Evaluating the Performance of Jabung Irrigation System

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Abstract. In order to achieve food self-sufficiency, operation and maintenance of irrigation networks is required from the time the irrigation network infrastructure is built. This is intended to maintain the physical condition and function of irrigation network infrastructure so that it can be of optimal use according to the planned life. One of the scopes of O&M activities is Performance Assessment, which means the process of problem identification, analysis and evaluation carried out objectively and professionally based on examinations to assess the truth, accuracy, credibility and reliability of information regarding an activity. The aim of this research regarding Performance Analysis of Surface Irrigation Systems in the Jabung Irrigation Area is to determine the condition of irrigation network assets and supporting assets for irrigation management through the e-PAKSI application and provide performance assessments according to the results of observations in the fields. This research has a duration of 4 months with research methods including inventory of irrigation networks and surveys carried out to obtain data on the number, dimensions, function and condition of all irrigation assets...

Keywords: irrigation performance, e-PAKSI, irrigation network.

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1 Introduction

In order to achieve food self-sufficiency, operation and maintenance (O&M) activities of the irrigation network are required from the time the irrigation network infrastructure is built. This is intended to maintain the physical condition and function of irrigation network infrastructure so that it can be optimally useful according to the planned life [1,2,3]. One of the scopes of O&M activities is Performance Assessment, which means the process of problem identification, analysis and evaluation carried out objectively and professionally based on examinations to assess the truth, accuracy, credibility and reliability of information regarding an activity [4,5]. In this case, an assessment of the irrigation network infrastructure is carried out, by comparing the assessed infrastructure with ideal benchmarks/criteria. By carrying out performance assessment activities, the latest information and data on irrigation networks can be obtained, including the formulation of problems and application of solutions, which is part of the process of increasing the utilization of irrigation networks as well as the utilization of water resources [6,7].

To carry out activities optimally and sustainably, performance assessments are carried out using e-PAKSI (electronic assessment of irrigation system assets and performance). The location of the activity is the Jabung Irrigation Area, East Lampung Regency. Jabung irrigation area is now a surface irrigation system where some parts were converted from a swamp irrigation system previously. It is assumed that the irrigation system may not perform well yet to date. Therefore, the purpose of this study is to evaluate the performance of the irrigation system of Jabung irrigation area both for primary and tertiary networks. It is expected that from the results of this activity, data and information regarding irrigation assets and effective and efficient performance assessments of irrigation systems will be obtained and expressed in a geographic information system, so that it can be used as a reference for making decisions (decision support system) in the future [8,9,10].

2 Research Methods

Administratively, the location of the Jabung Irrigation Area is in Pasir Sakti District, East Lampung Regency, while hydrologically it is included in the Sekampung River area with a geographic location at 105°40'40" East Longitude – 105°47'40" East Longitude and 5°30'00" South Latitude – 5°30' 45" LS. The Jabung Irrigation Area is under the management of the Lampung Provincial Irrigation Service. The standard area of the Jabung Irrigation Area is 7,288 Ha [11]. The water supply for the Jabung Irrigation Area comes from the Jabung Gerak Dam. Gerak Jabung Dam which takes water from the Way Sekampung River and then empties into the Java Sea. The border of Jabung Irrigation Area are Karya Tani Irrigation Area, East Coast of Lampung, downstream of Way Sekampung and Way Sekampung at north, east, south and west sides respectively. A map of the work location can be seen in Fig. 1.

