Evaluation of Sustainable Community-Based Sanitation Communal Wastewater Treatment (Case Study of Metro City, Lampung)

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Abstract. Community-based Sanitation Communal Wastewater Treatment Plant (WWTP) is one of the solutions for dense urban areas to improve environmental quality. This paper evaluates wastewater treatment plant-based Community participation in Community-based Organization (CBO) Mandiri, Metro City, Lampung. The methods used are quantitative with laboratory tests from the effluent of Communal WWTP conducted in the dry season in September and qualitative with interviews with board members and local facilitators. Laboratory test results show that the BOD and Ammonia parameters do not meet the standard requirements of the Ministry of Environment and forestry Regulation 68 of 2016 about the quality standard of domestic wastewater. The activities of the WWTP management group at CBO Mandiri did not run well and needs help for the government fundings to maintenance WWTP. New biofilter WWTP component and zeolite are necessary to reduce total coliform, BOD, and ammonia’s concentration of effluent and hold socialization for local community involvement to every process in this program.

1. Introduction

In 2015, around 13% of world population used toilet where the wastewater flushed to the nearest water body [1] Domestic wastewater is water that is used by human and contained with human waste (feces and urine) and along with water which is used to flush toilet, dishwasher, and kitchen waste [2]. In Indonesia, the houses which have proper sanitation is in the percentage of 67,80% in 2016. While the rate of appropriate sanitation facility in the urban area is 30% than in the rural area [3]. However, three-quarter of urban housings in Indonesia has a toilet. Still, the regional government surveillance is limited and low so that the public houses dispose of domestic wastewater in an unsafe way [4].

The proper toilet facility is a toilet which is connected with the septic tank or a canal that delivers it to domestic wastewater treatment, both onsite and offsite in the developing country with sanitation access problem such as are Indonesia. The access to proper and closed septic tanks in Indonesia, which also completed with Wastewater Treatment System is only 15,5% [1], [5]. The wastewater treatment system which is managed by the society is the opportunity of relatively quick sanitation improvement in the environment with a high priority which can be achieved by a community. Centralized or communal wastewater treatment can be functional in the location where the settlement density or high non-permanent settlement. The system would be beneficial if there were a limited area to build individual septic tanks, flood-prone space, and inadequate water resource [4].

1.1 Wastewater treatment system

Society Sanitation Program uses communal wastewater treatment which is similar to the concept of Bremen Overseas Research and Development Association (BORDA). This technology can be built and operated without a particular device, chemical and electric energy [6]. In the treatment of BORDA [7], it explained that the excellent treatment consists of sedimentation/ settler, second treatment with
filter, wetland treatment and aerobic/anaerobic treatment. However, in Indonesia uses the technology of Shared Bathroom or MCK+ and Wastewater Treatment and piping [8]; and domestic wastewater treatment uses the concept of BORDA which uses settler and filtration baffle (see figure 1). This domestic wastewater treatment system is in line with the research of Davies [9] that technology in CBO Program with low-cost sanitation improvement followed with reduced maintenance.

The Ideal Communal wastewater treatment [10] is going through primary treatment in sedimentation, secondary treatment, secondary aerobic treatment, and final treatment (figure 2). According to the laboratory-scale research, the primary and secondary waste treatment that uses Anaerobic Baffled Reactor (ABR) can reduce the COD rate to 80 per cent and can be a solution as the easy treatment and low cost [11].

![Figure 1. BORDA wastewater treatment concept [7]](image)

### 1.2 Community-based sanitation program

One of the programs of improved sanitation facility building with centralized wastewater treatment is called Community-based Sanitation. “Sanitasi Berbasis Masyarakat” (Sanimas) or Community-based Sanitation is a program focus in triggering behavioural changes to the sanitation [12]. Sanimas Program aims to change lousy sanitation environment in the high population settlement by providing the fund to build the facility of Wastewater Treatment System (WWTP), so the community can dispose the domestic wastewater to the treatment, and the sewer can be treated to be cleaner [4]. Community-based sanitation focuses on the behavioural changes compared to the sanitation infrastructure construction. This behavioural change is built through the simulation process by the facilitator [12]. The program implements the principle of society works together rather than works individually and focuses on reducing the number of open defecation [13].
Roma and Jeffrey research [14] proves that there is a relation between participation in Sanimas program with the feeling of inclusive and responsible of users in the maintenance and paying for technology improvement. According to Luthi et al. research [13], the community-based Sanitation program in an urban area has an advantage in triggering the community to develop empowerment and become a tool of changes into healthy life behaviour. However, the challenge to the Community-based Sanitation in Urban Areas is a government policy and technology funding [13]. Case study of community-based sanitation implementation in Indonesia concludes that the participation of the society in every process can improve the ownership of the community to the related technology [14]. One of the ways is to improve the life quality of society by improving sanitation to reduce poverty [15]. The community has to be an independent community for sustainable development; one of the ways is by raising society self-subsistent [14], [15]. However, in the implementation, the organization faces a financial problem [16]. Therefore, this research evaluates the Wastewater Treatment System (WWTP) of community-based Sanitation participation which is in Metro City, Lampung in the aspect of environment, social and economy.

2. Research method

2.1 Research site

This research was conducted in Community-based Organization (CBO)’s Mandiri, which located in Sub-district Metro, Lampung and held on September 2018. This program connects and serve 4 (four) neighbourhood in sub-district Metro. This location is in an urban area and the region near the water canal where community usually dispose of their domestic wastewater.

