

## Evaluation of Irrigation Network Performance Using the Irrigation System Performance Index (IKSI) Method in the Rejoso Irrigation Area: A Case Study of the Rejoso Kiri and Jati Secondary Canals

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**Abstract:** Irrigation networks are essential infrastructures for supporting agricultural productivity, water distribution equity, and sustainable agricultural management. However, irrigation system performance is often affected by physical deterioration, limited operation and maintenance support, weak documentation, and institutional constraints. **Objective:** This study aims to evaluate the performance of the irrigation network in the Rejoso Irrigation Area, focusing on the Rejoso Kiri and Jati Secondary Canals, using the Irrigation System Performance Index (IKSI) method. **Methodology:** This research employed a descriptive quantitative approach through field surveys, direct observations, structured questionnaires, and secondary data collection from relevant agencies. Data were analyzed using the IKSI weighted scoring system, which assesses six main components: physical infrastructure, crop productivity, supporting facilities, organization and personnel, documentation, and the institutional condition of Water Users Associations (P3A). **Findings:** The results show that the overall IKSI value of the Rejoso Irrigation Area is 64.3%, which falls into the poor performance category and requires attention. The most critical aspects are related to physical infrastructure, supporting facilities, documentation, and P3A institutional performance. **Implications:** These findings imply that irrigation management improvement should not only focus on canal rehabilitation, but also on strengthening operation and maintenance facilities, improving documentation systems, and increasing P3A participation. **Originality:** The originality of this study lies in its location-specific evaluation of secondary canals by integrating technical, operational, and institutional aspects to provide targeted recommendations for improving irrigation system performance.

**Keywords:** Agricultural sustainability; IKSI; Irrigation network; Irrigation performance; System evaluation.

## INTRODUCTION

Irrigation networks play a strategic role in supporting agricultural productivity, food security, and the sustainability of rural livelihoods. Globally, agriculture accounts for approximately 70% of freshwater withdrawals, showing that irrigation management is closely related to the efficiency of water resource use in agricultural production (Food & Agriculture Organization of the United, 2016; Ritchie & Roser, 2018). In Indonesia, irrigation infrastructure is essential for maintaining cropping intensity and ensuring the

availability of water for paddy fields, particularly in areas where rainfall variability and seasonal water shortages may affect agricultural output. Therefore, the performance of irrigation networks must be evaluated continuously to ensure that water can be supplied, regulated, and distributed effectively from upstream to downstream areas. In practice, many irrigation systems still face problems such as sedimentation, physical deterioration of canals, limited operation and maintenance facilities, weak documentation, and uneven water distribution. These problems may reduce irrigation service reliability and directly affect crop productivity at the farmer level. Fundamentally, irrigation management requires synchronization between water availability at the source and crop water requirements in agricultural land, which must be managed efficiently to support sustainable agricultural production (Tyasa & Saves, 2025). For this reason, the Irrigation System Performance Index (IKSI), as regulated under Ministerial Regulation of Public Works and Housing No. 12/PRT/M/2015, becomes an important assessment instrument for measuring irrigation system performance based on technical, operational, and institutional aspects (Kementerian Pekerjaan Umum dan Perumahan Rakyat Republik, 2015). Previous studies on irrigation performance can be grouped into three main categories. The first category focuses on irrigation water requirements, crop productivity, and water availability. Studies in this category explain that irrigation performance is closely related to the ability of the irrigation system to fulfill crop water requirements and maintain agricultural productivity. Tyasa and Saves emphasize that irrigation management requires synchronization between water availability and crop water needs to support sustainable agricultural production (Tyasa & Saves, 2025). Similarly, Kusuma show that irrigation network evaluation is important for detecting performance decline before it affects crop productivity (Kusuma et al., 2022). These studies indicate that water availability and irrigation service reliability are key factors in maintaining agricultural output. However, they mostly emphasize water requirements and productivity aspects, while detailed evaluation of physical canal conditions and institutional performance at the secondary canal level remains limited.

