Jurnal mandiri IT
Vol. 9 No. 1, July (2020), pp. 1-6

ISSN 2301-8984 (Print), 2809-1884 (Online)
Published by Institute of Computer Science

Determination of Priority for Agricultural Irrigation Development District Level In North Sumatra Province Using the Analytical Hierarchy Process

Saud Hasiholan Saragih
Electrical Engineering Education Study Program, Faculty of Engineering, Universitas Negeri Yogyakarta

ARTICLEINFO

Article history:

Received Jun 15, 2020
Revised Jul 02, 2020
Accepted Jul 30, 2020

Keywords:

Analytical Hierarchy Process (AHP);
Irrigation;
Ratio.

ABSTRACT

The development of irrigation areas in North Sumatra is a decision-making process with many criteria (multi-criteria decision making) that requires a tool or method that can convert qualitative data into quantitative data and to be used in making decisions on these problems. AHP (Analytical Hierarchy Process) is a method that can be used to determine the ranking or hierarchy of various alternatives that are the subject of discussion. The AHP method decomposes complex multi-criteria problems into a hierarchy that performs measurements to find the ratio scale of pairwise comparisons, both for discrete and continuous data. The AHP stage is to define the problem to be discussed, Then a hierarchical structure (levels) is made by making general goals as the beginning of making the hierarchy and then continuing with sub-goals, criteria and possible alternatives at the bottom of the hierarchy. The next step is to create a pairwise comparison matrix for each pair of elements and criteria that are the topic of discussion. These comparisons can be taken from actual measures or basic scales that reflect the strength of the decision maker's feelings and relative preferences.

Corresponding Author:

Saud Hasiholan Saragih,
Electrical Engineering Education Study Program,
Faculty of Engineering, Universitas Negeri Yogyakarta
E-mail: saudhasiholansaragih@gmail.com

1. INTRODUCTION

Agriculture is one of the mainstay sectors of North Sumatra as a source of income in the province. This is because North Sumatra is one of the agricultural bases in Indonesia because it is one of the provinces that contributes large agricultural products every year. Agriculture in North Sumatra has certainly been something that the provincial government has always paid special attention to. This is indicated by the government's programs that are always to further develop this agricultural sector with the aim of being able to further increase the agricultural output of the province of North Sumatra.

One of the things that cannot be separated from the government's attention in terms of improving the quality and quantity of agriculture in North Sumatra is irrigation. The government must always carry out maintenance and repairs as well as development to create irrigation networks that are adequate, effective and in accordance with the needs of the farming community in North Sumatra. The factors that cause irrigation systems and management in Indonesia are not optimal, among others, are the limited management of physical infrastructure, irrigation water,

irrigation management, irrigation management institutions and human resources and the lack of government guidance on irrigation systems.

Irrigation networks that have been built in various regencies/cities in North Sumatra are certainly built with the hope of being able to meet the needs of the entire community's rice fields. Of the 23 regencies in North Sumatra, irrigation networks have been built in 9 regencies under the authority of the central government, namely the area of irrigated area >3000 Ha. However, of the 9 irrigation areas, of course, it is necessary to determine the priority of maintenance and development of these irrigation areas with the aim that irrigation development in the district/city can be more directed, detailed, effective and in accordance with agricultural needs in North Sumatra.

In the problem of determining priorities, decision makers are faced with several criteria in giving priority to agricultural land development activities, this is called MCDM (Multi Criteria Decision Making). One approach that is widely used in solving MCDM problems is the Analytical Hierarchy Process (AHP). AHP can solve problems that combine quantitative and qualitative data. Based on the above, the author takes the title "Priority Determination of Agricultural Irrigation Development at the Regency Level of North Sumatra Province Using the Analytical Hierarchy Process (AHP)".

2. METHOD

1. Research methods

   The research method used in this study is as follows:

   a. Studying journals of reference materials, books and articles on the internet related to AHP (Analytical Hierarchy Process) as well as agricultural irrigation development in North Sumatra Province.
   b. Collecting data on irrigation systems per district in North Sumatra Province.
   c. Combining qualitative and quantitative data obtained during the study.
   d. Analyzing the data obtained in the study using AHP (Analytical Hierarchy Process).