2.2 Data analysis

This research used a quantitative method by measuring the quality of effluent parameter with the Regulation of Government of Indonesia Minister of Environment and Forestry 68 of 2016 about the Quality Standard of Domestic Wastewater. Test result compared with standard quality parameter from the Government of Indonesia Minister of Environment and Forestry Regulation. This research also used quantitative analysis with the qualitative method by field observation of wastewater treatment and interviewed with the one person of local facilitator and two members of the local operator of Community-based Organization (CBO) Mandiri, Lampung.

**Figure 2. Wastewater treatment process [10]**

Sedimentation
- Process of anaerobic fermentation of bottom sludge possible

Aerobic Digestion
- Settling of mineralised particles, collection of biogas

Aerobic and Facultative decomposition
- Settling of mineralised particles

Post-treatment
- Retaining of living and dead algae
3. Result and discussion

3.1 Environmental aspect

Wastewater Treatment System of (WWTP) in CBO Mandiri was built in 2017. This domestic wastewater treatment is made to change the behaviour of open defecation of the user community, which are in neighbourhood areas 06, 05, 03, and 10 Metro Village, Capital Metro Sub-district, Metro City, Lampung. A big water canal surrounds the user community, so it facilitates the community to dispose of domestic wastewater (toilet water, shower, and dishwater) to the water canal (see Figure 2). Besides, WWTP handles the housing, which has an individual septic tank that has never been treated and desludging. Therefore, WWTP is built to handle the pollution by domestic wastewater, and it is not disposed to the canal over the quality standard. The treatment in CBO Mandiri has the process of sedimentation and anaerobic management by using Anaerobic Baffled Reactor (ABR). The design of ABR Treatment is in the form of insulation baffle with four to six partitions [17], but WWTP in CBO Mandiri has consisted of eight barriers. This WWTP of CBO Mandiri has bio-filter, which is in ABR baffle, which has the function to grow decomposer of organic material in human waste. The biofilter is built from recycled plastic bottles.

| Parameter     | Unit     | Quality Standards | WWTP CBO Mandiri |
|---------------|----------|-------------------|------------------|
| TSS           | mg/L     | 30                | 44               |
| pH            | -        | 6,0-9,0           | 6,9              |
| BOD           | mg/L     | 30                | 37,5             |
| COD           | mg/L     | 100               | 87,8             |
| Ammonia       | mg/L     | 10                | 48,2             |
| Oil and Fat   | mg/L     | 5                 | <2               |
| Total Coliform| MPN/100 mL | 3000            | 560.000          |

This treatment serves 53 houses. This WWTP has already done for a year in treating domestic waste. After constructed, the treatment pool becomes a playground for early pre-school childhood. The result of effluent WWTP of CBO Mandiri is tested in the laboratory with the parameter as proper the Regulation of Minister of Environment and Forestry No. 68 the year 2016. The laboratory test result shows that for parameter pH and COD has already reached the quality standard. The parameters below the quality standard are TSS, BOD, Ammoniac and total coliform (see Table 1). ABR treatment is very effective in reducing COD rate, based on the research of ABR treatment. It can reduce COD rate to 90% [17]. To reduce the high standard of BOD and ammonia in the result of effluent WWTP of CBO Mandiri, can adds filter of zeolite which reduces the rate of BOD, COD, ammonia and other metals [19]. It can be added bio-filter in every ABF tub, so it can raise the bacteria performance in reducing the total coliform number to minimize the total coliform containment.
Figure 3. Water canal becomes community waste

Figure 4. Upper view of WWTP in CBO Mandiri, which is built as a playground for children of PAUD

3.2 Social aspect

Beside of constructing the communal wastewater treatment, the aim of the community-based sanitation program also changes the society behaviour toward sanitation and environment. However, based on the field observation result, it is seen that some wastewater canal is plugged by trash. And there is the behaviour of domestic flushing wastewater in the form of kitchen water waste which is thrown to the wastewater canal. The aim of the community-based treatment construction, besides to build proper sanitation facility, it also transforms the habit in the relation of adequate sanitation. However, this matter cannot be found in the user society of WWTP of CBO Mandiri yet. It can be seen by the wastewater canal that plugged with trash and also domestic wastewater such as kitchen waste. The previous research explained that the challenge of community-based communal wastewater treatment is the profound behavioural changes in society [13].

Figure 5. The condition of wastewater canal around the location of WWTP

3.3 Economic aspect

The sustainable treatment of WWTP can be seen from the independent community after the implementation [14]. One of it is the community can do self-subsistent for operational and WWTP facility improvement, which has been constructed. However, the interview with the community of WWTP management results that the society self-subsistent is due to the failed monthly tuition. When
the community needs operational funding for WWTP care, society asks from the government. One kind of increasing community self-help is to involve the community in every process [20], including operational and maintenance activities and nurses. Besides, conducting campaigns and socialization after the implementation of SPAL.

4. Conclusion
The research finds that WWTP in CBO Mandiri in Lampung does not meet the quality standard of domestic wastewater. Replenishment biofilters and zeolite can increase effectiveness and performance process of WWTP. Behaviour change cannot be found in CBO Mandiri and the community in the location of this program. The community still dispose of kitchen waste in water canal and doesn't collect contribution for operations and maintenance activities of WWTP. Conducting campaigns and socialization for community and CBO Mandiri can solve the problem of self-reliance to the community.

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