The second category focuses on the application of the Irrigation System Performance Index (IKSI) as a method for assessing irrigation system performance. (Mahardika et al., 2025; Malik et al., 2022; Mustaqimah et al., 2024) explain that IKSI assessment uses weighted parameters, including physical infrastructure, crop productivity, supporting facilities, organization and personnel, documentation, and Water Users Associations or P3A. These studies show that IKSI is useful for classifying irrigation network conditions

and determining whether an irrigation system requires routine maintenance, periodic maintenance, or rehabilitation. Nevertheless, most IKSI-based studies still present general performance scores and do not sufficiently explain how each component affects irrigation service conditions in specific canal segments, particularly in secondary canals.

The third category examines the relationship between physical canal conditions, institutional capacity, and irrigation management effectiveness. Sidharta and Priyambodo (2023) found that physical damage, sedimentation, and weed growth in canals contribute to the decline of IKSI values. Trimalino emphasized that evaluation at the secondary canal level can identify water loss points caused by structural damage (Trimalino et al., 2024), while Ardelia showed that field observation and descriptive survey methods are appropriate for assessing canal and structure conditions (Ardelia, 2024). In addition, Putra and Rizal highlighted that weak supporting facilities, low institutional participation, and limited coordination among irrigation actors may reduce irrigation management effectiveness (Putra & Salsabila, 2025; Rizal, 2023). However, these studies have not fully integrated physical conditions, operation and maintenance performance, institutional aspects, and water distribution variations among upstream, middle, and downstream sections in one location-specific assessment. Based on these research gaps, this study aims to evaluate the performance of the Rejoso Irrigation Area, specifically the Rejoso Kiri and Jati Secondary Canals, using the Irrigation System Performance Index (IKSI) method. This study examines six main assessment components, namely physical infrastructure, crop productivity, supporting facilities, organization and personnel, documentation, and institutional performance of Water Users Associations (P3A). In addition, this research integrates field observation, secondary data, and questionnaire responses from irrigation operators and P3A members to provide a more comprehensive description of irrigation network performance. The focus on secondary canals is important because these canals function as key distribution channels connecting primary irrigation supply with tertiary networks and agricultural fields. Therefore, performance problems at this level may affect the continuity of water distribution and create differences in water availability between upstream, middle, and downstream service areas.

The main argument of this study is that the performance of the Rejoso irrigation network is not only determined by the physical condition of canal infrastructure, but also by the availability of supporting facilities, the quality of documentation, the effectiveness of operation and maintenance, and the institutional capacity of P3A. Physical damage and

sedimentation in canal sections are expected to reduce conveyance efficiency and create uneven water distribution, particularly in downstream areas. At the same time, limited maintenance equipment, weak administrative records, and low participation of Water Users Associations may worsen irrigation management and delay necessary rehabilitation actions. Therefore, this study assumes that the integration of technical and institutional assessments through the IKSI method can provide a more accurate basis for identifying performance weaknesses and formulating targeted recommendations for improving irrigation system reliability in the Rejoso Irrigation Area.

## **RESEARCH METHOD.**

The unit of analysis in this study is the irrigation network performance of the Rejoso Irrigation Area, specifically the Rejoso Kiri Secondary Canal and the Jati Secondary Canal. These two secondary canals were selected because they function as important water distribution channels connecting the irrigation system with agricultural service areas. The analysis focuses on the physical condition of canal segments, irrigation structures, crop productivity, supporting facilities, organization and personnel, documentation, and the institutional role of Water Users Associations (P3A/GP3A/IP3A). The observation also considers the location of canal segments in upstream, middle, and downstream areas to identify differences in water distribution and irrigation service performance.

This study employed a descriptive quantitative research design using the Irrigation System Performance Index (IKSI) method. This approach was selected because the study aims to measure irrigation network performance using numerical scores, weighted indicators, and performance classifications. The IKSI method is appropriate because it evaluates irrigation performance through six main components, namely physical infrastructure, crop productivity, supporting facilities, organization and personnel, documentation, and Water Users Associations. These components are relevant because irrigation performance is not only determined by the physical condition of canals, but also by operation and maintenance support, institutional participation, and administrative documentation.

