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The Influence of Operation and Maintenance Activities on Improving the Performance Index of The Downstream Karang Agung Tidal Swamp Irrigation Area, Banyuasin Regency, South Sumatera Province

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Abstract

Karang Agung, Banyuasin Regency, South Sumatra Province, Indonesia is made up of a tidal SIA of 9,777 Ha (PUPR, 2020) at the downstream. The Performance Assessment conducted by the Ministry of Public Works and Public Housing obtained a poor Performance Index (PI) of 44.55 on a scale of 100 (PUPR, 2019). Presently, the Indonesian Government is trying to improve operational performance to obtain better agricultural production in an effort to achieve Rice Self-Sufficiency by determining the irrigation system performance. The components measured include (1) calibration of discharge measurement results, (2) annual water supply, (3) implementation of water distribution and provision, (4) arrangement of gates on the dam, (5) arrangement of mud pockets, and (6) P3A (Farmers Association of Water Users) activities. In 2022, the Performance Value of the Downstream Karang Agung Swamp Irrigation Area (SIA), obtained a NIK (Performance Index Value) of 70.65 after Operation and Maintenance (OM). The water level in the irrigation channel was between 0.1 m and 0.4 m from May to August, with a land pH value of 4 - 5, which was unsuitable for rice plants. Therefore, in May-August, the plants were replaced with horticulture with a planting pattern of 1:2, which increased the OM costs to IDR 1,844,642,214.42. The total amount was obtained from OM budget at 10% with a standard Cost per Ha, which led to a low NPV.

Keywords: *Tidal SIA, Operation Maintenance, Performance Index.*

INTRODUCTION

Operation and Maintenance (OM) is an irrigation water management activity that must be carried out in accordance with the guidelines and Regulation of the Ministry of Public Works and Public Housing PUPR (2015). This was aimed to achieve efficient and effective functioning of water resource infrastructure. Swamp irrigation network operations are efforts to regulate irrigation water and discharge, including opening and closing the gates, preparing planting pattern, and water distribution plans, designing calibrations, collecting, monitoring, and evaluating the acquired data. Meanwhile, swamp irrigation network maintenance is defined as an effort to preserve and secure the networks, enabling proper functioning. This also included facilitating the implementation of operations, to maintain effective performance (PUPR Regulation number 16, 2015).

Based on the research by Subhan (2020) and Dana (2019), the irrigation system in Indonesia had experienced a decline in performance caused by certain conditions, leading to improper functioning. This was because OM activities had not been carried out according to existing procedures. The research location, Downstream Karang Agung SIA, Banyuasin Regency, South Sumatra Province, Indonesia has a standard area and potential of 9,777 Ha.

In view of this, the irrigation system Performance Index (PI) determines the performance level, resulting in the measurement of certain components (Pani, et all, 2021). These includes (1) calibration of discharge measurement results, (2) annual water supply, (3) implementation of water distribution and provision, (4)

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arrangement of gates on the dam,(5) mud pockets, as well as (6) Farmers Association of Water Users (P3A) activities.

METHODOLOGY

Research Location

The research location is geographically situated between 2°14'55.03"S. - 2°14'54.79" Southern Latitude and 104°37'41.99" E - 104°45'58.24" East Longitude. It is also characterized by the following area identification, (a). Standard area 9,777 ha, (b). Potential Area 9,777 ha, (c) Functional Area 1,350 ha.

