Poll Res. 39 (3) : 553-561 (2020)

ISSN 0257–8050

EFFECTIVENESS OF HOSPITAL WASTEWATER MANAGEMENT ON WATER QUALITY, SOCIO-ECONOMIC CONDITION AND SOCIAL PERCEPTION: A CASE STUDY IN RSUP PROF. DR. R. D. KANDOU, MANADO, INDONESIA

B. LIMBONG TAMPANG[1] AND ETTY RIANI[2,*]

[1]*Faculty of Engineering, Manado State University, Jalan Tondano, South Tondano, North Sulawesi 95618, Indonesia*
[2]*Departmentof Aquatic Resources Management, Faculty of Fisheries and Marine Sience, Bogor Agricultural University, Jalan Raya Dramaga, Kampus IPB, Bogor 16680, Indonesia*

(Received 22 December, 2019; accepted 4 February, 2020)

ABSTRACT

Hospital rooms and their supporting unit generates a number of wastes. This study was aimed to analyze the effectiveness of wastewater handling activities in RSUP Prof. Dr. R. D. Kandou, to observe the community perception in surrounding hospital and the influence of the hospital on their socio-economic condition. The result of water pollution analysis were derived from inlet and outlet of waste disposal site was then compared with the quality standard of the Decree of Minister of Environment No. 58/MENLH/12/1995 and KEP-02/MENKLH/I/1998. Plankton diversity and evenness were analyzed using Shannon-Wiener index. The perception of 50 respondents who live around the building regarding the hospital waste and its influence on the socio-economic condition was analyzed using Chi-square test. The results showed that contamination of hospital wastewater causes low turbidity; whereas the level of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), coliform, and *E. coli* were low. Society has a negative (bad) perception about the organic waste discharges in a reason of considering that their aquatic environment has been polluted. Personal income has a significant relationship with the social perception of hospital wastewater disposal. Management was required for handling the hospital wastewater properly, the wastes have to be processed before disposing into the environment. Facilities and infrastructure procurement should be appropriate with the demand. It was also required the law enforcement and counselling to increase people's awareness of the environment.

KEY WORDS : Hospital, Wastewater, Disposal management.

INTRODUCTION

A hospital is a place intended to support health and to improve people's welfare. Generally, hospitals have medical centers, doctor's workspaces, and also other units such as surgery (operating) room, laboratory, pharmacy, administration, kitchen, laundry, waste processing, education and training room. Many benefits to people by the existence of a hospital to supports healing, but there is also a negative impact by the pollution that generated from the hospital's waste. In a case of improper waste handling, it could be a reverse benefit provided, where become a place of spreading diseases instead of healing the patient.

Hospital waste consists of both organic and inorganic, and the other type of infectious waste which is hazardous toxic materials (B3). About 10%-15% of the total was a type of infectious waste which contains heavy metals of mercury (Hg). The 40% of the total was the organic waste derived from food residues (patient, visitor, and nutritional kitchen), while the rest were inorganic waste such as infusion bottles, plastic, etc. Moersidik (2010) stated

that hospital wastewater contains microorganism, chemical toxic and radioactive which are dangerous to people's health and the environment. The waste is derived from various room and service, such as ward, medical service and support, kitchen and laundry. Chen et al (2013) said that antibiotic-resistant bacterial genes were found in samples from six rivers in China, including samples taken from the Pearl River, which is considered as the highest contaminated of antibiotic pollutant in China.

In a type of form, hospital waste is divided into solid, liquid and gas. They are also categorized into clinical and non-clinical waste thus highly potential to transmit the diseases. Specifically for liquid waste, according to Sugiharto (1997) states the substances contained in wastewater can be grouped of (1) 99.9% water, (2) 0.1% solid materials, consist of organic matter (65% protein, 25% carbohydrate and 10% fat) and inorganic matter (granules, salts, and metal).

