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Analytic Hierarchy Process as a Determinant of Irrigation Allocation Priorities with e-Paksi Parameters

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Abstract

Optimal management of irrigation water allocation is an important challenge especially in areas with limited resources. The Analytical Hierarchy Process (AHP) method can be used as a tool in complex decision-making by considering various factors that affect water allocation. In this study, AHP is applied to address the gaps in the e-Paksi program that uses individual judgement, which applied a subjective norm values. This study seeks to achieve balanced water allocation priorities using that approach, reflecting the existing physical conditions and social interests of the community, as represented by the assessment of field practitioners. The criteria used in the AHP analysis include Physical Structure, Crop Productivity, Supporting Facilities, Organisation Personnel, Documentation, and Water User Farmers, derived from e-Paksi. The case study was conducted in the SIM Irrigation Area, with secondary alternatives including Sumber Batang, Purwodadi, Ngabean, Bedilan, Karang, and Ulo. The results shows that the highest irrigation allocation priority is given to Karang secondary with a priority value of 0.1735. The condition of Karang secondary based on UPI BBWS BS has an average value of 3.83 on a scale of 1 to 5. Integration of AHP approach with e-Paksi value criteria provides more comprehensive results for decision making in fair and appropriate irrigation water allocation.

Keywords.

Analytical hierarchy process (AHP), e-Paksi, water allocation, irrigation area, SIM irrigation area

INTRODUCTION

Excessive groundwater extraction over a continuous period can result in the depletion of groundwater in the aquifer. The loss of groundwater creates voids in the soil layer, reducing hydrostatic pressure beneath the surface, which can lead to land subsidence [1]. The impacts of land subsidence include infrastructure damage (roads, healthcare facilities, educational and religious institutions), economic losses (housing and agricultural sectors), and indirect effects such as making an area prone to flooding [2]. The negative impact of excessive groundwater exploration can adversely affect farmers. One example of an irrigation area that needs to be reviewed based on current conditions is the Saluran Induk Madiun (SIM). SIM Irrigation Area covers a land area of 10,860 Ha with a primary canal length of 28,400 m and a secondary canal length of 52,103 m, which serves as the main source of income for farmers in Ngawi Regency, Magetan Regency, Madiun Regency, and Madiun City [3]. The division of land area according to regional administration can be seen in Table 1, involving 7 (seven) Regional Technical Implementation Units (UPTD) as managers, asset reporting and assessment of irrigation performance conditions. Groundwater extraction is carried out to supply water

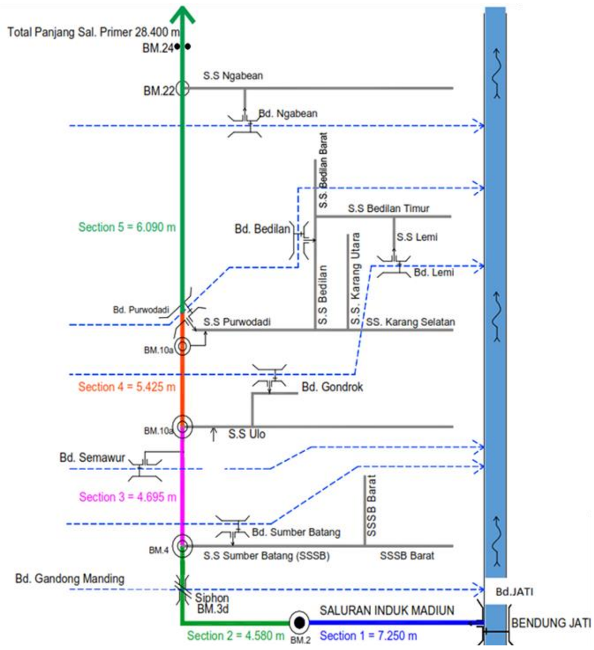

Figure 1 Schematic of SIM Irrigation Network

shortages in the area, amounting to approximately 403.43 m³ per day (4 to 6 hours) for a 1,400 m² [4].

Special attention is required to ensure uninterrupted operations. It can be evaluated through The irrigation networks to reduce the groundwater exploitation by the farmers and minimise adverse impacts. This evaluation is supported by previous studies showing the use of irrigation on a scale of 1 (one): 0.55 in favour of surface water irrigation and 0.45 in favour of groundwater irrigation [4]. Network evaluation is carried out by entering performance evaluation data recorded on the evaluation form into the Elektronik Pengelolaan Aset dan Kinerja Sistem Irigasi (e-Paksi) application. The grouping of values used is very good, good, fair, and poor conditions. [5]. Evaluation by entering IKSI (Indeks Kinerja Sistem Irigasi) data that evaluates the condition of each building and water channel according to site conditions in the form of the PAKSI Android application. [6].