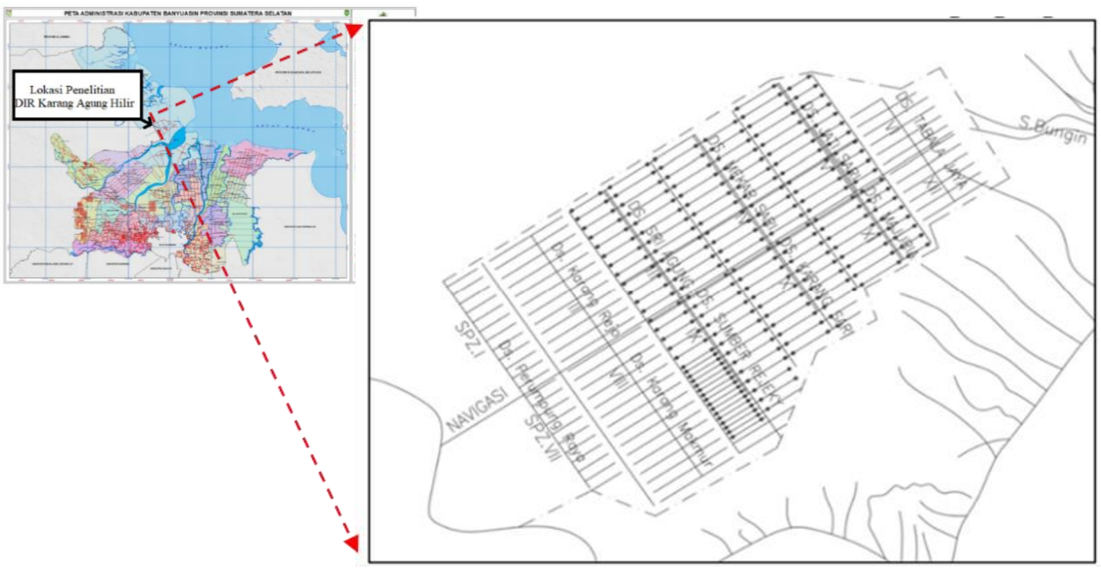

Figure 1. Schematic of the Irrigation Network of the Downstream Karang Agung Swamp

Research Methods

Channel Performance

The condition of the channel comprising three parts, namely (a). wet cross-section, (b). berm, and (c). embankment, was assessed (Bakti et al, 2023).

The assessment was carried out by weighting the wet cross-section Performance Index (PI), berm, and embankment conditions using equation (1),

PI = (Wet cross-section IC x W1) + (Berm PI x W2) + (Embankment PI x W3) /(W1+W2+W3) …….. (1)

where

W1= wet section weight

W2= Berm weight

W3= Embankment weight

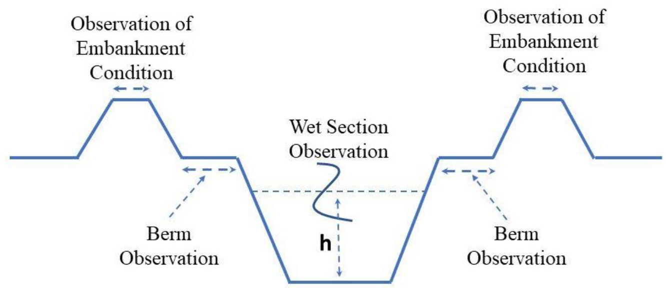

Figure 2. Shows sections of the condition of the irrigation channels in the measured swamp area.

The values of W1, W2 and W3 depict the relative weights of the wet cross-section, berm and, embankment – supporting the channel to drain water. Therefore, the weight of W1 > W2, and W2 > W3, with the ratio (a). W1 = 3, (b). W2 = 2, and (c). W3 = 1. In order to determine the existing condition in terms of water flow, measurement of the discharge is carried out at the ends of the channel, as stated in the following equation (Parra et al, 2020).

$$Q = V\ .\ A \qquad (2)$$

where Q Channel discharge (m^3/s)

V Flow velocity (m/s)

A Wet cross-sectional area (m^2)

Strickler method

The Strickler method was used to obtain the following equation (Cheng, 2017),

$$V = K^s R^{2/3} S^{1/2} \qquad (3)$$

Where

V is the average flow velocity (m/s),

Ks is the Strickler coefficient,

R is the hydraulic radius (m),

S is the slope or hydraulic gradient of the channel.

The Strickler coefficient was used to obtain (1) fine concrete channel = 70-90, (2) coarse concrete channel = 60-75, (3) natural soil channel = 30-50, rocky channel = 20-30, (4) natural river with gravel base = 30-40, and (5) natural river with vegetation = 10-30.

Channel K represents the total/combined (aggregate) conditions of W1, W2 and W3. The value of channel PI is within the range of one to five, namely (a). I1 (0-1), (b). I2 (> 1-2), (c). I3 (> 2-3), (d). I4 (> 3-4), and (e). I5 (> 5). In addition, the lesser the IK value, the better the channel function.

The interpretation of the channel PI values is as follows

(a). PI 1 functions between 76% to 100%,

(b). PI 2 functions between 51% to 75%,

(c). PI 3 functions between 26% to 50%,

(d). PI 4 functions between 1% to 25%,

(e). PI 5 very poor 0%.

