

# Operational Strategy Analysis of Septage Treatment Plant Performance Improvement in Blitar

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## ABSTRACT

The Septage Treatment Plant (IPLT) in Blitar City had a design capacity of 30 m<sup>3</sup>/day and had been in operation since 1992. However, the design capacity has not been fulfilled as expected. This study aimed to evaluate performance and establish an operational strategy in order that IPLT can operate in accordance with its design capacity. This study was conducted by collecting data of septage production and evaluating the existing septic tank conditions in Blitar City. Quantitative descriptive analysis was used for the determination of operational strategies. The results showed the average quantity of suctioning septage was only 3.5 m<sup>3</sup>/day with septage production rate of 0.28 L/person/day. The number of septic tank that meets the SNI standard is 6.7%. The improvement of IPLT performance strategy was done by gradually improving septic tanks and implementation the scheduling of septic tank emptying (LLTT) with the need of 5 transport units. Septic tank repair could be done using investment from the government funds (APBD), grant funds, Corporate Social Responsibility (CSR) and micro credit. IPLT design capacity could be fulfilled after gradual septic tank repair and implementation of LLTT.

**KEYWORDS:** Septic tank, emptying schedule, design capacity

## INTRODUCTION

The Septage treatment plant (IPLT) was one component of the local waste water management system (on site system). IPLT was designed only for treating septage from an on-site system and transported using a trucks [1]. The main purpose of septage treatment was to reduce the content of organic substances and eliminate the content of pathogenic microorganisms [2]. One of the pathogenic bacteria possibly present in water contaminated with septage was *Escherichia coli* bacteria [3]. IPLT had been built as many as 150 units spread across the city. The operating rate of IPLT that had been built only reached 65% and some was no longer operational [4]. The operation of IPLT in Indonesia had several problems including technical and non technical elements. Technical elements related to the supply of sludge into IPLT and building processing units. The non-technical element related to the management of IPLT, the community's knowledge of the obligation to emptying of septic tank. One of the reasons for the unoptimized operational condition of IPLT was the supply of septage had not yet fulfilled the design capacity [5].

Blitar City had an IPLT built in 1992 with a design capacity of 30 m<sup>3</sup>/day. It was located in Blitar Sub-District Sukorejo District. Since it was operated from 1992 until 2016, the average number of septage entering IPLT was 0.8 m<sup>3</sup>/day, so there was an idle capacity of 98% [6]. It caused the stool suction business did not dump septage into IPLT. It was estimated that low septage production of the community septic tank served as a cubluk was due to cracking or leakage. Well-performing septic tanks generally required emptying at regular intervals of time (3 -5 years) due to the accumulation of septage. To our knowledge, the cause of that condition has not been studied yet.

The low demand for emptying septic tanks in Blitar City had implications on the small local revenue (PAD) of Rp. 14,265,000.-/year. The operational cost and maintenance of IPLT in Kota Blitar was Rp. 40,016,000.-/year [6]. In Blitar there were 27,950 houses having septic tanks [7]. These data suggest that the potential for septage produced by residents of Blitar City should be more considerable. A review of strategies to increase the supply of septage must be done to ensure the sustainability of IPLT operations. Increasing the supply of septage to IPLT could increase the retribution to support the operation and maintenance costs.

## METHODS

The research was conducted by quantitative descriptive method. Samples were taken from the management agencies of IPLT, other relevant agencies and communities in the study area. Shooting of field conditions was conducted to determine the condition of the existing septic tank population and the activity of emptying septic tank performed by entrepreneurs.

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### 1. Primary Data Collection

Primary data was obtained through interviews and the delivery of questionnaires to the respondents. Respondents were households with latrines complete with septic tanks. Primary data required include the size of the septic tank, the number of users, the age and the interval of septic tank emptying. Interviews were also carried out for entrepreneurs. The data obtained include the average amount of emptying septic tank activity and the average volume of septage septic tank. The number of respondents in this study was 200 households. It was calculated according to Regulation of The Minister of Public Works No.18/2007 [8]. The formula for determining the number of respondents was explained as follows:

$$n = \frac{Np(1-p)}{(N-1)D + p(1-p)} \quad (1)$$

$$D = \frac{B^2}{t^2} \quad (2)$$

Description :

n = number of samples

N = number of family = 42.934

p = ratio from element that has the desired properties ( p = 0.5 )

B = error rate of each sample (6%)

t = trust level (95%)

### 2. Secondary Data Collection

Secondary data was obtained from the management agency of IPLT and related institutions. Secondary data include data of population in Blitar City, number of septic tank users, number of transportation and capacity of IPLT.