Table 1 Raw land area

Region		Regional Technical Implementation Unit (UPTD)	Land Area (Ha)
Ngawi Regency	Region 2 Ngawi	Gayung	3.166
		Karang Jati	667
Magetan Regency	Region 2 Magetan	Purwodadi	3.540
		Bringin	206
		Jejeruk	3
Madiun Regency	Region 2 Madiun	Jiwan	2.831
Madiun		Madiun City	447
Total Raw Land			**10.860**

Evaluation assessments to produce priority levels in e-Paksi have not involved aspects of social value in determining irrigation allocation priorities, because the assessment aspects are focused on physical and non-physical aspects of complementary structure networks. Therefore, an approach with a method that involves experts is necessary to determine irrigation allocation, this is based on subjective norms in the perceived social value of doing or not doing a behaviour. In this study, AHP is used to ensure the assessment from the experts is to the subjective norms, namely a person's view of the beliefs of others that will influence the person to accept or not accept the intended behaviour. [7]. The insights gained from this research pave the new way in determining priorities to predict irrigation allocations at SIM Irrigation Area. This study will evaluate the AHP result based on e-Paksi analysis developed by the Indonesian government to improve the results, to fulfil the Sustainable Development Goals (SDGs), especially on Goal No. 06 (six).

RESEARCH SIGNIFICANCE

This study aims to analyse the responses and values of decision makers in determining the allocation of irrigation water in the secondary SIM Irrigation Area based on existing conditions and based on IKSI data in 2022 as a reference which is shown on Table 2. IKSI or irrigation system performance index is part of the network inventory and monitoring activities which aim to continuously determine the condition of the irrigation system in an area.

Table 2 IKSI value of SIM IRRIGATION AREA

IRRIGATION SYSTEM PERFORMANCE ASSESSMENT

Irrigation Area	: SIM IRRIGATION AREA
Area	: 10,860 Ha
IKSI Year	: 2022

MAIN IRRIGATION SYSTEM

No.	Description	Weight Final	Condition Index Exist	Condition Index Max
		%	%	100%
i	***Physical Structure***	***30.24***	***67.2***	***45***
1	Main Structure	11.24	86.45	13
2	Carrier canal	7.87	78.65	10
3	Carrier canal structure	5.94	65.95	9
4	Drains	1.2	30	4
5	Driveway/inspection road	2.22	55.6	4
6	Office, housing, warehouse	1.77	35.49	5
ii	***Crop Productivity***	***11.66***	***77.73***	***15***
1	Fulfilment of water needs	5.83	64.76	9
2	Realisation of planting area	3.97	99.3	4
3	Rice productivity	1.86	92.99	2
iii	***Supporting Facilities***	***6.8***	***68***	***10***
1	Operation and Maintenance Equipment	2.8	70	4
2	Transport	1.2	60	2
3	Office equipment observer/UPTD	1.4	70	2
4	Communication tools	1.4	70	2
iv	***Organisation Personnel***	***11.18***	***74.53***	***15***
1	O&P organisation	4.16	83.2	5
2	Personnel	7.02	70.2	10
v	***Documentation***	***3.8***	***76***	***5***
1	D.I. Data Book	1.55	77.5	2
2	Maps and Images	2.25	75	3
vi	***Water Using Farmers***	***5.8***	***58***	***10***
1	The legal entity GP3A/IP3A	1.05	70	1.5
2	Institutional condition of GP3A/IP3A	0.35	70	0.5
3	Ulu-ulu/P3A/GP3A/IP3A Meeting	1	50	2
4	GP3A/IP3A actively participates in survey/network tracing	0.7	70	1
5	Participation of GP3A/IP3A members in network repair and natural disaster management	1.4	70	2
6	Dues of GP3A/IP3A to participate in main network improvements	0.6	30	2
7	Participation of GP3A/IP3A in Crop and Water Allocation Planning	0.7	70	1
	Total (i+ii+iii+iv+v+vi)	**69.48**		**100**

METHODOLOGY

The main analysis which used in this research are: elektronik Aset dan Kinerja Sistem Irigasi (e-Paksi) and Analytical Hierarchy Process (AHP). The e-Paksi analysis, which is based on the recording of irrigation assets and their existing conditions, reflects the actual state of the functional value of existing irrigation assets. On the other hand, the hierarchy process model will focus on policy-making considerations by experts based on e-Paksi values and community needs. Some important flows in this research are including: data collection, criteria determination, criteria weighting, survey process, analysis process and checking for inconsistency values.

