOPSIS methods can be used to determine the best strategy for increasing MSMEs. The FANP method is an advanced method from the AHP method which is then approached by the Fuzzy method. The FANP method can cover the shortcomings of the FAHP method where there is a relationship between criteria at a certain level.

Based on the methods that we have been used in the research above, in this study, the FANP method was used to assist in weighting the criteria. By using the FANP meth-od, it is possible to determine the most important criteria and have the greatest influence

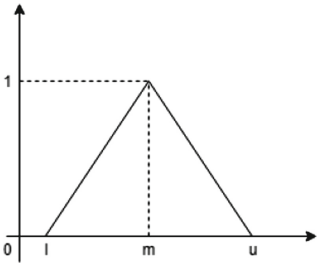

Fig. 1. Fuzzy Membership

[9] and [10]. The FANP method is used because in its calculations FANP can take into account the interrelationships between criteria that become an assessment factor in decision making. In addition, by using the FANP method, the weighting process can be more controlled because in the FANP calculation process, the level of consistency of the weight can be known.

2 Methodology

2.1 Data Collection

The data used is data on non-residential BP applicants for 2018–2021 at the Investment and One Stop Services Office of Sampang Regency, totaling 312 applications. The criteria used are the completeness of the files, building layout, designation and building intensity, building architecture, land suitability, environmental impact control, and community approval.

2.2 Fuzzy Analytical Network Process (FANP)

The Fuzzy Analytical Network Process is a combination of Analytical Network Process (ANP) and Fuzzy methods. The ANP method is a method developed from the AHP method. The ANP method takes into account the interaction or linkages be-tween criteria. ANP is used to solve problems in decision-making where there is a link to criteria at a certain decision hierarchy level. The Fuzzy method is used to minimize qualitative uncertainties so that the results of calculating the weight of the criteria become more consistent [9]. The membership function can be described in the curve below (Fig. 1):

And the degree of fuzzy membership according to the equation:

$$\mu[x, l, m, u] = \begin{cases} 0; x \leq lorx \geq u \\ \frac{x-l}{m-l}; l \leq x \leq m \\ \frac{u-x}{u-m}; m \leq x \leq u \end{cases} \quad (1)$$

The following are the calculation steps for the FANP method [9]:

1. Determine the problem and the solution to be achieved
2. Establish a hierarchical structure based on existing problems
3. Develop a matrix of paired criteria based on the rating scale
4. Calculating Synthesis (Si)
5. Determine the value of Vector (V)
6. Determine the defuzzification value (d) by selecting the smallest value from the Vector value of each criterion
7. Normalize the weight
8. Calculating the consistency of the weight ratio by changing the previous pairwise comparison matrix to be without fuzzy values
9. Normalize each column in the paired criteria matrix
10. Add up the value of each column to-i
11. Determine the priority weight of each criterion
12. Calculating the eigenvalue
13. Calculating index consistency (CI)
14. Calculating the consistency ratio (CR).

If the CR is consistent or sufficiently consistent then the weight can be used. Next is to calculate the value of each alternative based on the previously calculated FANP weights.

2.3 Match Rate

The test carried out is a test of the level of system accuracy. This test is carried out by comparing the results of manual calculations with the results of system calculations by means of

- Input alternative data and criteria into the system.
- Process submission data and the value of each criterion in the system so as to produce a final decision.
- Comparing the results of the final decision obtained from the system with the final decision results obtained from the DPMPTSP Non-occupied BP grant data.

Calculating the accuracy of the data suitability level with the equation:

$$Match\ rate = \frac{number\ of\ data\ compared - number\ of\ wrong\ data}{number\ of\ data\ compared} x100\% \quad (2)$$

3 Result and Discussion

Based on the Fig. 2 we can be seen that the system architecture consists of input, process, and output. The input from the system that will be made in this study is the criteria data

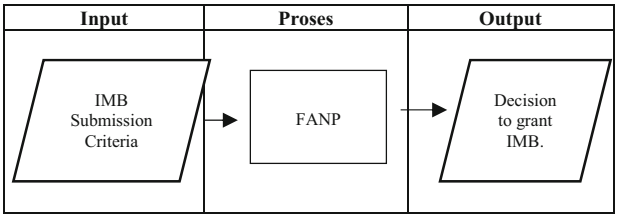

Fig. 2. Process Input Output Diagram

Table 1. Non-occupied BP Submission Data

No	Name	Address	Allotment
1	X1	Labuhan Market Labuhan Village, Sreseh District	Development of Traditional Markets and Polowijo
2	X2	Rajawali Street, Karang Dalam Village, Sampang District	Homes and Business Places
3	X3	Gruggak Hamlet, Sejati Village, Camplong District,	LPG Business Place
4	X4	Brambang hamlet Village. Sareh Park, Sampang District	Telecommunications Tower
5	X5	Nyabungan Hamlet, West Bira Village, Ketapang District	Telecommunications Tower

and the Non-Occupied BP application data along with the values for each criterion. The input data will then be processed in the system using the FANP method.

