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EFFECTIVENESS OF WASTEWATER TREATMENT INSTALLATION AND LIQUID WASTE QUALITY IN DR. SOETOMO GENERAL HOSPITAL, SURABAYA

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Abstract

Introduction: *Hospitals are institutions that produce liquid waste that may pollute the environment and have a dangerous impact on health. Hospital waste has the potential to contain hazardous chemicals, pharmaceutical waste, radioactivity and microbiological pathogens in liquid waste that can pollute the environment and disrupt the balance of the ecosystem. This study aims to determine the effectiveness of the Wastewater Treatment Plant (WWTP) and the quality of the liquid waste at the Dr. Soetomo General Hospital.* ***Methods:*** *This research was a quantitative descriptive study using secondary data from laboratory analysis of wastewater inlet and outlet of The Central Wastewater Treatment Plant (WWTP) of Dr. Soetomo General Hospital for the January-December 2020 period. Effectiveness was obtained by calculating the difference between the inlet and outlet values of each parameter divided by the inlet value multiplied by 100%.* ***Results and Discussion:*** *WWTP in Dr. Soetomo General Hospital Surabaya used a central WWTP which had 3 (three) units, namely WWTP Sequence Batch Reactor (SBR), WWTP Membrane Biostrain Reactor (MBR) and WWTP Aerobic Biofilter which aims to improve the quality of liquid waste. Based on the results of the research analysis, it has been found that hospital wastewater treatment using a central WWTP system is effective for reducing the levels of parameters, namely Total Suspended Solid (TSS) by 60.55%, Biological Oxygen Demand (BOD) by 72.52%, Chemical Oxygen Demand (COD) by 54.02%, Ammoniacal Nitrogen (NH3N) by 90.91%, Phospate (PO4) by 71.43%, bacteria group E. Coli by 99.93%. The temperature and Potential of Hydrogen (pH) parameters recorded at the outlet are in accordance with the established quality standards.* ***Conclusion:*** *The three WWTP units used in Dr. Soetomo General Hospital are able to treat liquid waste effectively. Liquid waste at each outlet parameter is in accordance with East Java Governor Regulation No. 72 of 2013 concerning quality standards for health facilities waste water, so that the effects of contamination on the environment can be minimized.*

INTRODUCTION

Hospitals as the health service provider are comprehensive, curative and preventive. They also function as the place for health check-up, therapy, treatment as well as recovery for the people (1). In carrying out such services, hospitals may potentially become the place of disease transmission and also the place where environmental contamination and health disorder may occur (2). The healthcare facilities generate radioactive, pathological, infectious, cytotoxic, pharmaceutical waste as well as sharps waste that could potentially cause adverse effects on the environment (3).

All activities conducted in the hospital generate waste, including liquid waste that require optimum management at WWTP which serves to turn such liquid waste into something not harmful to the living organisms (4). The liquid waste management is one of the environmental remedial efforts in order to protect the people from the danger of environmental pollution (5) due to the liquid waste that contains several hazardous substances and that could pollute the environment (6) as well as could potentially deteriorate quality of environment when immediately disclosed without any processing would result in serious potential environment disruptions (7).

The liquid waste management deriving from the health care facilities are crucial components in the Sanitation Safety Procedure where it is guaranteed the quality of the liquid waste would no longer be dangerous for the public health. Where the contents of the liquid

waste generated from the health facilities contain several hazardous substances, such as pharmaceutical and medicinal waste, hazardous chemical substances, pathogenic microbes such as bacteria, parasites, helminth and viruses, as well as radioactive waste (8). A research from Tunisia in 2020 discovered that about 40 pharmaceutical active compounds derive from hospital effluent, including among others the type of salicylic acid, sulfadiazine and sulfamethiozole with an average concentration of 340 µg/L and the Risk Quotients (RQ) is classified as medium or high (9). In addition, certain bacterial microbes are found on the water and liquid waste in around health care facilities (10-11).

The processing of liquid waste has not been fully enacted globally, as per the study on health care services in Vietnam in 2020 in which it was discovered that the number of liquid waste management in hospitals at the central region were amounting to 91%, at the province amounting to 73% and at the district region amounting to 50%, with the required budget allocation of 10 -15% from the total budget for health care facilities (12). Several methods have been studied and utilized in the liquid waste management globally. The first method is Sequencing Batch Reactor (SBR) that is a form of development from the Activated Sludge System (ASS) technique, this system would combine the anaerobic and aerobic bioreactors, where the liquid waste is processed through the methods of fill and draw. There are 5 steps in SBR: filling, reacting, settling, and decanting and idle (13).