A. DATA COLLECTING

The e-Paksi data was obtained from the authority of BBWS Bengawan Solo the following website: http://103.122.35.24 or http://epaksi.sda.pu.go.id, and the android-based e-Paksi application. The application is possible to used based on the authority access given. The tool provides access to irrigation networks, irrigation asset inventory, performance assessment and reporting data.

The weighting to evaluate the main irrigation system, by considering the relationship of several indicators/factors in the management of the main irrigation system. In the main network of IKSI assessment, the variable that has the highest weight and influence is the physical structure variable at 45%, and the lowest is the document variable at 5%. [8]. The weighting is shown in Table 4. The regulations that underlie the management of irrigation system assets and performance include Permen PUPR No.23/PRT/M/2015 on Irrigation Asset Management, Permen PUPR No.14/PRT/M/2015 on Criteria and Determination of Irrigation Area Status and Permen PUPR No.30/PRT/M/2015 on Irrigation System Development and Management.

Table 3 Irrigation system performance index values

Value	Description
80-100	Excellent performance
70-79	Good performance
55-69	Underperformance and needs attention
< 55	Poor performance and needs attention
*Max score: 100, Min: 55 and Optimum; 77.5	

Source: Permen PUPR No. 12/PRT/M/2015

Table 4 Irrigation system performance weights

Indicators	Weight
Physical structure	45%
Crop productivity	13%
Supporting facilities	10%
Personnel organisation	15%
Documentation	5%
Water user farmers association (GP3A/IP3A)	10%
Total	**100%**

Source: Centre for Education and Training in Water Resources and Construction, 2017

The main advantage of the AHP method that distinguishes it from other decision-making models is that there is no absolute requirement for consistency. This targets human behaviour, where decision-making always involves logic, emotion, experience and institutions. To make the decision problem easier to understand, AHP analysis degrades the problem into a hierarchy. Based on its hierarchical structure, there are several elements related to the decision-making problem consisting of alternatives and decision-maker indicators. [9]. This can be analysed by giving weight to one factor against another at each level, while the weighted factors are linked to other levels that are mathematically constrained in a concurrent manner. [10].

B. ANALYSIS

This research used a 2 (two) level hierarchical structure as shown in Figure 2. The first level consists of several criteria and the second level consists of several sub-criteria. This research consider the previous study, on the Evaluation of Groundwater and Surface Water Use, as the purpose of the study is to find out what irrigation systems are of interest in fulfilling irrigation needs by considering the availability of discharge, crop productivity, ease of operation, network maintenance, operational costs, water quality, environmental and irrigation water use impact, showing the results that the best choice is the use of surface water though it still not well supported due to poor performance of irrigation systems. [4].

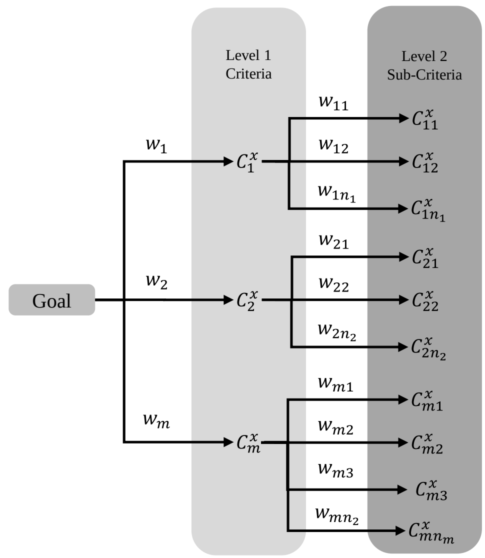

Figure 2 Level of criteria structure AHP

Table 5 Level of importance of questionnaire criteria

Scale	Level of Importance
1	Equally important
3	Relatively more important
5	More important
7	Very important
9	Much more important
2, 4, 6, 8	Value Range

Therefore, this research considers variables related to irrigation performance and preferences of experts. So as to better illustrate how the condition of priority allocation that

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Overview of the entire system in the SIM Irrigation Area

Which of the following criteria has a greater influence on supporting the irrigation and agriculture sectors.

Physical structure						✓												Crop productivity
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
									✓									Supporting facilities
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
								✓										Organisation personnel
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
									✓									Documentation
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
							✓											Water Using Farmers
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	

Crop productivity										✓								Supporting facilities
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
									✓									Organisation personnel
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
											✓							Documentation
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
																		Water Using Farmers
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	

Figure 3 Sample questionnaire and its completion

can be achieved. AHP is used to determine the weights of criteria and sub-criteria. Each weighting factor is obtained from a preference matrix that compares each criterion. This was evaluated based on the preference scale in Table 5. Pairwise comparisons were conducted for all criteria and sub-criteria in the hierarchical structure of AHP. The most important part is to simplify complex problems by handling two elements at once, which are analysed by putting the results into a matrix.

