



Original Article

The Effect of Operator Performance on the Condition of Sewage Sludge Treatment Plants

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Abstract:

Since 2019, Jayapura City has had a Wastewater Management Operator, but the city's Safe Sanitation target has not been achieved. This study aims to analyze the effect of operator performance on the condition and operational effectiveness of the Septage Treatment Plant (STP). Using a quantitative approach, this study explores the relationship between the Service Aspect, Financial Aspect, Operational Aspect, & Human Resource Aspect of the Wastewater Operator, to the physical condition and performance of the STP. The results showed that the performance of the Jayapura City UPTD PALD operator is still less than the performance standard, this can be seen from the Performance Index worth 4.542 points (category D). The operator performance factor that has the most significant influence on the condition of the Koya Koso STP is the Operational Aspect. This aspect only contributes 0.688 points out of a potential maximum score of 2 points. This is in line with field conditions, where a series of treatment units are no longer functioning normally. This study provides recommendations for light rehabilitation, especially in the processing unit, and intensive supervision in the implementation of the Technical SOP, so that the STP can return to normal functioning.

Keywords: Fecal Sludge, Operator, Performance, Safely Managed Sanitation.

Introduction

The increase in population in Jayapura City requires support for basic infrastructure, particularly sanitation. The provision of adequate sanitation infrastructure is a prerequisite for a healthy urban community. One of the goals of sanitation development is to improve access to adequate sanitation and achieve safe sanitation by 2024. This aligns with the objectives of the National Medium-Term Development Plan (RPJMN) 2020-2024. Safe sanitation refers to sanitation facilities owned by households that are connected to septic tanks. Access to safe sanitation



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typically involves regular pumping every 3-5 years, with the waste disposed of at a Sewage Sludge Treatment Plant (IPLT). However, based on calculations of safe sanitation access conducted by the Jayapura City Government with assistance from the USAID IUWASH Resilient Program, the data on safe sanitation access for Jayapura City in 2024 is 0.4%. This figure is still far from the national target of 70% for safe sanitation access. The author's assumption in meeting the Safe Sanitation access target is that one of the important things that needs to be prepared is the Sewage Sludge Treatment Plant (IPLT). The Sewage Sludge Treatment Plant is a wastewater treatment facility designed to receive and process sewage sludge that will be transported via sewage trucks. Sewage sludge treatment at the IPLT is an advanced treatment process because the sewage sludge that has been treated in septic tanks is not yet suitable for disposal into the environment ([data.pu.2024](#)).

In this study, the author aims to determine the influence of operator performance on the condition of the sewage sludge treatment plant, to understand the existing conditions, and to identify the technical reasons why the Safe Sanitation target has not yet been achieved. The research was conducted at the Sewage Sludge Treatment Plant (IPLT) in Jayapura City over a period of two months. The location is in Koya Koso village, Muara Tami District, Jayapura City. This facility serves as the final treatment site for sewage sludge generated from domestic activities in the city of Jayapura. The treatment system employs stabilization ponds, optimizing the use of decomposing bacteria to break down pathogens in wastewater. The Koya Koso IPLT was constructed in 2017 and officially put into operation in 2019. The facility has a processing capacity of 15 cubic meters per day. [Since 2019](#), the facility has been managed by the Jayapura City PALD UPTD.

This study is a quantitative research where the researcher collects and analyzes data in numerical form to address the research problem statement. The instrument used is an observation sheet for assessing the condition of the Koya Koso Wastewater Treatment Plant in Jayapura, which refers to the standards outlined in the IPLT Planning Guidelines Book A issued by the Directorate General of Public Works and Housing (PUPR) Ministry. Meanwhile, to assess the performance of the operator, the instrument used is a structured interview guideline, which refers to the Technical Guidelines for Performance Assessment of UPTDs also issued by the Directorate General of Public Works and Housing (PUPR).