The next method is membrane technology that have been widely used in liquid waste management where this technique utilizes the principle of separating physics and chemistry through the utilization of permeability difference. Membrane is a synthetic material with the width of < 1 mm and is semipermeable namely natural polymer deriving from cellulose (14). The Membrane Bioreactor (MBR) is an option in biological liquid waste management specifically on the liquid waste generated from the health care facilities with the ability to separate the flow of the liquid waste from the solid and nutrients. Such process is required for organic pollutant elimination on the next phase (15). The development of MBR among others with anaerobic dynamic membrane bioreactors were proven to be very cost-effective technology in liquid waste management (16).

The third method is biofilter that has been widely used in domestic liquid waste management that is often equipped with composite packing material in the form of Iron (Fe) and Carbon. This method was found to have decreased the nitrogen and phosphorus contents from the liquid waste (17). The previous relevant research with the hospital liquid waste elaborated that the decrease of the Chemical Oxygen Demand (COD) content from the hospital waste which is affected by COD/Hydrogen Peroxide (H_2O_2) as well as Power of Hydrogen (pH), and this would become at the optimum condition in the range of acidic condition between pH 3 as well as the ration of COD H_2O_2 10 that would lower the COD content on medical waste of up to 55.07% (18).

The effectiveness of liquid waste management is still a significant issue in health care facilities in Indonesia especially in the City of Surabaya, where liquid waste would not adhere with the required standards. One of the cases reported by the study in 2018 on the effectiveness of liquid waste management at Labung Baiji General Hospital at the City of Makassar by utilizing WWTP method, the anaerobic-aerobic biofilter system, elaborated that the outlet result on such parameter were Biological Oxygen Demand (BOD) 0.74 mg/L, Total Suspended Solid (TSS) 45.27 mg/L, Chemical Oxygen Demand (COD) <1.825 mg/L, and 2400 /100ml *E. Coli* virus group. All parameters being researched have not found the appropriate environmental quality standards (19). From here, it could be emphasized that the liquid waste management is crucial to be conducted at all health care facilities with the purpose of ensuring quality of service for customers without causing any adverse effects on surrounding environment.

Dr. Soetomo General Hospital is the health service referral center in the Eastern Region of Indonesia and is government-owned. The facilities are made conveniently made available, among others emergency departments, outpatient installation, palliative installation and pain free, as well as supporting facilities such as water resources, energy resources, planning system and liquid waste management, as well as other supporting facilities. Dr. Soetomo General Hospital has 3 Wastewater Treatment Plant (WWTP) system unit namely Membrane Bio-Strain Reactor (MBR), Sequence Batch Reactor (SBR), and anaerobic-aerobic biofilter whereas the records of the liquid waste management coming out of the hospitality is carried out through automatic flow meter (20).

The extent of the services provided by Dr. Soetomo General Hospital as well as the potential environmental impacts occurring, however, there is currently limited number of studies that explain the analysis results of the effectiveness of the liquid waste management unit as well as the quality of liquid waste being generated. This research serves to comprehend the effectiveness of WWTP and the quality of liquid waste at Dr. Soetomo General Hospital Surabaya in January – December 2020.

METHODS

This study utilized the descriptive-quantitative method through the use of secondary data deriving from the health installation around Dr. Soetomo General Hospital around January through December 2020. Inlets were liquid waste central collection tank that have not been processed and generated from hospital activities. The outlets were the disposal tank of the liquid waste management. The data obtained comprised of the average debit data of the liquid waste, the laboratory analysis result of the liquid waste located at the outlet and inlet of WWTP from the physical, chemical, biological that contain the TSS value, BOD, COD, pH, NH_3N, PO_4, as well as *E. Coli* group bacteria as the material for calculating the effectiveness of WWTP in reducing the liquid waste content.

This research comprised of independent variables namely methods or techniques of processing at the Wastewater Treatment Plant (WWTP), whereas the dependent variables in this study were the liquid waste volume at the WWTP inlet and outlet, as well as the Total Suspended Solid (TSS) parameter value, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Potential of Hydrogen (pH), Ammoniacal Nitrogen (NH_3N), Phospate (PO_4), *E.Coli* bacteria group. The standard regulation being applied as the reference for this study was Regulation of the East Java Governor Number 72 of 2013 on Wastewater Quality Standard For Industries And/Or Other Business Activities (21) as well as the Regulation of the Minister of Environment, number 5 of 2014 on wastewater quality standard for health care facility activities (22).

The data from the dependent variables (TSS, BOD, COD, NH_3N, PO_4, *E.Coli* bacteria group) were being analyzed in a descriptive manner by manually calculation, with an exception for the pH parameter and temperature of which could only be seen on the outlet results to be compared with the environmental quality standard of reference for the health care facility waste quality. The effectiveness was obtained through calculating the difference between the inlet parameter value being subtracted by the outlet parameter value and then being divided by the inlet parameter value and finally multiplied by 100%. The level of effectiveness was obtained through the equation below (23).