The assessment is based on a comparison scale of 1 to 9, where 1 indicates that both factors are equally important and 9 indicates that one factor is much more important than the other. The AHP method is analysed based on expert opinions. In this study, the analysis was carried out using a questionnaire. Therefore, it was necessary to create a questionnaire that could answer these questions and distribute it to several respondents who were competent in their fields of expertise. The respondents had various professional backgrounds, including academicians and municipal, provincial and central government employees. As shown in Figure 3, each respondent had their own opinions according to their ability to answer the survey questions. The AHP method was used to examine pairwise comparisons based on the questionnaire to improve decision-making.

In this research, AHP is used to determine the weight factor of criteria and sub-criteria. Each weight coefficient is taken from the priority matrix comparing each criterion[11]. This research selects a priority secondary network based on the rankings obtained by applying the basic AHP equation. This is shown in the equation,

$$R_x = \sum_{i=1}^{m} w_i C_i^x$$

With,

$$C_i^x = \sum_{j_i=1}^{n_1} w_{i j_i} C_{i j_i}^x$$

Risk value R_x is obtained from wi and C_i^x where w_i is the weight of each criterion at the first level and C_i^x is $w_{i\,j_i}$ multiplied by $C_{i\,j_i}^x$, where $w_{i\,j_i}$ is the weight of each criterion at the second level, and $C_{i\,j_i}^x$ is the value of the sub-criteria obtained from the data collection results. Where, i = type of criteria, ji = type of sub-criteria on type i, m = number of criteria, ni = number of sub-criteria for each criterion.

Consistency was used to test the validity of expert judgement. Comparative consistency was assessed using the consistency ratio (CR). CR analysis is necessary to evaluate whether the comparison is in accordance with the CR. In this case, if the CR value is ≤ 10% the calculation is considered correct [12]. CR is generated from pairwise comparisons using the following formula:

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}$$

$$\mathrm{CI} = ({}^{\gamma}\mathrm{maks} - \mathrm{n})/\mathrm{n}$$

CI represents the consistency index while RI is the random index, whose value is obtained based on the number of criteria and sub-criteria or matrix order. 45 (forty-five) questionnaires were distributed to experts from different fields of expertise. Respondents who answered the questionnaires came from various fields; 6 (six) academicians from civil and agricultural engineering at Merdeka University Madiun; 12 (twelve) officials from the PU SDA of the city/regency; 3 (three) officials from the BBWS Bengawan Solo; and 24 (twenty-four) officials from the food and irrigation sector of the city/regency agriculture office.

Based on the results of the CR calculation from the 30 (thirty) returned forms, some respondents have a CR < 10%, so it is necessary to repeat the interview and reduce the number of respondents to increase the level of consistency and reduce bias. Table 7 displays the expert judgement of level 1 or criteria, and the total score for each column. It also shows the average of each row as the normalised eigen vector or priority vector of the matrix, and the total score of each column divided by the relative weight of the matrix.

Table 8 shows the priority vectors for all criteria and sub criteria, and the calculations from Table 7 are also applied to all sub criteria at each level. As for the condition of the secondary network, the value is taken based on the decision of the Unit Pengelola Irigasi (UPI) representative of the BBWS Bengawan Solo and the responses of the officers or caretakers as found in Table 6 with the provision of values ranging from 1 to 5 which indicates how good or bad the condition of the secondary network.

Table 6 Secondary network condition values

NO	Criteria level	Secondary irrigation networks					
		Sumber Batang	Ulo	Purwodadi	Ngabean	Bedilan	Karang
	Criteria (Level 1)						
1	Physical structure	4	3	4	4	4	4
2	Crop productivity	4	4	4	4	5	4
3	Supporting facilities	4	4	4	4	4	4
4	Organisation personnel	4	4	4	4	4	4
5	Documentation	5	5	5	5	5	5
6	Water Using Farmers	3	3	3	3	3	3
	Sub-criteria (level 2)						
1	Main structure	3	3	4	4	4	4
2	Carrier canal	3	3	4	4	3	4
3	Carrier canal structures	3	4	3	3	3	4
4	Drains and their structures	3	3	3	3	3	3
5	Driveway/inspection road	4	3	3	2	3	4
6	Office, housing and warehouse	3	3	3	4	4	4
7	Fulfilment of water needs	4	3	4	4	5	5
8	Realisation of planting area	3	3	4	3	3	4
9	Crop productivity	4	3	4	4	4	4
10	Operational and maintenance equipment	4	4	4	4	4	4
11	Transport	4	3	3	3	3	3
12	Office equipment for ranting/observer/UPTD	3	4	4	4	4	4
13	Communication tools	3	3	4	4	4	3
14	O&P organisation and responsibilities	5	5	5	5	5	5
15	Personnel	4	4	5	3	4	4
16	Irrigation area book data	4	5	5	5	5	5
17	Maps and pictures	5	5	5	5	5	5
18	Legal entity	3	3	2	2	3	3
19	Institutional conditions	3	3	2	2	2	3
20	Ulu-ulu meeting	3	3	2	2	2	2
14	Actively participate in surveys/network tracing	3	3	3	3	3	3
22	Member participation in network repair and natural disaster management	2	3	2	3	2	3
23	Fees for participation in major network improvements	2	2	2	2	2	2
24	Participation in crop and water allocation planning	3	3	3	3	3	3