The data used in this study consisted of primary and secondary data. Primary data were obtained through field observations and structured questionnaires. Field observations were used to assess canal conditions, irrigation structures, sedimentation, vegetation growth, flow obstruction, and structural deterioration. Questionnaire data were collected from

irrigation operators and members of Water Users Associations to obtain information related to operation and maintenance practices, institutional participation, coordination, documentation, and irrigation service conditions. The respondents consisted of 2 irrigation operators and 12 P3A members from two P3A groups located along the secondary canals. Secondary data were collected from relevant government agencies and supporting documents, including irrigation area data, canal inventory, planted area data, crop productivity records, operation and maintenance documents, and institutional records.

Data collection was conducted from February 11, 2026 to April 20, 2026. Field observations were carried out directly along the Rejoso Kiri and Jati Secondary Canals using an observation checklist based on IKSI assessment indicators. The questionnaire was developed based on the same IKSI components and distributed to selected respondents using purposive sampling. This sampling technique was used because the respondents were selected based on their direct involvement in irrigation operation, maintenance, and water use. The selected P3A respondents included representatives from upstream, middle, and downstream areas to describe irrigation service conditions from different field locations.

Data analysis was conducted using the IKSI weighted scoring system. Each assessment component was scored based on field observations, questionnaire responses, and secondary data. The score of each component was then multiplied by its predetermined weight to obtain the weighted performance value. The final IKSI value was calculated by summing all weighted component scores. The formula used in this study is presented as follows:

$$IKSI = \frac{\sum(S_i \times W_i)}{\sum W_i}$$

Where

$S_i$  is the score of each assessment component, and

$W_i$  is the weight of each assessment component.

The IKSI assessment components and their weights are presented in Table 1 and Table 2.

**Table 1.** Irrigation System Performance Weighting

No.	Assessment Components	Weight (%)	Indicators/Sub-Components	Sub-Component Weight
1	Physical Infrastructure	45	Main structures	13
			Conveyance canals	10
			Structures on conveyance canals	9

No.	Assessment Components	Weight (%)	Indicators/Sub-Components	Sub-Component Weight
2	Crop Productivity	15	Drainage canals and their structures	4
			Inspection/access roads	4
			Offices, housing, and warehouses	5
			Fulfillment of water requirements / K-factor	9
			Realization of planted area	4
3	Supporting Facilities	10	Rice productivity	2
			Operation and maintenance equipment	4
			Transportation	2
			Office equipment for Branch/Observer/UPTD	2
4	Organization and Personnel	15	Communication equipment	2
			O&M organization established with clear responsibilities	5
5	Documentation	5	Personnel	10
			Irrigation Area data books	2
6	Water Users Associations (P3A/GP3A/IP3A)	10	Maps and drawings	3
			P3A/GP3A/IP3A is legally incorporated	1.5
			Institutional condition of P3A/GP3A/IP3A	0.5
			Meetings between Ulu-ulu/P3A/GP3A/IP3A and Branch/Observer/UPTD	2

**Table 2.** Irrigation System Performance Weighting Continued

No.	Assessment Components	Weight (%)	Indicators/Sub-Components	Sub-Component Weight
6	Water Users Associations (P3A/GP3A/IP3A)	10	P3A/GP3A/IP3A actively participates in network surveys/walkthroughs	1
			Member participation of P3A/GP3A/IP3A in network repairs and natural disaster handling	2
			P3A/GP3A/IP3A membership fees for participation in main network repairs	2
			P3A/GP3A/IP3A participation in cropping pattern planning and water allocation	1

The final IKSI value was then classified based on the irrigation system performance criteria. The performance classification used in this study is presented in Table 3.

**Table 3.** IKSI Performance Classification

Value Range	Performance Category
80–100	Very good performance
70–79	Good performance
55–69	Poor performance and requires attention
<55	Very poor performance and requires attention

In addition to the overall IKSI assessment, the physical condition of each secondary canal segment was also evaluated. The condition value of each canal segment was determined through field observation by identifying the level of canal damage, sedimentation, structural deterioration, vegetation growth, and disturbance to water flow. The damage value was calculated using the following equation:

$$Damage\ Value = 100\% - Condition\ Value$$

The results of the canal condition assessment were then used to determine the appropriate treatment recommendation for each segment, including routine maintenance, periodic maintenance, or major rehabilitation.

