Study of location selection of public facilities using the AHP method (Case of Lamongan District BLK location selection)

A K Raharja¹ and M Suef²
¹,² Department of Technology Management, FBMT ITS, Surabaya, 60111, Indonesia

Abstract. One procedure in the construction of public facilities is a location selection. The Lamongan district government has set up the construction of the Lamongan district job training center (BLK) on Jl. Jaksa Agung Suprapto, but the problem that arises is whether the decision making process for determining the construction location is correct or not. This research intends to conduct a study of the decision making process in which the research approach is done using the AHP method. From the research that has been done, there are 9 criteria for selecting the location of public facilities with respective weight value i.e spatial layout (TRW) of 0.263, electricity and water network availability (KJL) of 0.244, disaster potential (PBE) of 0.126, land condition (KOL) of 0.078, land area (LUL) of 0.074, road network availability (KJJ) of 0.029, population density (KP) of 0.017, population acceptance rate (TPP) of 0.037, and land availability (KEL) of 0.131. From the AHP calculation, scores have been obtained for each alternative location, i.e. location of Jl. Jaksa Agung Suprapto with a value of 0.610, location of Jl. Sumargo Tlogoanyar with a value of 0.173, and location of Jl. pahlawan with a value of 0.217. Jl. Jaksa Agung Suprapto is the location with the largest score, so that it is the best location for the construction of the Lamongan district job training center (BLK).

1. Introduction
The definition of development is a process of continuous change towards a better state. Development is a word that used to describe processes and efforts that improve the life of the economy, politics, culture, community infrastructure, etc [1]. One example of various types of development is the construction of government public facilities.

The Lamongan district Government has carried out the construction of public facilities namely the Lamongan district job training center (BLK). The development is based on the basis of the high potential of the industrial sector each year which is not matched by the high number of unemployed and the labor force participation rate in Lamongan district. The development is expected to be able to overcome labor problems which lead to the issue of poverty alleviation in Lamongan district [2].

One procedure in the construction of a public facility is location selection. Location selection is a very important issue in a development because apart from the commercial value of the construction site, the government must also prioritize locations that far from disaster areas and also those that are easily accessible by the society and also adjust to the regional spatial regulations. The Lamongan District Government has established the construction of the Lamongan District job training center (BLK) on Jl Jaksa Agung Suprapto, but the problem that arises is whether the decision making process for determining the construction location is correct or not. This research intends to conduct a study of the decision making process in which the research approach is done using the AHP method. AHP (Analytical Hierarchy Process) method is a decision-making technique that includes several criteria, both tangible,
intangible, qualitative and quantitative, which also take into account the existence of conflict or dissent [3].

2. Methods

2.1. Step Analysis
The analysis steps taken to achieve the objectives of the study are as follows [4]:
1. Identify all criteria in site selection in the construction of public facilities.
2. Establish the criteria that will be used for decision making.
3. Identify the characteristics of alternative locations that will be used as the location for the construction of the Lamongan district job training center (BLK).
4. Arrange a hierarchy that starts with entering goals, criteria, and alternatives.
5. Making questionnaires, for collecting data and facilitating respondents in deciding pairwise comparisons in the AHP process.
6. Establish pairwise comparisons between criteria in the form of a matrix.
7. Normalize the data and determine the weight of each criterion.
8. Test the consistency of hierarchy or data.
9. Establish comparison of alternative locations based on criteria in the form of a matrix.
10. Normalize the data and determine the weight of each alternative location for each criterion.
11. Test the consistency of hierarchy or data.
12. Establish global priorities by multiplying the weights of each criterion with the weights of each alternative location and adding them together.
13. Analyzing the results.
14. Perform sensitivity analysis
15. Make conclusions and suggestions

2.2. Data Sources
There are two data used in this study, namely as follows:
1. Secondary data, in the form of Lamongan Regency economic data, employment data of Lamongan Regency, and project area demographic data, obtained by collecting data from related literature.
2. Primary data, in the form of comparative values of several criteria and also alternatives derived from the results of interviews with policy makers in the Lamongan District job training center (BLK) construction project.

2.3. Research Variable
The variables used in the study are formed from a structure consisting of several criteria and alternatives. There are 9 criteria used in the study, namely spatial layout (TRW), electricity and water network availability (KJL), disaster potential (PBE), land conditions (KOL), land area (LUL), road network availability (KJJ), population density (KP), population acceptance rate (TPP) and land availability (KEL). while for alternatives, there are 3 alternative locations used, namely location on Jl. Jaksa Agung Suprapto, location on Jl. Sumargo Tlogoanyar, and location on Jl. Pahlawan.

3. Result and Discussions
3.1. AHP Structure Hierarchy Arrangement
The arrangement of the AHP structure hierarchy begins by entering the objectives, criteria, and alternatives that can be seen in Figure 1.
3.2. Criteria Pairwise Comparison

Pairwise comparisons between criteria can be specified in the form of a matrix. The diagonal value of the matrix for the comparison of a criterion with the criteria itself is filled with a value of 1, whereas for comparison a criterion with other criteria is filled with a value between 1 until 9 and the reverse [5].