Table 7 Pairwise comparison on each criterion (level 1)

Criteria	Physical Structure	Crop Productivity	Supporting Facilities	Organisation Personnel	Documentation	Water Using Farmers	priority weight
Physical Structure	0.24	0.35	0.15	0.31	0.21	0.21	0.25
Crop Productivity	0.06	0.09	0.08	0.15	0.07	0.07	0.10
Supporting Facilities	0.24	0.17	0.15	0.15	0.21	0.21	0.16
Organisation Personnel	0.12	0.09	0.15	0.15	0.21	0.21	0.15
Documentation	0.24	0.26	0.15	0.15	0.21	0.21	0.21
Water Using Farmers	0.08	0.04	0.31	0.08	0.07	0.07	0.11
Total	1	1	1	1	1	1	1
CI	0.11						
CR	0.09						

RESULTS AND DISCUSSION

This study uses 6 main criteria, namely physical structure, plant productivity, supporting facilities, organizational personnel, documentation and water-using farmers. The role of physical structure has the highest value because it plays a role in distributing and regulating irrigation water through the existence of main buildings, carrier channels, drainage channels, complementary buildings, inspection roads and offices, housing, warehouses. The plant productivity factor also affects socio-economic conditions, especially because of the level of fulfillment of water needs, the ability to realize the planting area and the rice production itself. While from the supporting facility factor, organizational personnel and documentation play a role as a complement, maintenance and regulator of the irrigation system. The factor of water-using farmers as subjects and actors in water needs also has a role, including participating in activities that have been agreed upon with BBWS.

Table 8 shows the priority factors of the pairwise comparison results in AHP which show the largest weight for the criteria (level 1) is physical structure (0.29), followed by plant productivity (0.28), water-using farmers (0.16), supporting facilities (0.10), organizational personnel (0.09) and documentation (0.08). It is assumed that physical structure is a criterion that has a significant influence in influencing irrigation water allocation. One of the sub-criteria (level 2) in the physical structure that plays a significant role in irrigation water allocation is the main building (0.30). The most influential sub-criterion of crop productivity is the fulfillment of water needs (0.41) which has a direct relationship with the realization and yield of the harvest. The sub-criterion of operating and maintenance equipment (0.48) is the most influential factor in supporting facilities. In the organizational section, the organizational O&P factor (0.57) of institutions plays a more important role than personnel, the existence of irrigation area data books (0.56) is also more important than maps and images. Furthermore, in the sub-criteria of water-using farmers, the role of the GP3A organization in planning crop and water allocation (0.18) is the most influential factor.

Based on the multiplication of the values in Table 8, the weight of the criteria and sub-criteria with the value of the secondary network conditions in Table 6 determines the condition or priority level of each secondary network against the criteria and sub-criteria. With a UPI value between 1 and 5 on the physical structure getting an average (3.8), with plant productivity (4.3), supporting facilities (3.5), organizational personnel (4.2), documentation (4.7) and water-using farmers of (2.7). While the lowest priority value is secondary Ulo with a physical structure (3.2), plant productivity (3.0), and water-using farmers (2.8). The average secondary Karang is (3.83) and Ulo is only (3.60). This physical condition value will later become a multiplier factor with priority weight.

Figure 4 and table 9 show the priority level of each secondary irrigation network according to the criteria at level 1 and level 2. There is a relationship where table 9 is a detail of the priority conditions in figure 4. for example, in the level 1 criteria, bedilan has a priority of (0.178) with the most influential criteria being plant productivity of (1.41) and the criteria that must be reviewed more are personnel organization and documentation. As this also