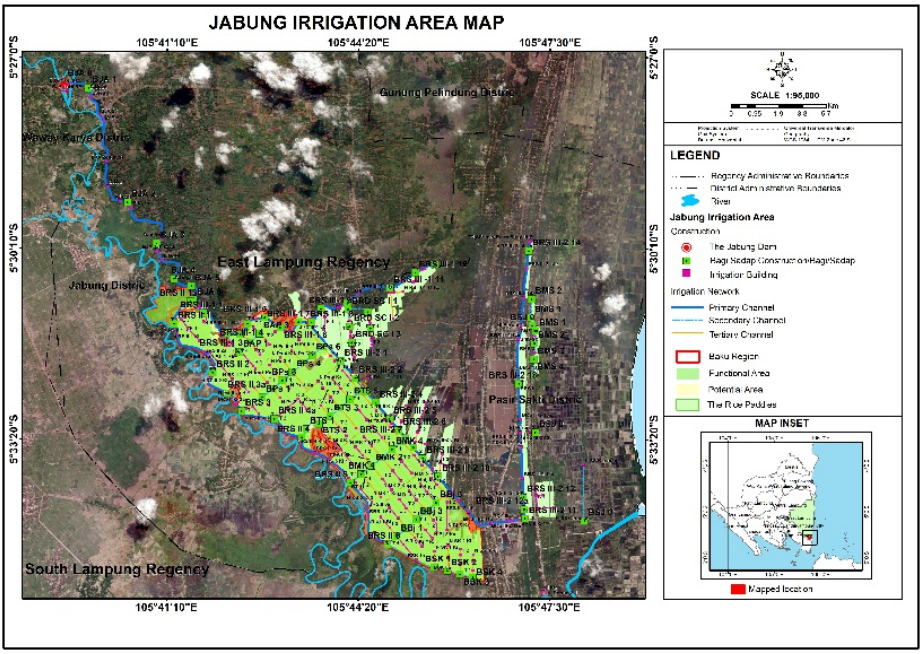

Fig. 1. Study area map.

In this research, the software used is e-PAKSI software which includes GIS based applications, satellite image maps from Google, Android-based e-PAKSI Survey Application and e-PAKSI Web Application. Hardware used in this activity includes smartphone or Android cellphone equipped with a camera and GPS, additional tools (if needed) such as GPS, camera and other supporting devices [12].

In this research based on the Electronic Asset Management and Irrigation System Performance (e-PAKSI), the observed data is recorded and input directly into the observation sheet which is available in the e-PAKSI application. e-PAKSI provides the main facilities in the form of Irrigation Asset Management (PAI) data collection sheets and Irrigation System Performance Index (IKSI) assessment sheets. The data studied is data on the condition of irrigation assets and their functions. The condition and function of the irrigation network studied is in the form of physical assets of the irrigation network consisting of irrigation buildings and irrigation canals. The analysis stages carried out in the field with the e-PAKSI instrument consist of two sequential stages whose order cannot be exchanged. e-PAKSI stages are as follows: 1) PAI Analysis Stage (Irrigation Asset Management). The PAI survey is the initial activity of collecting data on the specifications and characteristics of buildings and irrigation canals in the form of type, type, number and dimensions of buildings and irrigation canals. PAI must be carried out by tracing and recording data from upstream of the irrigation network to downstream of the network and not vice versa. PAI analysis takes the form of recording data on irrigation network specifications and characteristics. 2) IKSI Analysis Stage (Irrigation System Performance Index).

IKSI is carried out after PAI is completed. PAI data stored in the application will be used again as a basis for filling in the form for IKSI. Before carrying out IKSI, researchers must first synchronize the PAI data that has been worked on in the application. The data synchronization process is a PAI data entry process that has been carried out to be forwarded to the IKSI process. The IKSI assessment is carried out on all buildings and channels starting from the intake building (weir) to the waste channel. Evaluation of irrigation network performance is based on the following six parameters [13]: 1. Physical Infrastructure Aspects, 2. Aspects of Planting Productivity, 3. Aspects of Supporting Facilities, 4. Personnel Organizational Aspects, 5. Documentation Aspect, 6. Institutional aspect, namely P3A. Survey process on the infrastructure such as irrigation channel and gate are presented in Fig. 2.

(a) (b)

Fig. 2. Jabung Irrigation Area Survey Process (a) measuring the irrigation channel; (b) measuring irrigation gate.

3 Result and Discussions

In this electronic application-based research on Asset Management and Irrigation System Performance (e-PAKSI), the observed data is recorded and input directly into the observation sheet which is available in the e-PAKSI application. e-PAKSI provides main facilities in the form of Irrigation Asset Management (PAI) data collection sheets and Irrigation System Performance Index (IKSI) assessment sheets. The data is obtained from observing the condition of irrigation assets and their functions. The conditions and functions of the irrigation network studied are the physical assets of the irrigation network consisting of irrigation structures and irrigation channels. The analysis stages carried out with the e-PAKSI instrument are as follows:

This research requires primary and secondary data with data collection techniques used namely observation, interviews and documentation. The observation technique is carried out objectively to collect primary data, namely the condition of the irrigation network from the results of direct measurements and observations in the field. The interview technique is used as a data collection technique by researchers by conducting direct conversations and discussions with related parties to obtain initial information and complete unclear observation data in the field. Documentation techniques are used as a secondary data source [14,15,16]. The secondary data required is an irrigation network scheme document which provides an overview of the location and names of buildings and irrigation canals which is equipped with the nomenclature of each building and canal in an irrigation area along with other Jabung Irrigation Area identity data related to irrigation network management. such as the availability and need for water as well as the area of irrigated rice fields, data on operational and maintenance facilities and infrastructure as well as IP3A/GP3A/P3A institutional data for the Jabung Irrigation Area. Data analysis includes PAI and IKSI.