Based on the results of interviews and discussions with policy makers from the construction of public buildings in the Lamongan district job training center (BLK), the matrix values obtained can be seen in Table 1.

| Criteria Comparison Matrix |
|-----------------------------|
| TRW | PBE | KOL | LUL | KEL | KJJ | KP | TPP | KJL |
| TRW | 1   | 3   | 5   | 5   | 3   | 7  | 9   | 7   | 1   |
| PBE | 1/3 | 1   | 3   | 3   | 1   | 5   | 5   | 5   | 1/3 |
| KOL | 1/5 | 1/3 | 1   | 1   | 1/3 | 5   | 7   | 3   | 1/3 |
| LUL | 1/5 | 1/3 | 1   | 1/3 | 5   | 7   | 3   | 1/5 |
| KEL | 1/3 | 1   | 3   | 3   | 1   | 5   | 7   | 5   | 1/3 |
| KJJ | 1/7 | 1/5 | 1/5 | 1/5 | 1/5 | 1   | 3   | 1/3 | 1/5 |
| KP  | 1/9 | 1/5 | 1/7 | 1/7 | 1/7 | 1/3 | 1   | 1/3 | 1/9 |
| TPP | 1/7 | 1/5 | 1/3 | 1/3 | 1/5 | 3   | 3   | 1   | 1/7 |
| KJL | 1   | 3   | 3   | 5   | 3   | 5   | 9   | 7   | 1   |

3.3. Determination of Criteria Weight

After the criteria comparison matrix is formed, priority weights will be calculated for criteria comparison. Calculation of the weight of criteria using the expert choice 11 software can be seen in Figure 2. The biggest weight is located on the criteria of regional spatial (TRW) with a value of 0.26, while for the smallest weight is located on the criteria of population density (KP) with a value of 0.016. The inconsistency value is 0.06 or the value is ≤ 0.100 so the criteria comparison matrix is considered consistent and there is no need to revise the matrix assessment [6].
3.4. **Alternative Pairwise Comparison**

The next step is to make a comparison of alternative location matrices based on criteria to find the weight of alternative location priorities for each criterion. Comparison of alternative locations to several criteria along with weight calculations and the consistency of the ratio are as follows.

**Table 2.** Comparison of alternative locations matrix based on consideration of spatial layout criteria (TRW)

|          | Location A | Location B | Location C | Weight | Information |
|----------|------------|------------|------------|--------|-------------|
| Location A | 1          | 5          | 7          | 0.7456 | lamaks = 3.019 |
| Location B | 1/5        | 1          | 1          | 0.1343 | CI = 0.0095   |
| Location C | 1/7        | 1          | 1          | 0.1201 | CR = 0.016   |

**Table 3.** Comparison of alternative locations matrix based on consideration of potential disaster criteria (PBE)

|          | Location A | Location B | Location C | Weight | Information |
|----------|------------|------------|------------|--------|-------------|
| Location A | 1          | 3          | 1          | 0.4286 | lamaks = 3   |
| Location B | 1/3        | 1          | 1/3        | 0.1429 | CI = 0      |
| Location C | 1          | 3          | 1          | 0.4286 | CR = 0      |

**Table 4.** Comparison of alternative locations matrix based on consideration of land conditions criteria (KOL)

|          | Location A | Location B | Location C | Weight | Information |
|----------|------------|------------|------------|--------|-------------|
| Location A | 1          | 3          | 1          | 0.4286 | lamaks = 3   |
| Location B | 1/3        | 1          | 1/3        | 0.1429 | CI = 0      |
| Location C | 1          | 3          | 1          | 0.4286 | CR = 0      |

**Table 5.** Comparison of alternative locations matrix based on consideration of land area criteria (LUL)

|          | Location A | Location B | Location C | Weight | Information |
|----------|------------|------------|------------|--------|-------------|
| Location A | 1          | 1/3        | 3          | 0.2605 | lamaks = 3.050 |
| Location B | 3          | 1          | 5          | 0.6333 | CI = 0.025   |
| Location C | 1/3        | 1/5        | 1          | 0.1062 | CR = 0.043   |
Table 6. Comparison of alternative locations matrix based on consideration of land availability criteria (KEL)

| Location    | Location A | Location B | Location C | Weight | Information |
|-------------|------------|------------|------------|--------|-------------|
| Location A  | 1          | 5          | 5          | 0.7143 | λ maks = 3  |
| Location B  | 1/5        | 1          | 1          | 0.1429 | CI = 0      |
| Location C  | 1/5        | 1          | 1          | 0.1429 | CR = 0      |

Table 7. Comparison of alternative locations matrix based on consideration of road network availability criteria (KJJ)

| Location    | Location A | Location B | Location C | Weight | Information |
|-------------|------------|------------|------------|--------|-------------|
| Location A  | 1          | 3          | 1          | 0.4055 | λ maks = 3.035 |
| Location B  | 1/3        | 1          | 1/5        | 0.1150 | CI = 0.0175 |
| Location C  | 1          | 5          | 1          | 0.4796 | CR = 0.030 |