2. Basic Principles of AHP (Analytical Hierarchy Process)

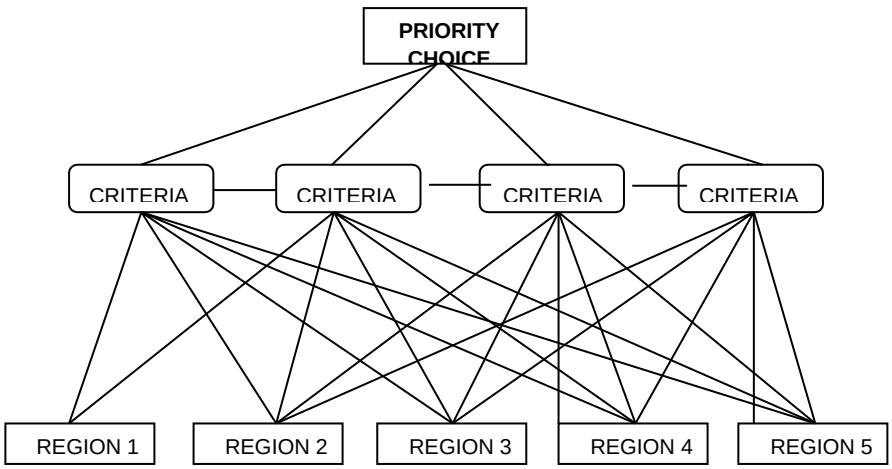

Figure 1. Hierarchical structure

3. RESULTS AND DISCUSSIONS

1. Data on Irrigation Development Programs in North Sumatra Province

   Based on the regulations, the responsibility for this agricultural irrigation network is shared by the central, provincial and district/city governments. The central government is responsible for the management of irrigated land covering an area of 2.32 million ha, the province 1.4 million

ha, and districts/cities 3.5 million ha. The criteria for the responsibility of the irrigation network are that an irrigation network covering an area of more than 3,000 ha is under the authority of the central government, 1,000-3,000 ha is the authority of the province, while less than 1,000 ha is the authority of regencies and cities.

Table 1.

Irrigation Development Program in North Sumatra

No	Area	Irrigation Area(Ha)	Maintenance costs (Rp)	Rice Fields	Repair Time (month)
1	D1	6300	1,575,000,000	6606	12
2	D2	4350	1,087,500,000	10203	10
3	D3	3017	754,250,000	18667	9
4	D4	15022	3,755,500,000	27950	36
5	D5	5000	1,250,000,000	41727	12
6	D6	6688	1,672,000,000	20339	12
7	D7	4194	1,048,500,000	7528	10
8	D8	6628	1,657,000,000	12200	12
9	D9	3300	825,000,000	11275	8

Table 3.1 Description:

a. area

D1 : (Raised) D6 : (Hone)
D2(South Tapanuli) D7 :(North Tapanuli)
D3 :(Deli Serdang) D8(Mandailing Christmas)
D4 :(Serdang Bedagai) D9 :(Labuhan Batu)
D5 : (Simalungun)

b. Irrigation Area

Contains the irrigation area in 9 districts which are irrigation areas managed by the central government.

c. Maintenance costs

That is, it contains an estimate of the rupiah value of maintenance costs for each irrigation area that is the object of research. This value is obtained from: Maintenante = irrigation area (ha) × Rp. 250.000, While Rp. 250.000,- is the estimated average price set by the government for the maintenance cost of 1 hectare of irrigation canals.

d. Rice Fields

Namely, it contains data on the area of rice fields in each district that is fed by the irrigation canal mentioned above.

e. Time

Contains the estimated time required by the government to repair the damage that occurred to the irrigation canals under the authority of the central government mentioned above, until it is in "good" condition.

2. Priority Criteria

The priority comparison for each of the existing criteria can be seen in the following pairwise comparison matrix:

Table 2.

Pairwise Comparison Matrix for All Factors

	Irrigation Area	Rice Fields	Maintenance costs	Time
Irrigation Area	1	3	1/7	5
Rice Fields	1/3	1	4	3
Maintenance costs	7	¼	1	5
Time	1/5	1/3	1/5	1

Table 3.
Complete Pairwise Comparison Matrix for All Factors

	Irrigation Area	Rice Fields	Maintenance costs	Time
Irrigation Area	1,000	3,000	0.143	5,000
Rice Fields	0.333	1,000	4,000	3,000
Maintenance costs	7,000	0.250	1,000	5,000
Time	0.200	0.333	0.200	1,000
Amount	8,533	4,583	5.343	14,000

Each data is normalized by dividing it by the number of each column, and the data is obtained as follows

Table 4.
Normalized Complete Pairwise Comparison Matrix

	Irrigation Area	Rice Fields	Maintenance costs	Time
Irrigation Area	0.117	0.654	0.027	0.357
Rice Fields	0.039	0.218	0.749	0.214
Maintenance costs	0.820	0.054	0.187	0.357
Time	0.023	0.073	0.037	0.071

Table 5.
Evaluation Factors All Criteria

	Irrigation Area	Rice Fields	Maintenance costs	Time	Priority
LI	0.117	0.654	0.027	0.357	0.289
LS	0.039	0.218	0.749	0.214	0.305
BP	0.820	0.054	0.187	0.357	0.354
W	0.023	0.073	0.037	0.071	0.051

From the calculations in the table above, it shows that: the Maintenance Cost criteria are the criteria with the highest priority in terms of the construction of irrigation canals in North Sumatra with a weight of 0.354 or 35.4%, then the criteria for Rice Fields with a weight value of 0.305 or 30.5%, the criteria for Irrigation Area with a weighted value of 0.289 or 28.9%, and the Time criteria with a weighted value of 0.050 or 5%.