WWTP's Effectiveness Formula (24):

$$= \frac{(\text{Parameter Inlet} - \text{Parameter Outlet})}{\text{Parameter Inlet}} \; x \; 100\%$$

Whereas the criteria of effectiveness refers to the classification on table 1 (25).

Table 1. Classification of Effectiveness Measurement

Percentage	Criteria
>80%	Very Effective
60% - 80%	Effective
40% - 60%	Moderately Effective
20% - 40%	Less Effective
<20%	Ineffective

RESULTS

The Waste Management Installation located at Dr. Soetomo General Hospital comprised of 3 sections namely the 800 m^3/hr activated sludge process of WWTP's Sequence Batch Reactor (SBR), 500 m^3/hr capacity of Membrane Bio-Strain Reactor (MBR), and anaerobic-aerobic biofilter with the capacity of 200 m^3/hr illustrated on the Figure 1. The daily liquid waste volume being disposed from the WWTP is around 875 m^3, proving that central WWTP of Dr. Soetomo General Hospital generates liquid waste that could accommodate it and there would not be any overload or excess waste capacity. The liquid waste production capacity at central WWTP still meets the required capacity. The various types of health care services available may affect the number and types of liquid waste generated from central WWTP. The water body becomes the disposal area for the liquid waste from WWTP, owned by Dr. Soetomo General Hospital, Central WWTP's automatic flow meter recorded the average flow of 875 m^3/hr.

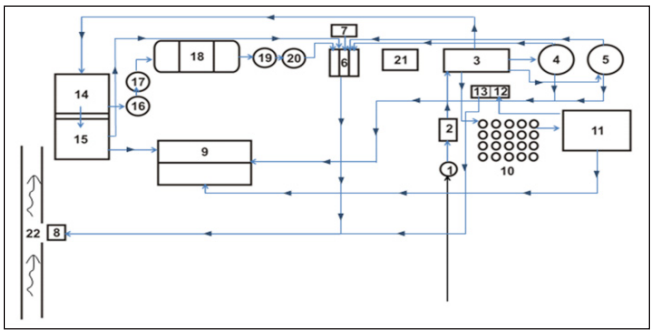

Figure 1. Flow of Wastewater Treatment at the Central WWTP of Dr. Soetomo General Hospital Surabaya

Description:

1. *Inlet*
2. *Agisak*
3. *Old Equalization*
4. *Bioreactor 1*
5. *Bioreactor 2*
6. *Baffle*
7. *Chlorinator*
8. *Outlet*
9. *Sludge Drying Bed*
10. *MBR (Membran Biostrain Reactor) Equalization*
11. *MBR (Membrane Biostrain Reactor) Reactor*
1. *Monitoring Body*
14. *Chlorinator New Equalization*
15. *Bioreactor 3*
16. *An-aerob 1*
17. *An-aerob 2*
18. *Aerobic Biofilter*
19. *Filter 1*
20. *Filter 2*
21. *Panel Room*
22. *River*
23. *Kalida*

The examination of Central WWTP's outcome processing for Dr. Soetomo General Hospital was conducted by a laboratory that have been accredited by the National Accreditation Committee and have been

appointed by Environmental Agency of East Java that is carried out on a monthly basis. Table 2 consists of the laboratory analysis result from central WWTP on inlet Dr. Soetomo for the BOD parameter, temperature, TSS, COD, pH, NH_3N, PO_4, *E. Coli* virus group on January to December 2020 resulted in the outcome of which it has not met the liquid waste quality standards. The parameters that have met the quality standard for the inlet analysis results are TSS parameters, in January (36.0 mg/L), BOD parameter in January (40.2 mg/L), February (64.4 mg/L), June (47.12 mg/L), and October (37.328 mg/L), COD parameter in January (100.0 mg/L) and February (161.4 mg/L), pH parameter and the NH_3N monthly average, *E. Coli* virus group parameter in January (1000/100ml), February (154000/100ml), March (750000 /100ml), and April (680000/100ml). For the PO_4 parameter in January through December has met the liquid waste quality standard.

According to Table 3 on the wastewater laboratory analysis result at the central WWTP outlet of Dr. Soetomo for TSS parameter, temperature, BOD, COD, pH, NH_3N, PO_4, *E. Coli* virus group on January through December 2020 indicated the outcome of which it has met the liquid waste quality standards. There has been an improvement of quality for every parameter after undergoing the processing (outlet), this has shown that the central WWTP outlet result at Dr. Soetomo General Hospital in 2020 have met the requirement when it will be disposed to the water body and it would no longer pose any danger to the surrounding living ecosystem.