The process carried out in the system is the calculation of the weight of the criteria using the FANP method. The first step in the FANP calculation is to change the criteria comparison matrix that has been previously inputted into fuzzy values can be seen in Table 2 and 3. The next step is to calculate the Si value for each criterion (Table 1).

Based on the Si value, the Vector value is determined. To determine the defuzzification value, it can be determined based on the smallest value vector for each criterion. Based on the defuzzification value, the weight of each criterion can be determined (Table 5).

The next process is to calculate the CI and CR values. Based on the CR value, a weight consistency check is carried out. If the CR value is 0 then the weight is said to be consistent and if the CR value is less than 0.1 then the weight is said to be quite consistent and can be used for further calculations.

The last step of the FANP method is to determine the final value for each alternative based on the previously calculated weights. If the final score is less than 3.6 then the result is accepted but if the final score is less than 3.6 then the result is rejected.

The final result or output of this system is a statement of acceptance or rejection of the granting of an BP to an alternative based on the value calculated in the previous process.

Table 2. Paired Matrix Comparison Criteria

	The completeness of the document	**Building layout**	**Designation and intensity of the building**	**Building architecture**	**Land suitability**	**Environmental impact control**	**Community approval**
The completeness of document		Equally important	Equally important	Equally important	Equally important	A little is not more important	A little is not more important
Building layout			Equally important	Equally important	Equally important	A little is not more important	A little is not more important
Designation and intensity of the building				Equally important	Equally important	A little is not more important	A little is not more important
Building architecture					Equally important	A little is not more important	A little is not more important
Land suitability						A little is not more important	A little is not more important
Environmental impact control							Equally important
Community approval							

Table 3. Pairwise Comparison Matrix With TFN Values

	The completeness of the document	**Building layout**	**Designation and intensity of the building**	**Building architecture**	**Land suitability**	**Environmental impact control**	**Community approval**
The completeness of the document	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	0.2 | 0.333 | 1	0.2 | 0.333 | 1
Building layout	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	0.2 | 0.333 | 1	0.2 | 0.333 | 1
Designation and intensity of the building	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	0.2 | 0.333 | 1	0.2 | 0.333 | 1
Building architecture	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	0.2 | 0.333 | 1	0.2 | 0.333 | 1
Land suitability	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	1 | 1 | 1	0.2 | 0.333 | 1	0.2 | 0.333 | 1
Environmental impact control	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 1 | 1	1 | 1 | 1
Community approval	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 3 | 5	1 | 1 | 1	1 | 1 | 1

Table 4. Weighting

CRITERIA	MIN V	W (BOBOT)
The completeness of document	0.336	**0.091331422**
Building layout	0.336	**0.091331422**
Designation and intensity of the building	0.336	**0.091331422**
Building architecture	0.336	**0.091331422**
Land suitability	0.336	**0.091331422**
Environmental impact control	0.336	**0.091331422**
Community approval	0.336	**0.091331422**

Table 5. Weight Consistency

CI:	0
RI:	1.32
CR:	0
Consistency:	Consistent

Table 6. Criteria Weighting Results

Criteria	Weight
The completeness of document	0.091331422
Building layout	0.091331422
Designation and intensity of the building	0.091331422
Building architecture	0.091331422
Land suitability	0.091331422
Environmental impact control	0.271671444
Community approval	0.271671444

The final result can be used as a recommendation in making a decision on granting an BP to the community or an alternative for applying for an BP permit.

Based on the comparison of predetermined pairwise matrices, the criteria weights are generated as shown in the Table 6:

From the weight of the criteria in the Table 4, a decision can be determined for each application for a decision to grant an BP using the system.

Accuracy testing is done by comparing the results of decisions using the manual method and the results of decisions using the system that has been built. The results of the decision to grant BP permits manually show that out of 312 data on non-residential BP

Table 7. Test Results

Number of Data Compared	Number of Data Correct	Level of conformity
312 Data	303 Data	$Match = \frac{303}{312} x100\% = 97.12\%$

applications in Sampang Regency in 2018–2021, 15 applications were rejected, and 297 applications were accepted. The results of the system decision show that 29 submissions were rejected, and 283 submissions were accepted.

Based on the results of the tests that have been carried out where the 312 BP application data compared produce as many as 303 system decision results that are the same as the decision data on manual decision-making. Based on these data, the accuracy level of the system can be determined which can be seen in Table 7:

4 Conclusion

Based on the results of research on the implementation of the FANP method in decision support systems for granting IMBs, it has been shown that the FANP method can be used to make decisions on granting IMBs with a suitability level of 97.12%.

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