### Data analysis

Analysis of survey data

The recapitulated survey results and calculated according to their respective categories. The same answer was collected to determine the percentage of other answers in the same data category.

Analysis debit of IPLT

The analysis of septage production rates was calculated based on the size of the septic tank, the number of occupants house and the emptying septic tank interval. The existing IPLT influent debits was calculated according to Regulation of The Minister of Public Works and People's Housing No.18/2007 No.4/PRT/M/2017 [9]. The formula was as follows:

$$Q = \% \text{ service} \times P \times q \quad (3)$$

Description :

Q = debit of IPLT (m<sup>3</sup>/day)

% = level of service IPLT

P = the number of people served

q = the productions rate of septage from septic tank (liter/person/day)

Analysis of IPLT capacity fulfillment with LLTT

The septage capacity entering IPLT was calculated based on the number of operating and capacity truck. The number of rotations the truck was calculated based on the distance of service.

Financial analysis

Financial analysis was done by calculating the operational and maintenance costs of LLTT implementation. The calculation of user charges was calculated based on the operational cost and maintenance of LLTT divided by the number of septic tanks served.

### Evaluation

Evaluation was done by comparing the existing condition with standard. Evaluation of existing septic tank conditions based on SNI 03-2398-2002 [10]. Evaluation of existing condition of IPLT based on IPLT design data. The preparation of IPLT processing capacity fulfillment strategy based on the analysis of existing condition.

## RESULTS AND DISCUSSION

### Evaluation of Existing Septic Tank Conditions

Based on questionnaire data on 200 respondents, 48 respondents stated that they had done emptying septic tank and 152 respondents had not. The average age of the respondent's septic tank was exceeded 10 years. The emptying of septic tanks should be done after the accumulation of septage was estimated to have reached one-third of the volume of the septic tank. This indication that the septic tank of 152 respondents was actually not a septic tank but a pit latrine. So water seep out of the tank and cause contamination of ground water. The effluent of a septic tank that seeps into the ground through the tank wall was more than the drain. This was supported by the results of well water quality testing on several respondent wells proven to be contaminated by *Escherichia coli* bacteria [11,12]. Septic tanks was considered to be the best waste water treatment, while land and water contamination was still occurring through permeation [13]. The average interval of emptying septic tank according to the respondents who had been drained was 7 years. The average septic tank volume is 3 m<sup>3</sup> and the average number of users is 5 people. The average septage production rate of septic tanks calculated based on the volume of the septic tank divided by the number of users and the emptying septic tank interval. The average rate of septage production from the respondent's septic tank is 0.28 liter/person/day.

### Evaluation Existing Conditions of IPLT Influent

The calculation of the quantity of septage produced by residents of Blitar City calculated from the number of activity emptying septic tank in Blitar City. The number of activity emptying septic tank performed by 4 stool suction services in Blitar City can be seen in Table 1.

**Table 1. FrequencyOf Septic Tank Emptying**

No.	Name of Company	Frequency of septic tank emptying / month (times)
1	CV. Central Jasa	15
2	CV. Sumber Rejeki	12
3	P. Jaclani	10
4	Environment Agency of Blitar City(DLH)	8
	Jumlah	45

Based on Table 1, the number of activity emptying septic tank in Blitar City in 1 month was 45 times. The volume of septage averaged 2 m<sup>3</sup> of septic tank. The quantity of septage produced is  $45 \times 2 \text{ m}^3 = 90 \text{ m}^3/\text{month}$  or 3.5 m<sup>3</sup>/day. Level of service of IPLT Blitar City on existing condition was calculated based on existing septage quantity of existing septage divided by IPLT capacity equal to 11,6%. The number of septic tanks that carried out in 1 year was 624 septic tanks. The calculation was based on the quantity of existing septage divided by the average volume of septage from a septic tank. If the emptying septic tank was done every 3 years, the number of septic tanks carrying out 1,872 septic tanks.

Septic tank who done emptying was a septic tank as per technical requirements. The technical requirements for septic tank construction include building materials must be strong, resistant to acid and watertight [10]. The percentage of standardized septic tanks is 6.7%. Determined based on the ratio of the number of septic tanks that emptying by the total number of septic tanks. The percentage of IPLT services was calculated based on the number of population served to the total population of Blitar City. The percentage of IPLT service in the existing condition is 6.2%.

Septage from emptying septic tank was taken by DLH Blitar City was taken to IPLT. Septage from emptying septic tank was taken by the private sector was taken apart to IPLT. Based on Table 1 could be seen the level of disposal of septage into IPLT. Calculated based on the number of suction activity that discharges septage into IPLT divided by total septage excretion activity. The value is 18%. This value indicates that there was still a small number of suction activity that dumps septage into IPLT.