Table 4. Effectiveness Value of WWTP Dr. Soetomo General Hospital Year 2020 Soetomo

Parameters	Units	Average Inlet	Average Outlet	The Effectiveness Value (%)
TSS	mg/L	10.24	4.04	60.55
Temperature	^{0}C	29.54	29.66	-
BOD	mg/L	25.68	7.06	72.52
COD	mg/L	58.51	26.9	54.02
pH	-	7.57	7.49	-
NH_3N	mg/L	0.22	0.02	90.91
PO_4	mg/L	0.84	0.24	71.43
Coliform	/100 ml	132291.25	95.42	99.93

Source: RKL-RPL Implementation Report at Dr. Soetomo General Hospital

Table 2. Liquid Waste Laboratory Result Analysis for Central WWTP Inlet of Dr. Soetomo General Hospital January – December 2020

Parameters	Units	Quality Standards	Test Results											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TSS	mg/L	30	36.0	19.2	11.2	4.5	2.8	4.0	8.2	11.3	11.3	7.7	3.1	5.3
Temperature	^{0}C	30	29.0	30.0	29.0	30.5	29.0	29.2	29.8	29.5	29.5	28.1	20.1	30.3
BOD	mg/L	30	40.2	64.4	25.4	9.22	10.0	47.1	12.4	11.6	11.6	37.3	18.4	26.0
COD	mg/L	80	100.0	161.4	64.8	30.2	23.5	28.2	41.3	41.3	41.3	79.7	46.7	43.3
pH	-	6-9	7.5	7.6	7.5	7.6	7.0	7.1	7.6	7.8	7.8	7.6	7.2	8.5
NH_3N	mg/L	0.1	0.604	0.410	0.325	0.010	0.012	0.296	0.0393	0.057	0.057	0.029	0.029	0.029
PO_4	mg/L	2	1.2	1.0	1.1	0.3	0.4	0.5	0.7	0.7	0.7	0.8	1.3	1.4
Coliform	/100 ml	10,000	154,000	750,000	680,000	182	140	120	63	120	460	210	1,100	1,100

Source: Liquid-Waste-Quality Standard-for Business and/or -Hospital-Activities (21)

Table 3. Liquid Waste Laboratory Result Analysis for Central WWTP Outlet of Dr. Soetomo General Hospital January-December 2020

Parameters	Units	Quality Standards	Test Results											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TSS	mg/L	30	10.2	3.5	6.0	1.9	1.4	2.9	4.0	6.1	1.8	2.2	6.5	1.8
Temperature	^{0}C	30	29.0	30.0	29.0	30.7	29.0	29.2	30.2	30.5	29.8	28.0	30.2	30.3
BOD	mg/L	30	7.2	3.3	5.8	5.4	7.0	4.0	4.5	3.9	4.0	9.4	13.0	17.0
COD	mg/L	80	17.4	8.7	14.4	30.2	22.0	8.5	41.3	41.3	41.3	18.2	37.8	41.3
pH	-	6-9	7.4	7.1	7.4	7.3	7.4	7.1	7.6	7.6	8.0	7.7	76.9	8.5
NH_3N	mg/L	0.1	0.0046	0.0206	0.0011	0.0100	0.0106	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296
PO_4	mg/L	2	0.07	0.04	0.02	0.07	0.10	0.20	0.40	0.03	0.08	0.20	0.97	0.65
Coliform	/100 ml	10000	150	200	200	104	120	84	110	84	30	12	15	36

Source: Liquid Waste Quality-Standard for Business and/or Hospital Activities (21)

Explanation:

I :	*January*	*VII:*	*July*
II :	*February*	*VIII:*	*August*
III :	*March*	*IX :*	*September*
IV :	*April*	*X:*	*October*
V:	*May*	*XI :*	*November*
VI:	*June*	*XII :*	*December*

According to Table 4, it shows that the percentage of the effectiveness value of the central WWTP Dr. Soetomo General Hospital in reducing the liquid waste namely for the TSS parameter reached 60.55%, for BOD of 72.52%, COD of 54.02%, NH_3N of 90.91%, PO_4 of 71.43%, *E. Coli* virus group of 99.93%. This analysis result indicated that the central WWTP of Dr. Soetomo General Hospital has become effective in reducing the levels of TSS, BOD, COD, NH_3N, PO_4, and coli virus group.