## RESULT

### Final Irrigation System Performance Index (IKSI)

The evaluation of the irrigation network performance in the Rejoso Irrigation Area, focusing on the Rejoso Kiri and Jati Secondary Canals, was conducted using the Irrigation System Performance Index (IKSI) method. The assessment covered several aspects, including physical infrastructure condition, crop productivity, supporting facilities, organizational structure, documentation, and the institutional performance of the Water User Associations (P3A). Based on the analysis results, the overall IKSI value obtained is 64.3%, which falls within the category of poor performance and requires attention. This value represents a combined assessment of all evaluated secondary canals, namely the Rejoso Kiri and Jati Secondary Canals, and reflects the overall performance of the irrigation network rather than individual canals performance.

**Table 4.** Final Irrigation System Performance Index (IKSI) of the Rejoso Irrigation Area

No.	Indicator	Condition Index (%)			
		Existing Condition	Maximum Value	Minimum Value	Optimum Value
1.	Physical Infrastructure	30.58	45	25	35
2.	Crop Productivity	9.75	15	10	12.5
3.	Supporting Facilities	4.66	10	5	7.5

4.	Organization & Personnel	2.26	15	7.5	10
5	Documentation	2.85	5	2.5	5
6.	Institutional (P3A)	4.20	10	5	7,5
<b>Irrigation System Performance Index</b>		64.3	100	55	77.50

This result indicates that the irrigation system in the study area has not yet functioned optimally in supporting agricultural water demands. The physical condition of the irrigation network shows deterioration in several locations, which effects water distribution efficiency. In addition, maintenance activities are not carried out optimally, leading to reduced system reliability. Crop productivity in the service area is relatively moderate, however, it is still influenced by uneven water distribution, especially during peak irrigation demand periods. Supporting facilities and infrastructure are also insufficient in some sections, particularly in terms of operational tools and maintenance equipment. Meanwhile, documentation related to irrigation operations is not well organized, which may affect decision making processes in system management.

In addition, weak institutional performance of the Water User Associations (P3A) contributes to suboptimal irrigation management. Limited participation of members, lack of coordination, and insufficient understanding of irrigation management responsibilities reduce the effectiveness of collective water distribution and maintenance efforts. Furthermore, poor documentation practices, including incomplete and irregular data recording, hinder monitoring and evaluation processes, making it difficult to determine appropriate maintenance and rehabilitation strategies. These interconnected issues ultimately lead to uneven water distribution, particularly affecting downstream areas, and consequently impact agricultural productivity. This finding confirms that irrigation performance is closely related to the effectiveness of both technical and non-technical aspects within the irrigation system.

**Table 5.** Condition Assessment and Recommended Treatment of Secondary Canals

No.	Canal Code	Length (m)	Condition Value (%)	Damage Value (%)	Recommendation
<b>A REJOSO KIRI SECONDARY CANAL</b>					
1.	BRJKI.1	910	75.42	24.58	Routine Maintenance
2.	BRJKI.2	1795	34.17	65.83	Major Rehabilitation
<b>B JATI SECONDARY CANAL</b>					
1.	BJT.1	229	72.08	27.92	Routine Maintenance
2.	BJT.2	829	63.75	36.25	Periodic Maintenance
3.	BJT.3	1100	98.75	1.24	Routine Maintenance

As shown in Table 5, the BRJKI.2 canal segment in the Rejoso Kiri secondary canal has a condition value of 34.17% and a damage level of 65.83%, which falls into the category requiring major rehabilitation. This indicates severe deterioration that significantly disrupts water conveyance. In contrast, other canal segments such as BRJKI.1 and BJT.3 are still categorized under routine maintenance, indicating relatively good conditions. However, the presence of even a single severely damaged segment can disrupt the overall performance of the irrigation network, as water distribution depends on the continuity of the canal system. The crop productivity aspect scored 9.75 out of 15, indicating moderate performance. However, this condition is closely influenced by the uneven distribution of irrigation water caused by infrastructure limitations. Areas located in the upstream sections tend to receive sufficient water, while downstream areas experience shortages, leading to variability in agricultural yields. This confirms that irrigation performance has a direct impact on crop productivity.