Results

Sub 1 Analysis of the Physical Condition of Sewage Sludge Treatment Facilities

The physical condition assessment of IPLT as a form of evaluation is carried out using an approach to assess the level of damage to buildings based on Minister of Public Works Regulation No. 24/PRT/M/2008. The aspects of assessment reviewed are structural condition criteria and functional condition criteria. The structural condition of the infrastructure is in accordance with the design plan.

Based on Ministry of Public Works Regulation No. 12/PRT/M/2015, the level of damage to assets is evaluated based on four damage criteria. These assessment criteria are as follows:

- 1) Good condition, if the damage level is < 10% of the initial condition of the building/channel.
- 2) Slightly damaged condition, if the damage level is 10-20% of the initial condition of the building/channel.

3) Moderately damaged condition, if the damage level is 21-40% of the initial condition of the building/channel.

4) Severely damaged condition, if the damage level is >40% of the initial condition of the building/channel.

In addition to physical condition, buildings must also be assessed from the perspective of their functional condition, in accordance with their intended use. This aspect is known as functional condition assessment. The criteria for functional condition assessment include:

1) Good function, meaning it still functions as intended when designed and constructed, with the capacity to safely convey water and full operational capability.

2) Poorly functioning, with a decline in hydraulic water flow functionality, possibly due to inadequate maintenance and sediment buildup (silt).

3) Severely poorly functioning, if the functionality is indicated by changes in the physical condition of the structure, which will reduce the functionality of the structure and require immediate attention and repairs.

4) Non-functional, if the asset with this criterion can no longer function at all, thereby potentially affecting service performance.

The assessment of the overall condition of the treatment unit, both physically and functionally, is conducted by evaluating the condition of the Separation Solid Chamber (SSC), anaerobic pond, facultative pond, maturation pond, Constructed Wetland, and sludge drying pond.

The results of field observations were discussed for each sewage sludge treatment unit. The analysis was conducted on five IPLT Koya Koso treatment units, namely:

Solid Separation Chamber (SSC)

From the physical condition observations, out of 8 evaluation criteria for the SSC tank, only 2 criteria met the standards: the presence of a screen/bar screen and the slope of the tank floor. When calculated as a percentage, the physical condition score is 25%.

Meanwhile, the results of the functional condition observation indicate that the SSC tank is no longer functioning normally. There is no filter medium to separate solids and liquids, so solid particles enter the anaerobic pond. The connecting pipe to the anaerobic pond is also leaking and detached, causing liquid to overflow into the backyard of the SSC tank. It can be concluded that this building falls into the category of "Very Poor Functioning."



Anaerobic Pond

Based on the physical condition observation results, out of 4 assessment indicators, the Anaerobic Pond meets the standards for 2 criteria, namely pond depth and length-to-width ratio. When expressed as a percentage, the physical condition value is 50%. Meanwhile, the results of the functional condition observation indicate that the anaerobic pond is still functioning normally on the right side. The left side of the pond is no longer connected to the SSC tank. Additionally, evidence was found that sewage sludge is often disposed of directly without passing through the SSC tank. This activity is carried out outside of the operator's working hours. It is concluded that this structure falls into the “poorly functional” category.



Facultative Pond

The observation results indicate that the design parameters meet the design criteria. The existing condition of this pond consists of two pond units arranged in series, rectangular in shape with concrete construction. Based on field observations, there is a significant amount of brown algae on the upper surface of the facultative pond. The interconnection pipes to the maturation pond are in good condition. However, Pond 1

(on the left) is not functioning due to the absence of flow from the anaerobic pond. Out of 4 assessment indicators, the facultative pond meets 1 indicator. When calculated as a percentage, the physical condition value is 25%. Meanwhile, the observation results on functionality indicate that the facultative pond is still functioning normally, specifically the right-hand pond. The left side of the pond is no longer connected to the anaerobic pond. It is concluded that this structure falls into the category of poorly functioning.



Maturation Pond

The field visit results indicate that the design depth parameter of the maturation pond meets the design criteria. Out of 3 evaluation parameters, this structure meets all criteria, with a percentage of 100%. Regarding functionality, the existing condition of the maturation pond, which consists of two units made of concrete, shows no structural damage. However, only pond number 2 (on the right) is operational, filled with thick sludge. It is concluded that this structure falls into the category of underperforming.