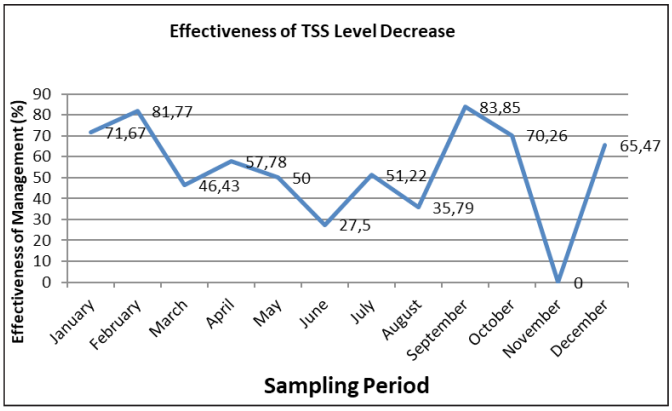

Figure 2. The Effectiveness of Central WWTP Wastewater Management at Dr. Soetomo General Hospital in Reducing the TSS Level

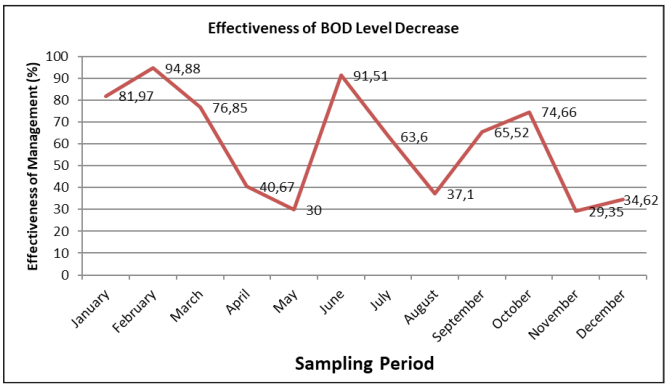

Figure 3. The Effectiveness of Central WWTP Wastewater Management at Dr. Soetomo General Hospital in Reducing the BOD Level

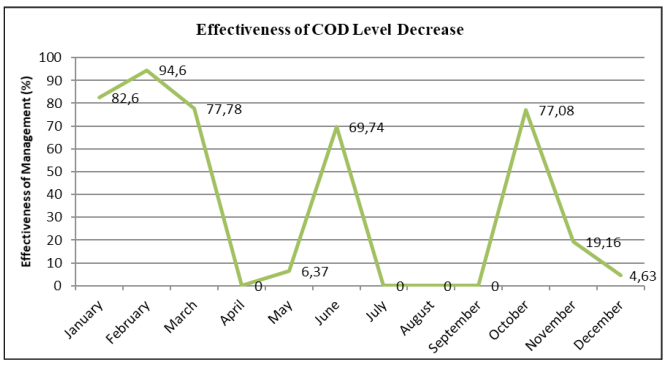

Figure 4. The Effectiveness of Central WWTP Wastewater management at Dr. Soetomo General Hospital in Reducing the COD Level

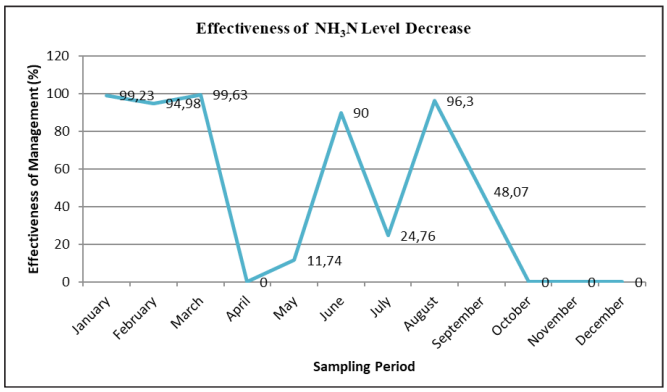

Figure 5. The Effectiveness of Central WWTP Wastewater Management at Dr. Soetomo General Hospital in Reducing the NH_3N Level

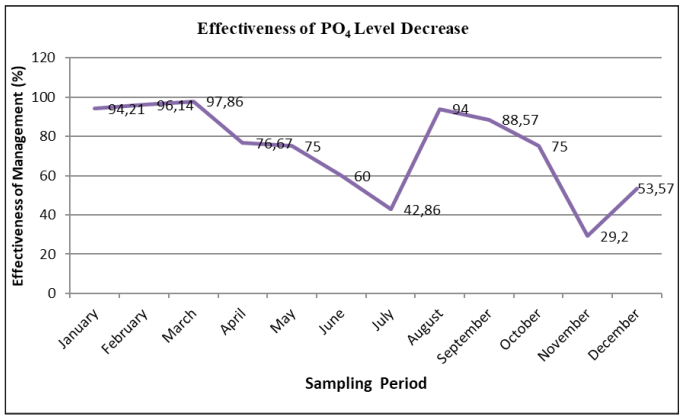

Figure 6. The Effectiveness of Central WWTP Wastewater Management at Dr. Soetomo General Hospital in Reducing the PO_4 Level