Table 8. Comparison of alternative locations matrix based on consideration of population density criteria (KP)

| Location    | Location A | Location B | Location C | Weight | Information |
|-------------|------------|------------|------------|--------|-------------|
| Location A  | 1          | 5          | 1          | 0.4796 | λ maks = 3.035 |
| Location B  | 1/5        | 1          | 1/3        | 0.1150 | CI = 0.0175 |
| Location C  | 1          | 3          | 1          | 0.4055 | CR = 0.030 |

Table 9. Comparison of alternative locations matrix based on consideration of the population acceptance rate criteria (TPP)

| Location    | Location A | Location B | Location C | Weight | Information |
|-------------|------------|------------|------------|--------|-------------|
| Location A  | 1          | 1          | 5          | 0.4545 | λ maks = 3  |
| Location B  | 1          | 1          | 5          | 0.4545 | CI = 0      |
| Location C  | 1/5        | 1/5        | 1          | 0.0909 | CR = 0      |

Table 10. Comparison of alternative locations matrix based on consideration of electricity and water networks availability criteria (KJL)

| Location    | Location A | Location B | Location C | Weight | Information |
|-------------|------------|------------|------------|--------|-------------|
| Location A  | 1          | 7          | 5          | 0.7235 | λ maks = 3.107 |
| Location B  | 1/7        | 1          | 1/3        | 0.0833 | CI = 0.053 |
| Location C  | 1/5        | 3          | 1          | 0.1932 | CR = 0.091 |

All CR values are ≤ 0.100 so that the comparison matrix of alternative locations based on consideration of all criteria is considered consistent and there is no need to revise the matrix assessment.

3.5. Determination of the location of the construction of Lamongan district job training center (BLK)

After the weight of the criteria and the weight of alternative locations for each criterion is known, the next step is to calculate the weight of global priorities to find the best alternative locations. The calculation of global priority weights is done by multiplying the weight of the criteria with the weight of alternative locations for each criterion.
From the results of calculations, it can be concluded that location A, the location on Jl. Jaksa Agung Suprapto is the best location alternative for the construction of the Lamongan district job training center (BLK) because the weight value of location A is higher than the other alternative locations.

3.6. Sensitivity Analysis
Sensitivity analysis is used to determine the sensitivity of the values of each criterion. In this study, sensitivity analysis will be carried out by changing the weight of each criterion by adding weights of around 10%. After that, changes of weight of other criteria were seen, whether these changes had an impact on the alternative order of location selection for Lamongan district job training center.
Figure 4. Sensitivity Analysis Before Changing the Criteria Weights

The results of the analysis show that the increase in the one criteria weighting value by 10% causes a decrease in the weight value of all criteria. these changes no affect the order of priorities except the land area criteria (LUL). In the land area criteria (LUL), the order of alternative priority locations on Jl. Sumargo Tlogoanyar Lamongan changed to number 2. and, the order of alternative priority locations on Jl. Pahlawan Lamongan changed to number 3. However, these changes did not affect the decision making of location selection.

Figure 5. Sensitivity Analysis After Adding a Criteria Weight by 10% in Land Area Criteria (LUL)

4. Conclusions
Based on AHP analysis, location A is the location on Jl. Jaksa Agung Suprapto is the best alternative location for the construction of the Lamongan district job training center (BLK). Based on the results of the sensitivity analysis, it shows that there is one criterion that changes the order of alternative priorities for the job training center location selection, land area criteria (LUL), but these criteria do not change the decision making that makes Jl. Jaksa Agung Suprapto as the best alternative location. Based on the results of the research, the decision-making process carried out by the Lamongan district government is appropriate and can be scientifically accountable to the Lamongan district community.

5. References
[1] Fakih, Mansour. 2001. Runtuhnya Teori Pembangunan dan Globalisasi. Yogyakarta: Insitpres bekerjasama dengan Pustaka Pelajar.
[2] BPS, (2015) Kabupaten Lamongan Dalam Angka 2015. BPS Kabupaten Lamongan, Lamongan.

[3] Saaty, T.L. 1998. Decision Making for Leaders; The Analytical Hierarchy Process for Decision in Complexes Words. RWS Publication, Pittsburgh.

[4] Darmanto, E, Latifah, N dan Susanti N. (2014) Penerapan Metode AHP (Analythical Hierarchy Process) untuk Menentukan Kualitas Gula Tumbu. Jurnal SIMETRIS, Vol 5 No 1.

[5] Atmanti, H. D. (2008) Analytical Hierarchy Process Sebagai Model yang Luwes. Prosiding INSAHPS Teknik Industri UNDIP, Semarang.

[6] Turban, E, dkk. 2005. Decision Suport Systems and Intelligent System. Penerbit Andi, Jogjakarta.