The supporting facilities aspect obtained a score of 4.66 out of 10, indicating insufficient availability of operational and maintenance equipment. The lack of measurement tools and monitoring facilities reduces the ability to control water distribution accurately and limits the effectiveness of maintenance activities. As a result, irrigation management becomes less responsive to actual field conditions. The organization/personnel aspect scored 12.26 out of 15, showing that human resources are generally available. However, the effectiveness of coordination and technical capacity still needs improvement. Without strong coordination, the implementation of operation and maintenance activities cannot be carried out optimally.

The documentation aspect, with a score of 2.85 out of 5, indicates that administrative records and irrigation data are not well organized. Incomplete and irregular data recording makes it difficult to conduct monitoring and evaluation, which in turn affects decision-making processes related to maintenance and rehabilitation planning. Furthermore, the institutional performance of Water Users Associations (P3A) scored 4.20 out of 10, indicating weak performance. Limited participation of members, lack of coordination, and insufficient understanding of irrigation management responsibilities reduce the effectiveness of collective water management. This condition contributes to suboptimal maintenance practices and uneven water distribution.

These findings are generally consistent with other irrigation performance studies, which show that low IKSI values are commonly associated with poor infrastructure conditions and weak institutional capacity. However, compared to irrigation systems with better management practices, the performance in the Rejosso Irrigation Area is relatively lower, particularly in terms of supporting facilities and institutional effectiveness. Overall, the results indicate that improving irrigation performance requires an integrated approach that includes physical rehabilitation of canals, enhancement of supporting facilities, strengthening of institutional capacity, and improvement in documentation systems. Without addressing these aspects simultaneously, the irrigation system will continue to operate below its optimal capacity

## DISCUSSION

The Irrigation System Performance Index (IKSI) in the Rejosso Irrigation Area was evaluated based on six main aspects, namely physical infrastructure, crop productivity, supporting facilities, organization/personnel, documentation, and Water Users Associations (P3A) institutional performance. Each aspect was assessed using a weighted scoring system.

### 1. Physical Infrastructure Aspect

The physical infrastructure aspect obtained a score of 30.58 out of 45, indicating that the condition of the irrigation canals is below optimal performance. This low score is primarily caused by sedimentation, structural deterioration, and reduced flow capacity, as observed in several canal segments. These physical issues directly affect hydraulic efficiency, leading to water losses and uneven distribution. The findings are supported by the condition assessment in Table 5, where the BRJKI.2 segment shows severe damage (65.83%), requiring major rehabilitation. This indicates that damage is not only localized but has a systemic impact on the network. Poor physical conditions in upstream or midstream sections can significantly reduce water availability in downstream areas, highlighting that infrastructure degradation is a key factor influencing overall IKSI performance.

### 2. Crop Productivity Aspect

The crop productivity aspect scored 9.75 out of 15, indicating moderate agricultural performance. However, this value reflects underlying issues in water distribution rather

than purely agricultural factors. Uneven irrigation supply causes variability in crop yield, particularly between upstream and downstream areas. Farmers in upstream locations tend to receive sufficient water, while downstream farmers experience shortages, especially during peak irrigation periods. This imbalance suggests that the irrigation system has not yet ensured equitable water allocation, which is essential for achieving optimal productivity.

### 3. Supporting Facilities Aspect

The supporting facilities aspect obtained a score of 4.66 out of 10, which indicates inadequate infrastructure for irrigation operation and maintenance. This condition is mainly due to the limited availability of measurement tools, maintenance equipment, and monitoring facilities. The lack of supporting facilities reduces the ability of operators to control water discharge accurately and respond to field conditions. As a result, maintenance activities tend to be reactive rather than preventive, allowing minor damages to develop into more serious structural problems. This explains why physical infrastructure degradation is still found in several canal sections.

### 4. Organization / Personnel Aspect

The organization/personnel aspect scored 12.26 out of 15, indicating that human resources are relatively adequate. However, this score does not fully reflect operational effectiveness. Field findings suggest that coordination between personnel is still weak, and technical capacity in irrigation management is not evenly distributed. Although staff are available, the lack of structured coordination and clear task implementation reduces the efficiency of operation and maintenance activities. This condition shows that human resources alone are not sufficient without strong organizational management.