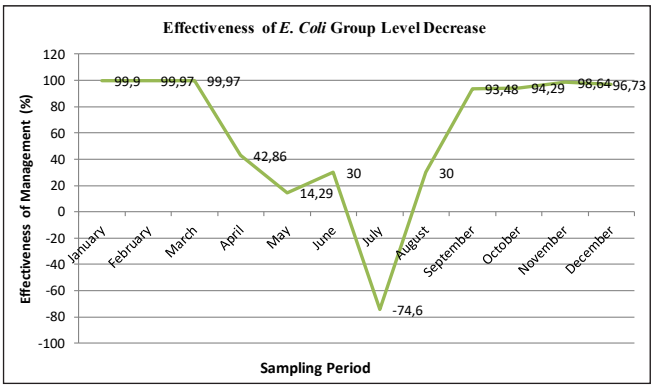

Figure 7. The Effectiveness of Central WWTP Wastewater Management at Dr. Soetomo General Hospital in Reducing the *E.Coli* Group Level

In Figure 2 to Figure 7 have stated that the central WWTP of Dr. Soetomo General Hospital has become effective in reducing the levels of TSS, BOD, COD, NH_3N, PO_4, and *E. Coli* virus group. The central WWTP of Dr. Soetomo General Hospital have been effective in reducing the level of COD, namely in January (82.6%), February (94.6%), March (77.78%), June (69.74%), October (77.08%).

However, the central WWTP of Dr. Soetomo General Hospital has not become effective in reducing the levels of TSS, BOD, NH_3N, PO_4, and *E. Coli* virus group in certain months namely the TSS parameter in June (27.5%), August (35.79%), November (0%). The BOD parameter in May (30%), August (37.1%), November (29.35%), December (34.62%). The NH_3N parameter in April (0%), May (11.74%), July (24.76%), October through December (0%). The PO_4 parameter in November (29.2%). The *E.Coli* virus group parameter in May (14.29%), June (30%), July (0%), August (30%).

DISCUSSION

All liquid waste being generated from the hospital derived from the domestic or hospital clinical activity waste being gathered and compiled through the wastewater collection pipe, namely a pipe network system consisting of secondary pipes and main pipe that flow the wastewater to the control tub to the collection tub for then it to be streamed to WWTP (26-27). The liquid waste management through the use of the SBR method is a waste management that utilizes microorganisms aerobically in a suspended condition and could generate methane gas (28). The liquid waste debit capacity being generated by Dr. Soetomo General Hospital Surabaya could contain liquid waste being generated on a daily basis. Such method is line with the previous research which stated that the liquid waste debit capacity that is generated every day reaches to 40 m^3/day by using the anaerobic-aerobic biofilter WWTP could contain the liquid waste and there would not be any overcapacity (29).

The average inlet and outlet rate on TSS parameter have been reduced namely the average inlet is from 10.24 mg/L to outlet 4.04 mg/L and may reduce the level of effectiveness of 60.66%. However, in November, the Central WWTP of Dr. Soetomo General Hospital has not become effective in reducing the level of TSS, as it was discovered an increase of the level of TSS on the outlet in November. Based on the researcher's interview results on WWTP's person in charge and the result of the document study, this could mainly me due the low level of accuracy from the TSS testing method that caused instability of the TSS level, thus causing the increase of the liquid waste on the outlet that could cause ineffectiveness on that particular month. Such result does not go in line with the Bali Med Denpasar hospital which stated that there was a decrease of inlet TSS level of inlet 32 mg/L to 3,3 mg/L value and proved to be effective in reducing the TSS level, this is due to the liquid waste management that utilizes the biofilter system by utilizing bacteria as the pollutant decomposer. On other hand, WWTP of Dr. Soetomo General Hospital utilized the anaerobic *biofilter* that could only reduce up to 60%-80% for BOD and COD parameters by utilizing plastic ring media and flow meter configuration (30).