3.1 PAI Analysis Stage (Irrigation Asset Management)

The PAI survey is the initial activity of collecting data on the specifications and characteristics of buildings and irrigation canals in the form of type, type, number and dimensions of buildings and irrigation canals. PAI is carried out by tracing and inputting data from upstream to downstream of the irrigation network [17].

Identifying the number and condition of structures and channels based on e-PAKSI results in the Jabung Irrigation Area. Data on the number and condition of buildings and irrigation channels was obtained by field surveys conducted using the Android-based e-PAKSI application and interviews with operations and maintenance officers who are the authorities in the irrigation area. The following is an overview of the result of survey process carried out (Table 1)

Table 1. Analysis Results Management of Irrigation Area Irrigation Assets Jabung.

No.	Total Assets (PAI)	Amount
1	Length of Main Channel (Km)	52.87
2	Length of Secondary Channel (Km)	19.96
3	Length of Supplement Channel (Km)	0
4	Length of Waster Channel (Km)	39.54
5	Length of Tertiary Channel (Km)	51.03
6	Length of Waster Tertiary Channel (Km)	0
7	Number of Weirs (Unit)	1
8	Number of Regulator Structure (Divide/Divide Tapping/ Tapping) (Unit)	235
9	Number of Complementary Structures (Unit)	251
10	Number of Miscellaneous Structures (Unit)	119
11	Office (Unit)	2
12	Housing (Unit)	14
13	Warehouse (Unit)	0

Irrigation Asset Condition Management (PAI) was achieved from information condition asset channels and structures. Results of Analysis of Management of Irrigation Asset Conditions (PAI) are shown in Fig. 3 and Fig. 4. Recommendations for handling the condition of irrigation network assets are as follows [18,19]:

- Good Condition (B) = Very Good (BS) with damage level > 0% - 10%;
- Condition of Light Damage (RR) = Good (B) with damage level > 10% - 20%;
- Moderate Damaged Condition (RS) = Medium (S) with a level of damage >20%–40%; and
- Condition of Severe Damage (RB) = Bad (J) with damage level > 40%.

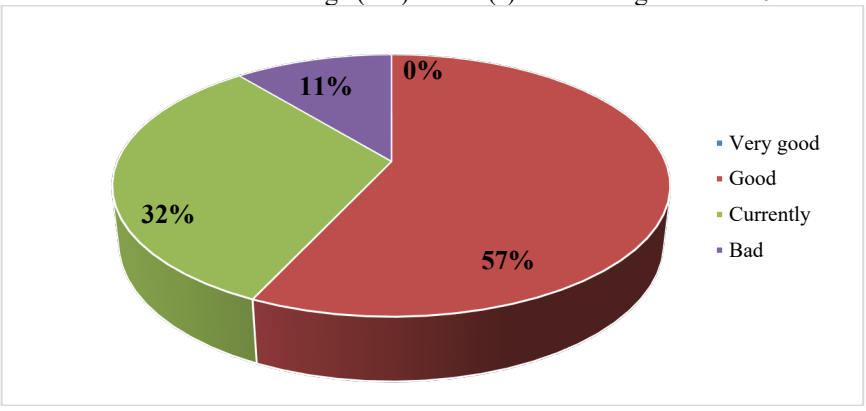

Fig 3. Percentage Condition of Irrigation Area Channel Assets Jabung.