Table 8 Criteria and sub criteria

Criteria	w_1	Sub-criteria	$w_{11} - w_{16}$
Physical structure	0.290	Main structures	0.300
		Carrier canal	0.214
		Carrier canal structures	0.176
		Drains and their structures	0.118
		Driveway/inspection road	0.110
		Office, housing and warehouse	0.082
Criteria	w_2	Sub-criteria	$w_{21} - w_{23}$
Crop productivity	0.283	Fulfilment of water needs	0.415
		Realisation of planting area	0.316
		Crop productivity	0.270
Criteria	w_3	Sub-criteria	$w_{31} - w_{33}$
Supporting facilities	0.101	Operational and maintenance equipment	0.479
		Transport	0.238
		Office equipment for ranting/observer/uptd	0.146
		Communication tools	0.137
Criteria	w_4	Sub-criteria	$w_{41} - w_{42}$
Organisation personnel	0.095	O&P organisation and responsibilities	0.574
		Personnel	0.426
Criteria	w_5	Sub-criteria	$w_{51} - w_{52}$
Documentation	0.076	Irrigation area book data	0.560
		Maps and pictures	0.440
Criteria	w_6	Sub-criteria	$w_{61} - w_{67}$
Water user farmers (GP3A/IP3A)	0.155	Legal entity	0.170
		Institutional conditions	0.094
		Ulu-ulu meeting	0.151
		Actively participate in surveys/network tracing	0.161
		Member participation in network repair and natural disaster management	0.144
		Fees for participation in major network improvements	0.124
		Participation in crop and water allocation planning	0.177

Table 9 Priority Criteria and sub criteria

Value x Criteria Weight 1						
Main Item	**SB**	**UL**	**PU**	**NG**	**BE**	**KA**
Physical structure	1.16	0.87	1.16	1.16	1.16	1.16
Crop productivity	1.13	1.13	1.13	1.13	1.41	1.13
Supporting facilities	0.40	0.40	0.40	0.40	0.40	0.40
Organisation personnel	0.38	0.38	0.38	0.38	0.38	0.38
Documentation	0.38	0.38	0.38	0.38	0.38	0.38
Water user farmers (GP3A/IP3A)	0.47	0.47	0.47	0.47	0.47	0.47
Total	**3.92**	**3.63**	**3.92**	**3.92**	**4.20**	**3.92**
Ranking	**2.00**	**6.00**	**2.00**	**2.00**	**1.00**	**2.00**
Priority	**0.17**	**0.15**	**0.17**	**0.17**	**0.18**	**0.17**
Value x Criteria Weight 2						
Physical structure	**SB**	**UL**	**PU**	**NG**	**BE**	**KA**
Main structures	0.90	0.90	1.20	1.20	1.20	1.20
Carrier canal	0.64	0.64	0.86	0.86	0.64	0.86
Carrier canal structures	0.53	0.70	0.53	0.53	0.53	0.70
Drains and their structures	0.35	0.35	0.35	0.35	0.35	0.35
Driveway/inspection road	0.44	0.33	0.33	0.22	0.33	0.44
Office, housing and warehouse	0.24	0.24	0.24	0.33	0.33	0.33
Total	**3.11**	**3.18**	**3.51**	**3.49**	**3.38**	**3.88**
Ranking	**6.00**	**5.00**	**2.00**	**3.00**	**4.00**	**1.00**
Priority	**0.15**	**0.15**	**0.17**	**0.17**	**0.16**	**0.19**
Crop productivity						
Fulfilment of water needs	1.66	1.24	1.66	1.66	2.07	2.07
Realisation of planting area	0.95	0.95	1.26	0.95	0.95	1.26
Crop productivity	1.08	0.81	1.08	1.08	1.08	1.08
Total	**3.68**	**3.00**	**4.00**	**3.68**	**4.10**	**4.41**
Ranking	**4.00**	**6.00**	**3.00**	**4.00**	**2.00**	**1.00**
Priority	**0.16**	**0.13**	**0.17**	**0.16**	**0.18**	**0.19**