This analysis result indicated that the central WWTP of Dr. Soetomo General Hospital has experienced a decrease of average BOD parameter inlet from 25.689 mg/L to 7.06 mg/L outlet and the average COD parameter inlet from 58.51 mg/L to 26.9 mg/L outlet. Such WWTP could also reduce the percentage of effectiveness amounting to 72.52% for BOD and 54.2% for COD. Such decrease is supported by the anaerobic and aerobic biofilter process conducted at WWTP of Dr. Soetomo General Hospital, where the anaerobic step in the compartment is without oxygen with plastic ring media as the media and controlled flow. The process was reported to successfully reduce the levels of BOD and COD above 60%. Pursuant to Regulation of East Java Governor No. 72 of 2013 on health care facility liquid waste quality standard the results still meet the requirement, where the highest concentration quality standard for the temperature of 30^o C, pH 6-9, BOD 30 mg/L, COD 80 mg/L, TSS 30 mg/L, NH_3N 0,1 mg/L, PO_4 2 mg/L, the total coliform of 10,000 (MPN/100 ml) (21). Different results were generated from the previous research which stated that the existing WWTP at dr. H. M. Ansari Saleh General Hospital could reduce the percentage of the level of effectiveness for liquid waste the BOD and COD parameters of -18, this is due to the use of Rotating Biological Contactor (RBC) method as the liquid waste management with ineffective inflow and outflow system caused by the liquid waste debit fluctuation (31).

The MBR method applied at WWTP of Dr. Soetomo General Hospital consists of several parts, namely automatic Hybrid Membrane Process (HMP) that serves to absorb heavy metal contents as well as the media for purification and filtration media of undesirable ions (Ca, Mg) to be exchanged with Potassium and Hydrogen by utilizing using an ion exchange resin. In addition to the WWTP system MBR of Dr. Soetomo General Hospital also has 2 screen units that serves to filter big particles as well as fine particles. The next unit after MBR is Bio-strain reactor that facilitates the process of decomposing the organic matter along with the existence of microorganisms that are dissolved and attached to the media. Such layered process on several units generates a WWTP waste quality of Dr. Soetomo General Hospital that resonates the decrease among others the TSS parameter or dissolved solid residue with an average decrease of 60% in 12 months (January – December 2020) as well as the decrease of NH_3N of

90.91%. The MBR technology for WWTP of Dr. Soetomo General Hospital could be developed by adding several components to improve its effectiveness and efficiency in managing liquid waste.

The development of MBR with the use of Sponge Membrane Bioreactor (Sponge-MBR) in managing the hospital liquid waste combined with operating ozonation could reduce 7 types of antibiotics (trimethoprim, norfloxacin, erythromycin, ofloxacin, ciprofloxacin) of 45-93% and even for tetracycline could reach 100%. Additionally, this technique could reduce nitrogen by way of nitrification and de-nitrification simultaneously in different flux (32). Although this research has not shown the pharmaceutical liquid residue parameter, the implementation of Sponge-MBR is assumed to have reduced the level of pharmaceutical pollution or pyrogen towards the environment.

In the previous research, the use of algae macrocapsule for MBR, where algae would be place on fiber macrosphere coated with polymer were proven to be efficient in separating the wastewater with the high level of ammonia nitrogen, with a level of efficiency of 97.38% as well as the level of Chemical Oxygen Demand (COD) of 62.23, such result proved that MBR could save energy in managing non-degradable liquid waste management (33). The application of dynamic membrane with hollow fiber was reported as ultra-filtration and low-cost membrane, as well as having the ability to separate high level COD (14). Both studies could explain significant decrease of level of NH_3N of 90.91% as well as for COD of 54.02% for the use of MBR system, at WWTP of Dr. Soetomo General Hospital, although no information has been found on the microorganisms being used.

The average inlet and outlet value for the *E. Coli* virus group parameter experienced an average decrease of inlet of 133.25 mg/L to outlet of 95.42 mg/L and could reduce the percentage of effectiveness of 99.93%. Based on the WWTP document study of Dr. Soetomo General Hospital, it could be explicated that the process of aerob-anaerob biofilter consists of several steps, namely the anaerobic process through the use of plastic ring as the media followed by delivering oxygen using the ring blower, and then sedimentation, filtration and chlorination process. The provision of chlorine for this step serves as the effective disinfection to decrease or remove pathogenic microorganism such as bacteria and viruses. The result of *E. Coli* decrease being generated was 99.93%. Therefore, it could be concluded that the ability of central WWTP of Dr. Soetomo General Hospital in reducing the level of *E. Coli* virus group has been proven effective.

The effectiveness of WWTP of Dr. Soetomo General Hospital is line with other research that explain that WWTP at RSU Bunda Thamrin is effective in reducing the level of coliform MPN (34). Based on the analysis found at the central WWTP of Dr. Soetomo General Hospital has experienced a decrease of average NH_3Nt parameter inlet from 0.22 mg/L to 0.02 outlet and the average PO_4 parameter inlet from 0.84 mg/L to 0.24 mg/L outlet. Such WWTP could also reduce the percentage of effectiveness of 90.91% for NH_3N and 71.43% for PO_4. Similar findings from previous research elaborated that the existing WWTP at Sunan Kalijaga Demak General Hospital could reduce the liquid waste inlet and is effective in reducing the level of PO_4 namely 97.77% (35). However, the effectiveness of WWTP of Dr. Soetomo General Hospital is rather different from the analysis result carried out at Panti Wilasa Citarum Hospital Semarang which elaborated that WWTP being utilized is still ineffective in reducing the level of *E. Coli* virus group, this is due to the fact that WWTP utilized at RS Panti Wilasa Citarum Semarang utilized the Decentralized Wastewater Treatment Systems (DEWATS) that does not conduct the chlorination step (36).