3. Global Priority Total Calculation
   a. Total Evaluation Factor

      From all evaluations carried out on the 4 criteria, namely irrigation area, rice field area, maintenance costs and time, which are then multiplied by priority vectors. Thus we obtain a table of relationships between criteria and alternatives.

Table 6.
Matrix of Relationship Between Criteria and Alternative

	LI	LS	BP	W
D1	0.105	0.016	0.105	0.086
D2	0.044	0.039	0.044	0.051
D3	0.023	0.069	0.023	0.033
D4	0.453	0.211	0.453	0.502
D5	0.069	0.392	0.069	0.086
D6	0.115	0.152	0.115	0.086
D7	0.050	0.020	0.050	0.048
D8	0.116	0.046	0.116	0.086
D9	0.025	0.053	0.025	0.024

4. Total Rank

Calculations using the matrix above can be described in the table for each value obtained for each criterion which is compared according to each region. Namely as follows.

Table 7.
Total Rank for Region 1 (Langkat)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.105	0.289	0.030
Rice Fields	0.016	0.305	0.005
Maintenance costs	0.105	0.354	0.037
Time	0.086	0.051	0.004
			0.077

Table 8.
Total Ranking for Region 2 (Tapanuli Utara)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.044	0.289	0.013
Rice Fields	0.039	0.305	0.012
Maintenance costs	0.044	0.354	0.016
Time	0.051	0.051	0.003
			0.043

Table 9.
Total Rank for Region 3 (Deli Serdang)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.023	0.289	0.007
Rice Fields	0.069	0.305	0.021
Maintenance costs	0.023	0.354	0.008
Time	0.033	0.051	0.002
			0.038

Table 10.
Total Rank for Region 4 (Serdang Bedagai)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.453	0.289	0.131
Rice Fields	0.211	0.305	0.064
Maintenance costs	0.453	0.354	0.160
Time	0.502	0.051	0.026
			0.381

Table 11.
Total Rank for Region 5 (Simalungun)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.069	0.289	0.020
Rice Fields	0.392	0.305	0.120
Maintenance costs	0.069	0.354	0.024
Time	0.086	0.051	0.004
			0.168

Table 12.
Total Ranking for Region 7 (Tapanuli Utara)

	Evaluation Factor	Weight Factor	Evaluation Weight
Irrigation Area	0.050	0.289	0.014
Rice Fields	0.020	0.305	0.006
Maintenance costs	0.050	0.354	0.018
Time	0.048	0.051	0.002
			0.041

From the results of matrix calculations and through the table above, it is obtained as follows:

D1 = 0.076
D2 = 0.043
D3 = 0.038
D4 = 0.381
D5 = 0.168
D6 = 0.125
D7 = 0.041
D8 = 0.093
D9 = 0.033

4. CONCLUSION

Utan prioritas pembangunan daerah irigasi di Sumatera Utara dengan mempertimbangkan keseluruhan kriteria yang ada adalah. 1. D4 =Serdang Bedagai(0,381 = 38,1%), D5 = Simalungun(0,168 = 16,8%), D6 = Asahan(0,125 = 12,5%), D8 = Mandailing Natal(0,093 = 9,3%), D1 = Langkat(0,076 = 7,6%), D2 = Tapanuli Selatan(0,043 = 4,3%), D7 = Tapanuli Utara(0,041 = 4,1%) , D3 = Deli Serdang(0,038 = 3,8%), D9 = Labuhan Batu(0,033 = 3,3%)

References

Anton, Howard – Silaban, Pantur. 1998 “Aljabar Linier Elementer”. Jakarta : PT. Penerbit Erlangga.
Mulyono, Sri. (2004). “Riset Operasi”.Jakarta : Fakultas Ekonomi Universitas Indonesia.
Mulyono, Sri. 1996. “Teori Pengambilan Keputusan”. Jakarta: Fakultas Ekonomi Universitas Indonesia.
Saaty, T.L. 1993. “Pengambilan Keputusan Bagi Para Pemimpin, Proses Hirarki Analitik untuk Pengambilan Keputusan dalam Situasi yang Kompleks”. Jakarta: PT. Pustaka Binaman Pressindo.
Supranto, Johanes. (1998). “Pengantar Matriks”. Jakarta : PT. Rineka Cipta.
Supranto, Johanes. (1998). “Teknik Pengambilan Keputusan”.Jakarta : PT. Rineka Cipta.
Suryadi, Kadarsah dan Ramadhan, Ali.(1998). “Sistem Pendukung Keputusan Suatu Wacana Struktural Dealisasi dan Implementasi Konsep Pengambilan Keputusan”.Bandung : PT. Remaja Rosdakarya.
http://syaifullah08.files.wordpress.com/2010/02/ pengenalan-analytical-hierarchy- process.pdf (diakses 07 juni 2012)
http://www.scribd.com/hery.seputro/d/2908406-Modul-6-Analytic-Hierarchy-Process (diakses 07 juni 2012)