Constructed Wetland

The current condition of the constructed wetland shows no structural damage visually, but there is thick sludge in the pond. It is suspected that sewage trucks are directly discharging into the wetland pond without passing through the SSC and stabilization pond. The ratio of the pond's length to width does not meet the design criteria. Out of the 5 evaluation criteria, the structure meets 2 design criteria, accounting for 20%. Regarding functionality, on-site observations reveal a flow from Pipe 1 (left side) toward the constructed wetland, while Maturation Pond 1 (left side) is not functioning. There is a strong suspicion of a leak, causing overflowing liquid from SSC Pond 1 to directly enter the constructed wetland pond. This is dangerous for the environment, as the liquid has not undergone treatment. It is concluded that this structure falls into the category of poorly functioning. Based on design criteria, the sludge drying pond does not yet meet the requirements. Additionally, due to its distance of approximately 30 meters from the SSC pond, this has been a concern for operators in transferring solids, as it is considered too far.

Furthermore, there is no drainage pipe for filtered water (filtrate) in the sludge drying tank. This needs to be installed to channel the remaining liquid for treatment in the stabilization pond. Out of 5 evaluation criteria, only 1 criterion is met, which amounts to 20% when calculated as a percentage.

This structure can still be used, but



Sludge Drying Bed (SDB)

Based on design criteria, the sludge drying pond does not yet meet the requirements. Additionally, due to its distance of approximately 30 meters from the SSC pond, this has been a concern for operators in transferring solids, as it is considered too far. Furthermore, there is no drainage pipe for filtered water (filtrate) in the sludge drying tank. This needs to be installed to channel the remaining liquid for treatment in the stabilization pond. Out of 5 evaluation criteria, only 1 criterion is met, which amounts to 20% when calculated as a percentage. This structure can still be used, but it requires the addition of filter media and the installation of a filtrate discharge pipe. In terms of functionality, this structure falls into the category of being less functional.



Sub 2 Performance Analysis of Management Operators

The analysis was conducted using official guidelines from the Directorate of Settlement Environmental Health Development, namely Technical Guidelines for Performance Assessment of Regional Technical Implementation Units for Domestic Wastewater Management (UPTD PALD) released in 2018.

The scope of the Performance Assessment of the Domestic Wastewater Management Technical Implementation Unit covers four aspects, namely:

Service Aspects

The service aspect describes the performance of the UPTD in achieving domestic wastewater treatment plant capacity and the speed of UPTD services.

Financial Aspects

The financial aspect describes the performance of the UPTD in its efforts to obtain an adequate budget for the implementation of services and the effectiveness of the UPTD PALD's expenditure management.

Operational Aspects

The operational aspect describes the performance of the UPTD in meeting the requirements/provisions for proper and correct domestic wastewater treatment.

Human Resources & Governance Aspects

The Human Resources and Governance aspect illustrates that the performance of the UPTD has been supported by sufficient human resources for the implementation of UPTD service governance.

Table 1. Recap of Performance Assessment of UPTD PALD Operators in Jayapura City

No.	Indikator	Skor Penilaian	Skor dikalikan Bobot
1.	Service		1,032

	1.1 Growth in the number of SPALD customers	0	0,000
	1.2 Level of Service Capacity Fulfillment of Treatment Plants	2	0,174
	1.3 SPALD Complaint Resolution Rate	2	0,138
	1.4. Level of fulfillment of fecal sludge removal (L2T2 or L2T3) and new customer demand (SPALD-T)	10	0,720
2.	Financial		2,088
	2.1 Availability of calculations for operational and maintenance costs for UPTD	0,760	0,228
	2.2 Optimization of revenue collection	2,600	0,780
	2.3 Effectiveness of UPTD expenditure management	3,600	1,080
3.	Operational		0,688
	3.1 Availability and implementation of technical SOPs for each SPALD subsystem	2,080	0,416
	3.2 Compliance with effluent quality standards for treated water discharged from treatment plants into receiving water bodies	0,000	0,000
	3.3 Sampling of effluent is carried out once a month.	0,000	0,000
	3.4 Treatment of sludge produced by the treatment plant	0,520	0,104
	3.5 Implementation of SPALD operations and maintenance	0,840	0,168
	3.6 Achieving the level of efficiency of the treatment plant	0,000	0,000
4.	Human Resources & Governance Aspects		0,864
	4.1 Effectiveness of human resource planning at UPTD	0,960	0,192
	4.2 Availability of organizational structure and work procedures for UPTD (job map and description/details of each position) for UPTD operations	0,680	0,136