Parameters of temperature and pH do not include the calculation of effectiveness in the study with very diverse pH and temperature characteristics of wastewater source for the inlet, thus requiring the researcher to only observe the result for the outlet to be compared with the health care liquid waste quality standard level. As discovered in the previous research which stated that WWTP utilized at the hospital “X” is still ineffective to reduce the level of temperature namely 0.46% and pH, this is due to many mud at the tub base indicating lack of maintenance and care, but for WWTP of Dr. Soetomo General Hospital, should the testing results show that the mud level reaches 400 mg/L, the tool that disposes the mud shall be a pump and a decanter, such tools also serve to process the mud after aeration and sedimentation process (37). This is in line with the previous research which stated that the use of anaerobic-aerobic biofilter process at the hospital by utilizing liquid waste would reduce the parameter concentration of good TSS, BOD , PO_4, NH_3N , COD, *E. Coli* virus group (38).

Meeting the liquid waste quality standard is also supported by one of the processing methods utilized namely the Sequencing Batch Reactor (SBR) where this technique performs better in terms of efficiency for managing BOD, COD, Total Nitrogen (TN) and PO_4^3 (24). The photosynthetic aeration in SBR method by

growing algae on Photobioreactor (PBR) has proved to increase the COD decrease from 52.2% (prior to the external aeration) to 90.3%, whereas the decrease of N-NH_4^+ is 63.5% and P-PO_4^{3-} is 90.4% (39). Although when compared with High-Rate Algae Pound (HRAP), the SBR method is considered to be less efficient economically and for the environment, this is caused by its higher Global Warming Potential (GWP) and Eutrophication Potential (EP) values. Additionally, the gas emission released in the form of N_2O dominates the active mud system in SBR method (40).

The use of SBR combined with Ceramic Membrane Bioreactor (CMBR) in managing the waste water in oil and gas industries is very effective in reducing the COD and oil concentration of 80 times lower than the previous management, it could also grow and retain microorganisms effectively in the processing tanks (41). The wastewater management technique combines 2 biological process steps consisting Anoxic Biofilter (AF) and Biological Aerated Biofilter (BAF) that are proven to be very effective in managing the liquid waste in domestic areas. Such combination techniques could reduce the level of COD (amounting to 91.5% or the final level would become 20.3mg/L), ammonia (NH_4^+ N) of 98.3% would become 0.5mg/L, total nitrogen (TN) of 64.8% would become 11.5mg/L and total phosphor of 90% would become 0.3mg/L (17).

The analysis result carried out at RK Charitas hospital elaborated the changes of the liquid waste being generated after redesigning WWTP for the parameters of pH, TSS, BOD, COD, NH_3N, and PO_4 (42). WWTP utilized at Mutiara Sukma hospital could reduce could reduce the parameters of temperature, pH, BOD, COD, NH_3N, PO_4, but there are still some shortcomings namely the performance of WWTP that is not yet optimal and the control tub that does not match the incoming liquid waste (43). The COD parameter requires oxygen in order to chemically oxidate (degrade) the organic materials contained in the water (44). To reduce the organic materials contained in the water requires sufficient amount of oxygen (45). The level of Orthophosphate (PO_4) utilized for the waters indicated the fertility in such waters (46). The parameters of BOD and COD serves to reduce the oxygen content and as to monitor the pollution in the waters (47).

Based on the description of each parameter result, it could be concluded that the application of the three waste management techniques serves to complement one another to be able to decompose the contaminants as well as to improve the waste water being generated. Aside from the outcome shown in this research, there are still many rooms for improvements where the source data relies on secondary data and is solely limited to one year – only for 2020. The subsequent research should carry out an observation of the parameter directly with longer duration for comparison.

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CONCLUSION

The liquid waste management process at Dr. Soetomo General Hospital utilizing central WWTP has already become effective in reducing the level of most of the liquid waste parameters. After undergoing the WWTP process, the parameters on the liquid waste outlet have met the required quality standard in accordance with the Regulation of East Java Governor Number 72 of 2013. Therefore, the WWTP product disposal to the water body shall be confirmed as safe for the surrounding environment and public health.

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