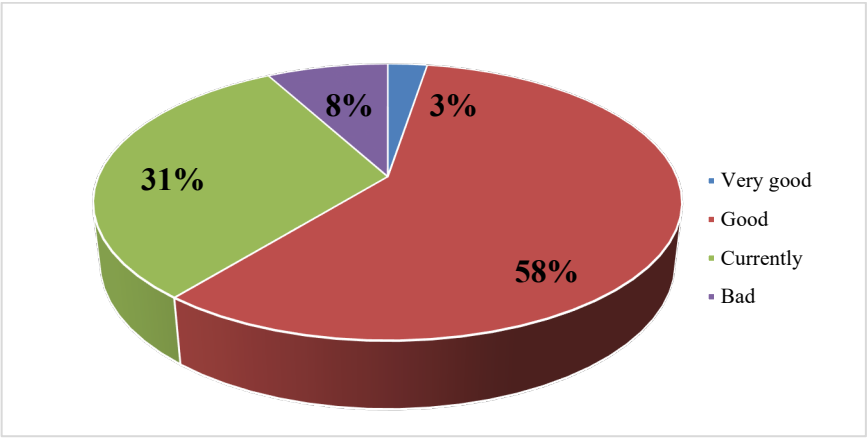

Fig 4. Percentage Condition of Irrigation Area Building Assets Jabung.

3.2 IKSI Analysis Stage (Irrigation System Performance Index)

The IKSI survey is carried out after the PAI survey is complete and data synchronization has been carried out. Like the PAI survey, the IKSI survey was also carried out by tracing the irrigation network from upstream to downstream. The difference is that the PAI survey collects asset data, but the IKSI survey assesses the performance of assets that have been recorded. The IKSI search scheme is the same as the PAI search strategy while still following the actual situation in the field. A condition and function category guide has been provided on the e-PAKSI assessment form as a technical guide for assessing the condition and function of irrigation network assets [20].

In this assessment, direct discussions were also held at the location of the assets being assessed with the accompanying technical team and irrigation observers to obtain an agreement in providing an assessment of the assets being assessed visually. The assessment categories are available in the assessment form, consisting of conditions (1) very good, (2) good, (3) moderate, and (4) poor, as well as function (1) good, (2) poor, (3) poor, and (4) does not work.

IKSI assessment is based on Minister of Public Works Regulation No.12/PRT/M/2015 concerning Exploitation and Maintenance of Irrigation Networks, evaluation of irrigation network performance is based on the six parameters (1) Physical Infrastructure Aspects; (2) Aspects of Planting Productivity; (3) Aspects of Supporting Facilities; (4) Aspects of Personnel Organization; (5) Documentation Aspect, and (6) Institutional aspect, namely P3A.

Table 2. IKSI Analysis of Combined Irrigation Areas Jabung.

No.	Component	Main Irrigation System		Tertiary Irrigation System		Total Value
		Index Existing Conditions	Weight (80%)	Index Existing Conditions	Weight (20%)	
1	Infrastructure Physique	30.38	24.30	15.24	3.05	27.35
2	Planting Productivity	11.06	8.85	13.68	2.74	11.58
3	Supporting Facilities	3.00	2.40	15.50	3.10	5.50
4	Personnel Organization	9.29	7.43	9.60	1.92	9.35
5	Documentation	3.73	2.98	2.74	0.55	3.53
6	Water user organization P3A/GP3A/IP3A	5.76	4.61	16.81	3.36	7.97
	Total	63.21	50.57	73.57	14.71	**65.28**

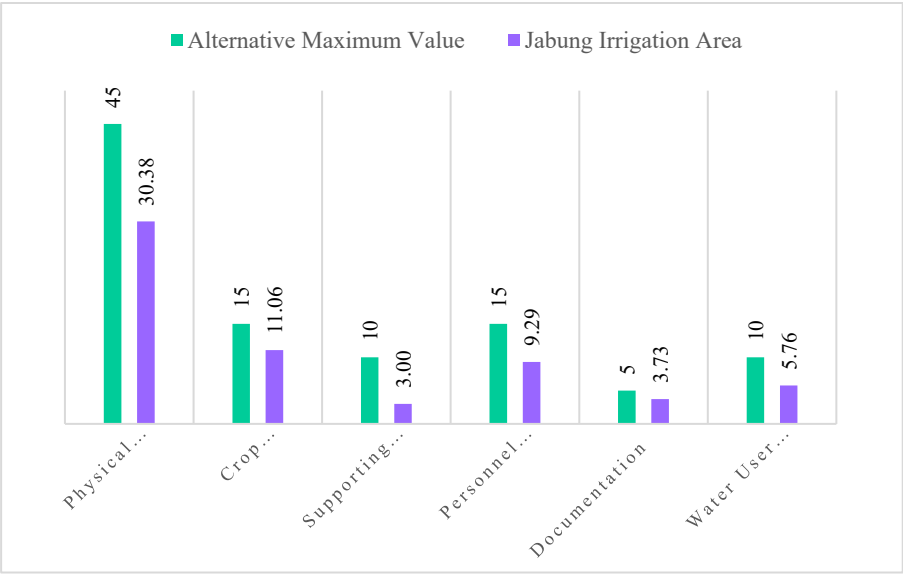

Fig. 5. Main Network IKSI Value.