### 5. Documentation Aspect

The documentation aspect obtained a score of 2.85 out of 5, indicating that data management and administrative recording are not well organized. This is reflected in incomplete, inconsistent, and irregular documentation of canal conditions and maintenance activities. Poor documentation limits the ability to conduct systematic monitoring and evaluation. Without accurate data, decision-making related to maintenance and rehabilitation becomes less effective and often delayed. This contributes indirectly to the worsening condition of the irrigation infrastructure.

## 6. Water Users Associations (P3A) Institutional Aspect

The institutional aspect of Water Users Associations (P3A) scored 4.20 out of 10, indicating weak institutional performance. This is mainly caused by low member participation, limited coordination, and lack of understanding of irrigation management responsibilities. As a result, collective activities such as canal cleaning, maintenance, and water distribution management are not carried out optimally. Weak institutional capacity also reduces the sustainability of irrigation management, as community involvement is a key factor in maintaining system performance at the tertiary level.

## Overall Result

When compared with previous studies on irrigation performance assessment, the IKSI value obtained in this study is relatively similar to several irrigation systems that are categorized as having low to moderate performance. Previous studies generally report IKSI values ranging between 60%–70%, indicating that many irrigation systems in similar regions face common challenges such as deteriorating physical infrastructure, limited supporting facilities, and weak institutional management. However, some well-managed irrigation systems have achieved higher IKSI values above 75%, which fall into the good performance category. This comparison shows that the condition of the Rejoso Irrigation Area is still below optimal standards and reflects similar structural and managerial issues found in other irrigation systems, particularly in developing regions. Therefore, improvements in infrastructure maintenance, enhancement of supporting facilities, and strengthening of Water Users Associations (P3A) are necessary to improve overall irrigation performance.

## CONCLUSION

Based on the objective of this study, which is to evaluate the performance of the irrigation network using the Irrigation System Performance Index (IKSI) method, the results show that the overall IKSI value in the Rejoso Irrigation Area, covering the Rejoso Kiri and Jati secondary canals, is 64.3%. This value is classified as “poor and requires attention,” indicating that the irrigation system has not yet functioned optimally in supporting agricultural water needs. The results also confirm that the IKSI value represents a combined performance of all evaluated secondary canals, reflecting the overall system

condition rather than individual canal performance. Among the six assessed aspects, the most critical conditions are identified in the physical infrastructure (30.58/45), supporting facilities (4.66/10), documentation (2.85/5), and institutional performance of Water Users Associations (P3A) (4.20/10). These aspects show significant deficiencies that directly affect water distribution efficiency and system reliability.

The main problems observed include sedimentation and structural damage in canal sections, particularly those requiring major rehabilitation, limited availability of operation and maintenance equipment, incomplete and irregular documentation systems, and low participation and coordination within P3A institutions. These interconnected issues contribute to uneven water distribution, especially in downstream areas, ultimately affecting agricultural productivity. In contrast, the crop productivity (9.75/15) and organization/personnel (12.26/15) aspects show relatively better performance; however, their effectiveness is still constrained by the limitations in technical and institutional support. Therefore, practical recommendations for improving irrigation system performance should prioritize both technical and non-technical interventions. From a technical perspective, routine and periodic maintenance activities such as sediment removal, canal cleaning, and targeted rehabilitation of severely damaged sections must be implemented consistently. Additionally, the provision of adequate supporting facilities, including measurement tools and maintenance equipment, is essential to improve operational control.

From a non-technical perspective, strengthening institutional capacity of P3A is crucial through increasing farmer participation, improving coordination, and providing technical training related to irrigation management. Furthermore, improving documentation systems through regular data recording and monitoring is necessary to support effective decision-making in operation and maintenance planning. Overall, integrated improvements in infrastructure condition, operational support, documentation, and institutional performance are required to enhance irrigation system reliability and ensure sustainable agricultural productivity in the Rejoso Irrigation Area.

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