The comparison of IPLT influent debits based on the design and analysis results (existing) as seen in Table 2.

**Table 2. Comparison of Influent Design With Influence Existing**

Description	Influent Design	Influent Existing
a. The number of people served	152,097	152,097
b. Level of service IPLT	40%	11.6%
c. The productions rate of septage from septic tank (liter/person/day)	0.5	0.28
d. Disposal of sludge into IPLT	100%	18%
Influent of IPLT (m <sup>3</sup> /day)	30	0.89

The quantity of influent from the analysis (existing) is 0.5 m<sup>3</sup>/day. This value was smaller compared to the design-based IPLT influent. Factors that cause the difference between the quantity of influent IPLT according to the design and the results of the analysis (existing) are as follows:

1. Percentage of population was done emptying septic tank only 6.2%
2. The production rate of septage used as the basis for calculation in the design of 0.5 liters/person/day. The value was higher when compared with the results of the analysis of 0.28 liters/person/day
3. The factor of the tendency of truck to dispose of septage to IPLT is only 18%.

### Restructuring of Septic Tank

Based on the above analysis, the low production of septage from population's septic tank was caused by the construction of septic tank which was not water-resistant. The water can seep out of the tank and reduce the number of septage. Therefore, it was necessary to restructure the population's septic tank by conducting septic tank construction in accordance with the Restructuring of septic tanks Standard not only to support LLTT program which was one of IPLT's capacity fulfillment strategies, but it also to improve public health status. Considering that 80% of the people in Blitar City are using well water to meet their daily needs, whereas well water quality test results showed that several respondents' wells contained *Escherichia coli* bacteria.

Implementation of septic tank development requires funding source. Some funding sources that could be used for septic tank development activities include: APBD, Local Wastewater Management Grants from the Ministry of Public Work and Housing, CSR and self-help by micro credit. The allocation of funds sourced from APBD for septic tank development was very limited, only for the construction of 30 septic tank units per year. To obtain grant funds, the regions were still struggling to finance the implementation of regional grants because they used reimbursement system. In addition to government funding sources, septic tank development should be funded from CSR. But the cooperation in the field of sanitation thus far was still not yet maximum. It was necessary to create a superior product that can attract the interest of CSR. One of the most effective funding options for septic tank development was microcredit. Through this micro credit, people could divide the cost into several parts. It was not too burdensome and more affordable. Payment could be made on a weekly or monthly basis which was usually done within a period of 1-2 years.

### Analysis of septage production by optimizing existing truck

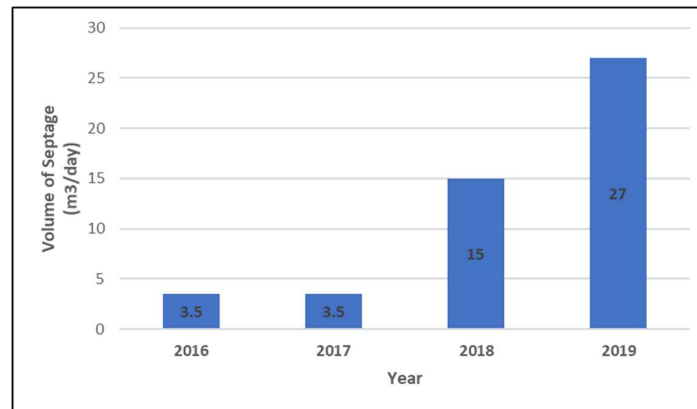
Truck was an important factor in IPLT operations. The truck was used to transport septage from septic tanks to IPLT. The number of truck in Blitar City can be seen in Table 2.

**Table 2. Number of Truck**

No	Name of Company	Capacity (m <sup>3</sup> )	Number (unit)
1	CV. Central Jasa	3,5	1
2	CV. Sumber Rejeki	2	1
3	Environment Agency of Blitar City(DLH)	3,5	1

The volume of septage was sucked of septic tank is 1.5 m<sup>3</sup> per. The number of rotations that could be done in 1 day as much as 2 rotations. 2 units of truck capacity of 3.5 m<sup>3</sup> capable transporting of septage was 12 m<sup>3</sup>/day. 1 unit of car with capacity 2 m<sup>3</sup> capable transporting of septage 3 m<sup>3</sup>/day. The optimization of 3 transport fleets could produce 15 m<sup>3</sup>/ day of septage in 2018.