Value x Criteria Weight 2						
Supporting facilities	**SB**	**UL**	**PU**	**NG**	**BE**	**KA**
Operational and maintenance equipment	1.92	1.92	1.92	1.92	1.92	1.92
Transport	0.95	0.72	0.72	0.72	0.72	0.72
Office equipment for ranting/observer/uptd	0.44	0.58	0.58	0.58	0.58	0.58
Communication tools	0.41	0.41	0.55	0.55	0.55	0.41
Total	**3.72**	**3.62**	**3.76**	**3.76**	**3.76**	**3.62**
Ranking	**4.00**	**5.00**	**1.00**	**1.00**	**1.00**	**5.00**
Priority	**0.17**	**0.16**	**0.17**	**0.17**	**0.17**	**0.16**
Organisation personnel						
O&P organisation and responsibilities	2.87	2.87	2.87	2.87	2.87	2.87
Personnel	1.70	1.70	2.13	1.28	1.70	1.70
Total	4.57	4.57	5.00	4.15	4.57	4.57
Ranking	2.00	2.00	1.00	6.00	2.00	2.00
Priority	0.17	0.17	0.18	0.15	0.17	0.17
Documentation						
Irrigation area book data	2.24	2.80	2.80	2.80	2.80	2.80
Maps and pictures	2.20	2.20	2.20	2.20	2.20	2.20
Total	**4.44**	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**
Ranking	**6.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Priority	**0.15**	**0.17**	**0.17**	**0.17**	**0.17**	**0.17**
Water user farmers (GP3A/IP3A)						
Legal entity	0.51	0.51	0.34	0.34	0.51	0.51
Institutional conditions	0.28	0.28	0.19	0.19	0.19	0.28
Ulu-ulu meeting	0.45	0.45	0.30	0.30	0.30	0.30
Actively participate in surveys/network tracing	0.48	0.48	0.48	0.48	0.48	0.48
Member participation in network repair and natural disaster management	0.29	0.43	0.29	0.43	0.29	0.43
Fees for participation in major network improvements	0.25	0.25	0.25	0.25	0.25	0.25
Participation in crop and water allocation planning	0.53	0.53	0.53	0.53	0.53	0.53
Total	**2.79**	**2.94**	**2.38**	**2.52**	**2.55**	**2.79**
Ranking	**2.00**	**1.00**	**6.00**	**5.00**	**4.00**	**3.00**
Priority	**0.17**	**0.18**	**0.15**	**0.16**	**0.16**	**0.17**

applies to the level 2 criteria. for example, in physical infrastructure, Karang has a priority of (0.19) with the main building influencing criteria (1.20) and the criteria that need to be reviewed are housing offices and warehouses. While in the productivity of planting, Karang is still a priority (0.19) with the fulfillment of water needs (2.0) as the most influential factor. However, rice productivity must still be considered because it is a factor with the lowest priority (1.0). The priority value obtained in the criteria (level 1) shows that the Bedilan secondary irrigation network has the best condition. If reviewed based on sub-criteria (level 2) it shows that the Karang secondary irrigation network is the main priority in the fields of infrastructure, documentation and plant productivity. While in the field of supporting facilities, the priority position is occupied by the secondary Purwodadi, Ngabean and Bedilan. This happens because they have the same value. Then the secondary Purwodadi becomes the main priority in the field of personnel organization and Sumber Batang in the field of water user farmers.