	4.3 Availability of UPTD 5-year work plan documents	0,380	0,076
	4.4. Innovations made to facilitate services	0,640	0,128
	4.5 Implementation of the public satisfaction index survey	0,300	0,060
	4.6 Availability and implementation of administrative SOPs	1,360	0,272
TOTAL			4,672

The performance score of 4.672 indicates that the performance of the UPTD PALD in Jayapura City requires attention. When categorized in letter form, the score is D, which is a score that does not meet the standards/is insufficient. Out of the four aspects, none have reached the maximum target. The Financial aspect has the smallest gap between achievement and target, while the Service aspect has the largest gap between achievement and target. The Service aspect is the one that requires the most attention in efforts to improve UPTD performance. The following table presents the GAP between the Performance Achievement Score and the Maximum Performance Score for each aspect.

If observed, the aspect with the lowest contribution to performance is the Operational aspect. This aspect only contributes 0.688 points out of a potential maximum of 2 points, or only 34% of its maximum potential. This aligns with field conditions, where stabilization pond units such as the SSC Tank, Anaerobic Pond, Facultative Pond, Maturation Pond, and Construction Wetland are no longer operating properly. There are pipeline network damages, blockages at the SSC inlet, and hardened solid sludge throughout the stabilization pond system. The poor operational performance is primarily due to the failure of operators to properly implement the established technical standard operating procedures (SOPs). Processes such as solid waste removal, maintenance, minor repairs to the piping system, and routine testing of treated effluent are not being carried out properly. Additionally, operators have failed to prevent unauthorized trucks from directly discharging sewage waste into the stabilization ponds.

Table 2. The difference between actual results and targets for each aspect

Aspect	Score	Maximal Score	GAP
Services	1,032	3	1,968
Financial	2,088	3	0,912
Operational	0,688	2	1,312
Human Resources & Governance	0,864	2	1,136

Conclusion

Based on the analysis and discussion conducted in the previous section, the following conclusions were reached:

1. The performance of the UPTD PALD operator in Jayapura City is still below the

- performance standard, as evidenced by a Performance Index score of 4.672 points (category D);
2. The overall condition of the Koya Koso Wastewater Treatment Plant (IPLT) does not meet service standards, as the wastewater treatment facility cannot operate normally;
 3. There is a significant influence between operator performance and the condition of the Koya Koso IPLT;
 4. The operator performance factor with the most significant influence on the condition of the Koya Koso IPLT is the Operational Aspect. This aspect only contributes 0.688 points out of a maximum potential value of 2 points. This aligns with the field conditions, where the SSC Tank, Anaerobic Pond, Facultative Pond, Maturation Pond, and Construction Wetland no longer function normally for wastewater treatment.

Suggestion

Based on the research results, several recommendations are proposed:

1. Minor rehabilitation is needed, especially in the treatment unit. The pipe series from the SSC tank needs to be replaced, the sludge that has settled in the stabilization pond needs to be dredged, the filter media in the SSC tank needs to be replaced, and the location of the portal to prevent illegal dumping needs to be moved. The civil structure can still be used after minor rehabilitation;
2. Intensive supervision is needed, particularly in the implementation of technical SOPs at the UPTD PALD in Jayapura City. This is necessary to improve the performance of wastewater operators so that they can at least achieve standard performance (IPLT operating normally);

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