Riani (2012) stated that heavy metals as a pollutant both in freshwater and seawater will accumulate in the organ of aquatic biota. Riani *et al.* (2014) also showed that heavy metals cause congenital defects of *Dicrotendipes simpsoni* larvae (diptera: chironomidae). However heavy metal pollution from hospital activities is relatively small, so in this study heavy metal pollution is disregarded. Similar condition are applied for antibiotic contamination too. While the different result occurred on the contamination of organic materials which increase along as the number of patients. Therefore, organic pollution from hospital waste becomes attractive to observe. The potential of waste pollution which contains organic carbon for microbial purposes is measured by the amount of oxygen which used during the growth of the organism inside. The parameters mentioned are BOD, COD and DO. So, the effectiveness of wastewater management in this study which generally dominated by organic material was measured on the BOD, COD and DO.

The hospital located in Manado. Along with the increasing number of patients, they are facing various issues in patient service, pollution, internal management, and etc. Fortunately, the problems of management, service and other similar have been handled through the relevant instances. But the problem of pollution which is relatively invisible, have not be resolved properly yet and even it has spread into social problems, thus causing the wide refusal from the community. Based on this, it is necessary to find information related to pollutants and information from local community about the hospital. Therefore, the research was conducted entitled "Study of the effectiveness of liquid waste management of RSUP Prof. Dr. R.D. Kandou Manado".

RSUP Prof. Dr. R.D. has a capacity of 735 beds. The number of inpatients is increasing as the year. In 2014, inpatient installations reached amount 22,568. The organic waste disposed into the ditch and flew into the Malalayang coast. According to Kendeigh (1975), the existence of waste input from human activities which is a foreign material for natural waters will contaminate the aquatic environment and may cause in physical, chemical and biological changes. For more details, the urgency of research can be seen in Figure 1.

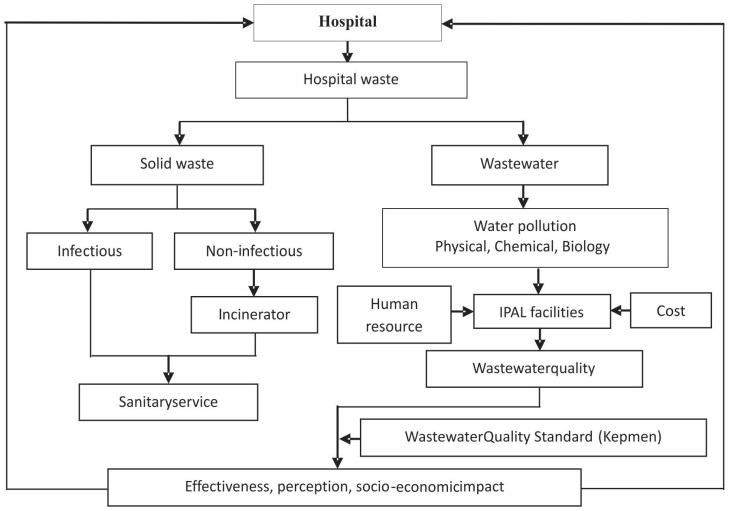

Fig. 1. Flowchart of the urgency of the research.

MATERIAL AND METHOD

Location and sampling method

Sampling location was determined based on the hospital location and the hospital dispersed wastewater from; i.e. (1) At the point before it being processed (inlet), (2) At the point after it being processed (outlet) in determining of the landfill. Sampling was 6 times with 2 weeks interval and conducted at 09.00-11.00. Water quality analysis was conducted both in situ and in laboratory of Manado Environmental Health Engineering Center and Physical Chemistry Laboratory FMIPA UNIMA.

Water quality parameters

Water parameters analysis was in physical, chemical and biological. Parameter and method on water quality measurement refer to the decree of MENLH No: KEP-58/MENLH/ 12/1995 (Table 1).

The materials were used water sample from hospitals and reagents for physical, chemical and biological analysis, while the tools and equipment used were cooling thermos, BOD bottle, spectrophotometer, pH meter, MPN table, and Sedgwick rafter cell (Prescott, 1995; Lay, 2009).