By using interpolation, the channel function can be determined based on the PI value. For example, PI = 2.46 is equivalent to the channel condition = 50% - (2.46-2.0) / 1 x 25 = 50% - 11.5 = 38.5% (channel functions 38.5%).

RESUTS AND DISCUSSION

Performance Index (PI) of Downstream Karang Agung

In accordance with the irrigation network scheme, the Downstream Karang Agung has an area of 9,777 Ha covering a major canal, eight secondary canals and 161 tertiary canals, with an average production yield of approximately 4.5 tons to 5.6 tons annually.

Table 1 Performance Index Assessment in 2021 and 2022

Water Level Conditions During One Year						
No.	Chanel	High water level (m)	Month	Minimum high Water level (m)	Fase	Condition
1	Primary Navigation I	1,1	January	-	Generatif	
2	Secondary Channel III	0,6	January	0,5-0,6		Fulfilled
3	Tertiary Channel 1-KA.SPZ-III	0,2	January	0,2-0,5		Fulfilled
4	Primary Navigation I	0,9	February	-	Growth	
5	Secondary III	0,5	February	0,3		Fulfilled
6	Tertiary Channel 1-KA.SPZ-III	0,2	February	0,1-0,2		Fulfilled
7	Primary Navigation I	1,2	March	-	Harvest	
8	Secondary III	0,6	March	-		-
9	Tertiary Channel 1-KA.SPZ-III	0,2	March	-		-
10	Primary Navigation I	1,4	April	-	Dry soil	
11	Secondary III	0,7	April	-		-
12	Tertiary Channel 1-KA.SPZ-III	0,2	April	-		-
13	Primary Navigation I	1,1	May	-	MT II Palawija (PH Condition 4-5)	
14	Secondary III	0,5	May	0,2-0,5		Fulfilled
15	Tertiary Channel 1-KA.SPZ-III	0,2	May	0,1-0,3		Fulfilled
16	Primary Navigation I	0,5	June	-		
17	Secondary III	0,2	June	0,2-0,5		Fulfilled
18	Tertiary 1-KA.SPZ-III	0,1	June	0,1-0,3		Fulfilled i
19	Primary Navigation I	0,4	July	-		
20	Secondary III	0,2	July	0,2-0,5		Fulfilled
21	Tertiary 1-KA.SPZ-III	0,1	July	0,1-0,3		Fulfilled
22	Primary Navigation I	0,6	August	-		
23	Secondary III	0,3	August	0,2-0,5		Fulfilled
24	Tertiary 1-KA.SPZ-III	0,1	August	0,1-0,3		Fulfilled
25	Primary Navigation I	0,5	September	-	Preparation MT 1	
26	Secondary III	0,3	September	-		-
27	Tertiary 1-KA.SPZ-III	0,1	September	-		-
28	Primary Navigation I	1,6	October	-		
29	Secondary III	0,8	October	-		-
30	Tertiary 1-KA.SPZ-III	0,3	October	-		-
31	Primary Navigation I	1,1	November	-	Vegetatif	

32	Secondary III	0,5	November	0,3-0,5	Fulfilled
33	Tertiary 1-KA.SPZ-III	0,2	November	0,1-0,2	Fulfilled
34	Primary Navigation I	1,2	December	-	
35	Secondary III	0,6	December	0,3-0,5	Fulfilled
36	Tertiary 1-KA.SPZ-III	0,2	December	0,1-0,2	Fulfilled

PI assessment was carried out by field survey, monitoring the Irrigation Network (IN) by measuring the water level. The results of the survey (Table 1), showed that the lowest and highest water levels were detected in June and October at 0.03m and 0.8m during the dry and rainy seasons, respectively.

Based on this, Figure 2 shows that the Planting Season (MT) MT-1 occurred within November to February, due to the availability of sufficient water for the rice plants. The harvest season occurred in March, because it does not require water, while April is a non-planting period, usually after MT1. From April to September, the water pH is within 4 to 4.7 while the availability is insufficient, due to the dry season. This led to the planting of secondary crops, such as corn and cassava.