In the year 2018 conducted procurement of 2 units of tank truck capacity 3.5 m<sup>3</sup>. The procurement of trucks was done by the Public Works and Spatial Planning Agency and the Environmental Agency of Blitar City. Procurement of trucks could be used for operations in 2019. The number of fleets in 2019 as much as 4 truck capacity of 3.5 m<sup>3</sup> and 1 unit of stool capacity of 2 m<sup>3</sup>. The optimization of 5 transport fleets can produce septage of 27 m<sup>3</sup>/day by 2019. The result of the analysis of the estimated septage results from the optimization of existing transport fleet operations was presented in Figure 1.



**Figure 1. Estimated Production of Septage**

Existing truck operations in 2018 focused in the promotion and socialization of planned implementation of the scheduling of septic tank emptying (LLTT). Promotion could be done by providing free sterilization service for 3000 septic tanks and communal WWTP. This is adjusted to the available the truck to emptying septage from septic tank of 15 m³/day. Blitar City Government must provide operational budget promotion in 2018. Promotional funding could be done through cooperation with CSR.

IPLT Capacity Fulfillment Analysis was with the scheduling of septic tank emptying (LLTT). The operations of the freight fleet should be supported by activities periodic emptying of septic tank. These activities was the scheduling of septic tank emptying programs (LLTT). The concept of LLTT implementation showed the period of emptying, the number of customers and financial estimates. A customer was a building that had a septic tank to be serviced by LLTT. Priority buildings that have potential as LLTT customers was as follows:

1. Government office building
2. School buildings
3. Health facility building
4. Public facility building / market building
5. Commercial building
6. Regular settlement building
7. Residential buildings are solid and irregular.

Number of customers that could be served for 1 LLTT (3 years) period by operating 5 transport fleets as many as 14,976 customers. The calculation of the number of services for the classification of customers each year in 1 LLTT period as in Table 3.

**Table 3. Number of services for each customer classification in 1 LLTT period**

Customer Classification	Number of services		
	Year 1	Year 2	Year 3
Government office building	17	17	17
School buildings	80	80	79
Health facility building	13	13	13
Public facility building	1	1	1
Commercial building	5	5	5
Residential buildings	4.749	4.749	4.748

#### **Operational Costs and Retribution LLTT**

In 2016, revenues received from septic tank emptying levies can not meet the operational costs of IPLT. Revenue from retributions could be sufficient for the operational costs of IPLT by implementing the LLTT program. Cost components for LLTT operations include personnel costs, operating costs of suctioning and transportation, maintenance costs and administrative costs. The cost required to pay the salary of an employee for an LLTT operation is Rp. 178,632,000.00/Year. The cost of suctioning consists of the cost of suction and the cost of fossil fuels of Rp. 563,472,000.00/year. The cost of truck maintenance consists of repair and replacement cost of truck spare parts of Rp. Rp. 76,640,320.00/year. Maintenance cost of processing unit consists of maintenance cost of processing unit, septage removal Rp. 28,829,040.00/year. Office administration costs consist of the cost of purchasing office supplies, influent and effluent testing, promotion and electricity amounting to Rp.

49,500,000.00/year. Based on the calculation of each component of operational and maintenance cost, the total operational cost of LLTT each year is Rp. 897,073,360,00.

The calculation of the basic levy of LLTT was done so the income of LLTT retribution could be sufficient for operational cost of LLTT. The basic levy was the average levy that be charged to LLTT customers but not the levy charged to LLTT customers. Customers levies was calculated based on the basic retribution taking into account the profitability plan. The calculation of basic levy based on operational cost divided by the number of subscribers, which is Rp. 4,992.00/month. The amount of LLTT customer levy was calculated by adding a profit of 10% of the basic LLTT levy, earned a value of Rp. 5,500.00/month. Levy for 1 LLTT (3 years) period of Rp. 198,000.00. Levy based on Peraturan Daerah Kota Blitar No. 7/2017 is Rp. 200,000.00 for once emptying of septic tank [14]. The result of LLTT retribution is smaller than the levy based on Peraturan Daerah Kota Blitar No. 7/2017.

Mechanism of payment of retribution of LLTT implementation could be done in 2 ways, namely regular payment and once payment. One payment is the payment of levies made after the customer receives a septic tank emptying service. Routine payment is the payment of retributions made gradually in the form of monthly payments in the hope of not incriminating customers. The levy payment mechanism is expected to integrate with existing payment systems.

## CONCLUSIONS

The low production of septage from septic tanks in Blitar City was due to non-water resistant septic tank construction. Implementation of septic tank recovery program and LLTT could fulfill the design capacity of IPLT in 2019. The operational and maintenance costs of IPLT could be fulfilled from retribution revenue if the LLTT program was running well.

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