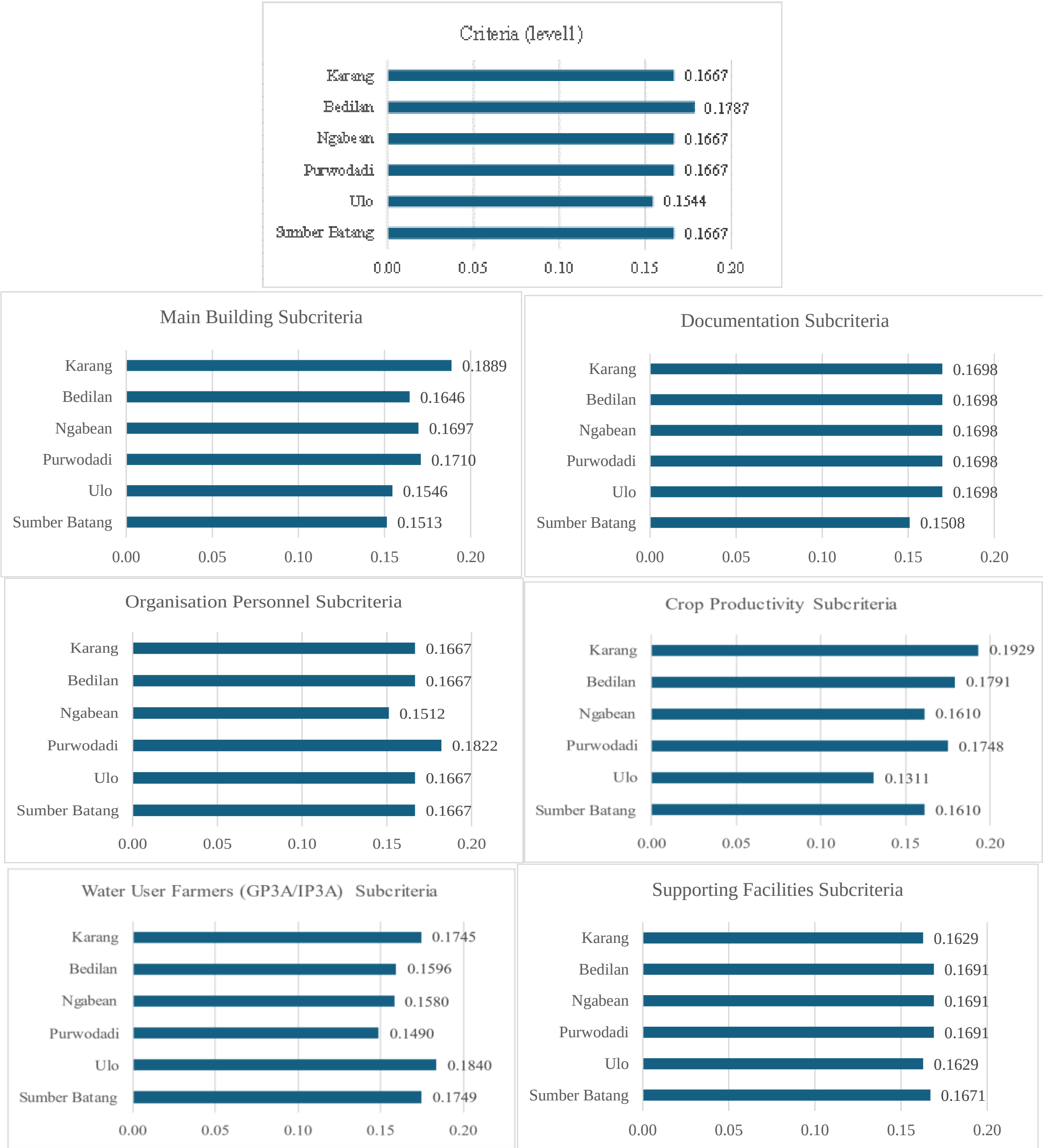

Figure 4 Secondary prioritisation of each criterion

The priority of all aspects of the criteria and the multiplication of the weight with the existing value, the selected secondary with the best condition is the secondary Karang, which is based on the sum of the overall criteria levels. As seen in Figure 5 which is followed by the secondary Bedilan, Purwodadi, Ngabean, Sumber Batang and the last is Ulo. Secondary Karang has better conditions

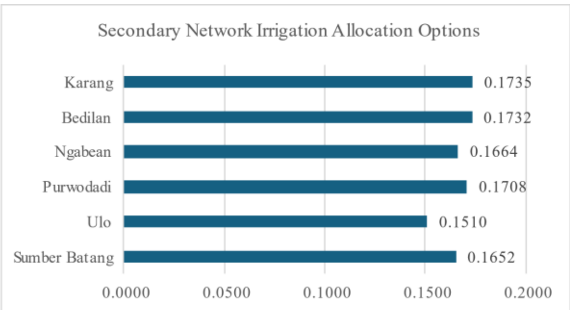

Figure 5 Illustration of AHP (hierarchical analysis

in all aspects compared to other secondaries. because each channel in the irrigation network has a priority with the highest value meaning good condition and a low value as bad condition, cooperation is needed between related agencies and water-using farmers.

CONCLUSIONS

1. This study uses the Analytical Hierarchy Process (AHP) method to determine irrigation water allocation by considering irrigation system performance index criteria. This method transforms data gaps that are only taken by individuals into qualitative analyses that are easy to understand with input values from various decision-making elements. Excellence in determining the dominant criteria and sub-criteria based on the priority vector value. This assessment is an effective way for the government to

determine irrigation water allocation, by selecting and choosing criteria that are easier to prioritise.

2. This analysis combines quantitative data with expert judgement, this analysis obtains the priority of irrigation water allocation in the secondary network with aspects of irrigation performance criteria. The order of priority is the secondary network of Karang, Bedilan, Purwodadi, Ngabean, Sumber Batang and Ulo. This was obtained based on the overall results of the secondary network criteria of corals had a higher priority of (0.174) compared to other secondary networks in order (0.173), (0.171), (0.166), (0.165), (0.151). However, even though the main priority is still something that needs to be considered in the coral secondary network based on the level 1 criteria, personnel organization and documentation both have the same priority value (weight x existing value) which is (0.38). Meanwhile, for the level 2 criteria that need to be considered, are housing and warehouse conditions, rice productivity, communication equipment, personnel, maps and images, as well as participation in GP3A/IP3A contributions for participation in the repair of the main network which has a priority value (weight x existing value) in order (0.33), (1.07), (0.41), (1.70), (2.20), (0.25). So that follow-up is still needed from both the government and farmers to participate in improving and maintaining the condition of irrigation assets and networks.
3. The results of this analysis can be used by governments when they are choosing which secondary or irrigation area to prioritise. This method has low cost, adaptive, easy to apply and comprehensive, so the government can use it as part of its water allocation strategy in addition to considering the value of the e-Paksi results.

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