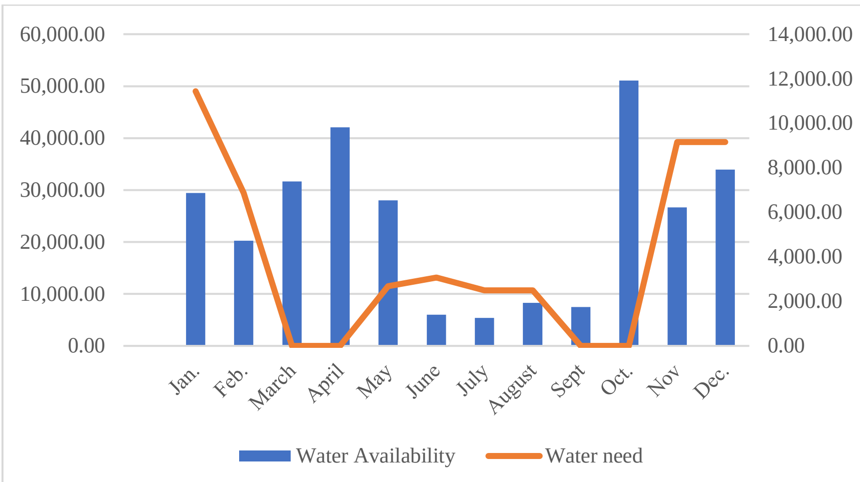

Figure 3 Graph of Water Availability and Needs

Performance Index Analysis

In line with the acquired data, the results of the PI assessment obtained between 2021 and 2022, after carrying out OM activities, are shown in the following Table 2.

Based on the comparison of the performance index assessment in 2021 and 2022, it was inferred that maintenance activities had a significant influence with an overall percentage weighting of 60% of the 100% scale comprising physical infrastructure and planting productivity. Meanwhile, operational activities had an overall percentage weighting of 40% of the 100% scale constituting supporting facilities, personnel organizations, documentation and water user farmer associations. In 2021 and 2022, a decrease in the Performance Index Value (PIV) of -1.53% was recorded due to rehabilitation maintenance activities that disrupted irrigation optimization.

Table 2. Performance Index Assessment 2021 and 2022

No.	Description	Year, 2021 Weight	Year, 2021 Total	Year, 2022 Weight	Year, 2022 Total	difference	Types of Work
		%	%	%	%	%	
1		2	3	4	5	6	8
1	Physical Infrastructure	29,02	41,28	27,49	39,75	-1,53	Maintenance
2	Planting Productivity	12,26		12,26			
3	Supporting Facilities	5,4	29,4	5,4	30,9	1,5	Operation
4	Personnel Organization	12,75		12,75			
5	Documentation	4,25		4,25			
6	Association of Water Users Farmers (P3A)	7		8,5			
Performance Index Assessment			70,68		70,65		

This included irrigation channels that were dredged, due to accumulated sediment, several landslide channels, full of weeds or aquatic plants, and damaged water gates. However, there was an increase of 1.5% in operational activities such as meetings, including the participation of GP3A/IP3A and P3A/GP3A/IP3A members in network monitoring tasks. The value was quite minimal, only 1.5%, depicting operational activities had an insignificant influence on the irrigation performance index.

The comparison of the performance index assessment carried out in 2021 and 2022, showed that maintenance activities had a significant influence. The percentage weighting level was 60% of the 100% scale, comprising physical infrastructure and planting productivity.

CONCLUSION

In conclusion, the performance of DIR Karang Agung, based on observations of water level conditions, in MT 1 for rice plants was only assessed once from November to February. While the other months were used for the cultivation of secondary crops.

The influence of OM on the irrigation IP had increased water availability, and in accordance with the analysis, the vegetative period required 9,150 m^3 of water/month, with the availability of water being 33,918 m^3/month. In the generative season, 11,438 m^3 was required monthly, while the availability of water was 29,448 m^3/month. During land processing, a discharge of 6,862 m^3/month was needed, with the availability being 20,221 m^3/month. In the planting of secondary crops, the largest water requirement of 3,068 m^3/month, was recorded in July, with an availability of 6,035 m^3/month.

OM tasks that had an influence on the DIR Karang Agung irrigation IP, included maintenance activities of 45%, and 15% for physical infrastructure and planting productivity resulting in a total of 60%. While operational activities consisted of 10%, 15%, 5%, and 10% for supporting facilities, personnel organization, documentation and P3A, respectively amounting to a total of 40%.

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