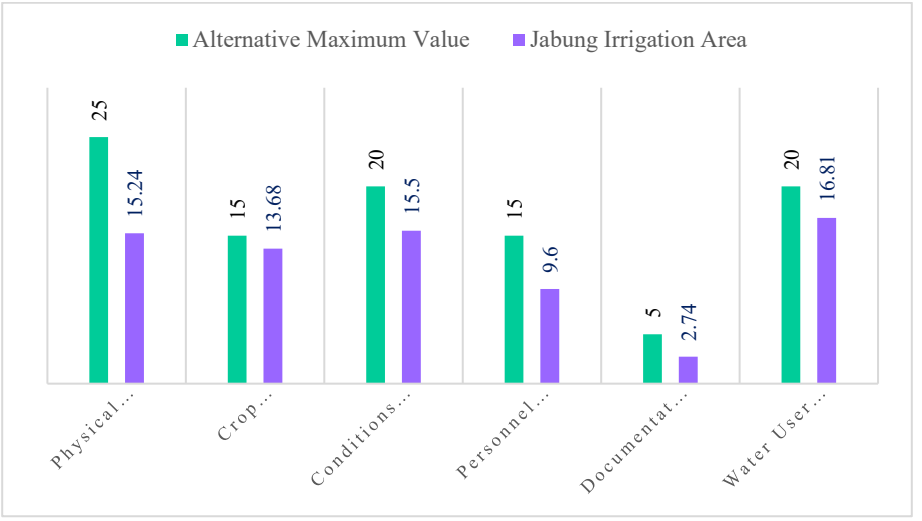

Fig. 6. Tertiary Network IKSI Value.

IKSI values for each component of the main network are presented in Table 2, while Fig. 5 shows the IKSI value for each component compared to the maximum IKSI value for corresponding component for main network. It can be seen that the physical infrastructure score is 30.38%, which is about two thirds of the maximum score (45%). Recommendation for this condition is maintenance or even rehabilitation for the structures which experienced damage. The score of plant productivity component is 11.06%, so it needs to increase 3.94% to reach maximum condition. This condition is considered good, but it needs to pay attention as paddy productivity may be affected by the large number attack pests on plants rice. As for the component of supporting facilities the score obtained is 3.0% out of 10%. The score is quite low and to increase it can be done by completing some equipment needed such as a communication tool. The fourth component is personnel organization with the score of 9.29% out of 15% and it is considered as good. Next component is documentation and the score achieved 3.73% out of 5% and is categorized as good. This can be done by providing a necessary map for the irrigation networks and structures. The last component is IP3/GP3A which is related to farmer organization. The score achieved is 5.76% out of 10.00% meaning that it needs to have farmer involved in the operation and maintenance network and to get more involved in the organization meeting.

IKSI values for the components of tertiary network are presented in Table 2 and the graph comparing each component's IKSI values to the corresponding maximum values is presented in Fig. 6. It can be seen from Fig. 6. that the maximum values for the tertiary network component differ from the maximum values for the main network component. The score of physical infrastructure component is 15.24% out of 25%. The score for this component can be increased such as by maintaining board operation and lining embankment. The score of plant productivity is 13.68% out of 15% which is considered as good. The score of operation and maintenance is 15.50% out of 20% and

the score can be improved by doing the routine maintenance. The fourth component is personnel organization and the score achieved is 9.6% out of 15.0%. The fifth component is documentation with the score achieved is 2.74% out of 5.0% and it can be improved by providing Operation and Maintenance manual and completing the administration organization. The last component is Water User Association with the score is 16.81% out of 20%. The score is considered good, but to improve it to reach the maximum score can be done by legalized the status of the water user organization.
Overall, the IKSI value of Irrigation Area Jabung is 65.28%. This is computed by applying the weight of 80% and 20% for main and tertiary networks respectively. According to the regulation applied Irrigation Area Jabung considered as Poor and it needs attention for operation and maintenance.

4 Conclusion

Based on results and discussion previously so can concluded that Irrigation Area Jabung achieves Index Performance Assessment and Systems Irrigation score of 65.28% which is considered as poor condition, and it needs necessary attention in the operation and maintenance both for the irrigation network and structures in main as well as tertiary networks.

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