Water data parameter of physical, chemical, and biological was obtained from laboratory analysis, while socio-economic condition data was obtained by questionnaires and interviews to 50 respondents who are the communities around the hospital. Respondents as a research unit were selected by Cluster Random Sampling method, which is distribution of population into groups by area or luster, and then the sample was randomly taken. Secondary data was obtained from related institutions.

To determine the level of pollution, the result was compared with the Wastewater Quality Standard from Hospital activities based on the Minister of Environment Decree No:KEP-58/MENLH/12/1995. Plankton diversity in each observation station was calculated using the Shannon-Weaver Diversity Index method. Furthermore, to calculate the uniformity type index (evenness) were using Shannon-Weaver function.

The data were analyzed statistically using Statistical Program Social Science (SPSS) software. In this research, to know the difference content of organic matter and plankton in each observation station was used the randomized block design by one way analysis of variance (ANOVA). The relation of public perception about organic waste discharges of hospital's wastewater in aquatic environment and the influence of the existence of hospital on socio-economic condition were analyzed with Chi-square.

RESULTS AND DISCUSSION

Physical parameter

The result of physical parameters (temperature, and turbidity) by laboratory analysis of aquatic environment around hospital is presented in Table 2.

Temperature is one of the important factors in metabolism process. Water temperature mostly affects the oxygen solubility in the water. The rising temperature will ruin the life of aquatic biota and organisms as the decreasing levels of dissolved oxygen in the water, whereas they require oxygen to breathe. Dissolved oxygen in water comes from the air and diffuses slowly into the water. But the solubility is inversely to the water temperature. Higher temperature means less dissolved oxygen in it.

Table 1. Water quality parameters and analysis methods

Parameter	Unit	Analysismethod	Tools and equipment
Physical			
Temperature	°C	Heating	Thermometer
Turbidity	NTU	Turbidmetric	Turbidimeter
Chemical			
pH	unit	pH meter	pH meter
BOD	mg/L	Titrimetric	Titration
COD	mg/L	Titrimetric	Titration
DO	mg/L	Titrimetric	Titration
Biological			
Coliform	MPN/100 mL	Filtration	MPN Table, incubatortube
E. coli	MPN/100 mL	Filtration	

The results show that the temperature of the river waters in a range from 29.1 to 25.1°C, which is the result of variance analysis ($p > 0.05$). Nowadays, the climate is irregular so there was not found significant temperatures between the rainy seasons and dry seasons (Riani 2012). Furthermore it is said that the similar condition which also happens a slight shift thus the dry season is longer and the rainy season is relatively short. So the temperature observed during the study did not show any significant difference. Stockbridge (2010) suggested that temperature has a significant effect on mostly biochemical reactions. Biological activity is enhanced by rising temperatures.

Spellman (2003) mentioned that water turbidity is caused by suspended solids, both inorganic and organic. Inorganic substance usually derived from weathering (rocks and minerals), while organic substance derived from plants or animals. Wastes from industrial activity may also become a source of turbidity. Organic substances can be a source of nutrients for bacteria which support the reproduction. On the other hand, the compositions of bacteria in the waters were also counted as suspended organic matter, so the addition of bacteria will increase the water turbidity. Similarly for the algae, due to the existence of nutrients (N, P, and K) they will increase the water turbidity too. Turbid water is difficult to disinfect because the microbes are covered by the suspended substance. This is certainly harmful to health, particularly considering the hospital waste which are potentially contaminated by pathogenic microbes.

Analysis result of water turbidity showed that the value range of 36-50 NTU. This value hospital has exceeded the Quality Standard determined by Kep-51/MENLH/1995 (which standard value of 30 NTU). This is due to the high input of organic waste which comes from the patient room, emergency room, operation room, clinical installation or anatomical pathology, kitchen, laundry, hemodialysis, mortuary or autopsy room. Saeni (1989) stated that turbid water cannot be a highly productive source of biomass although the water contains a lot of nutrients, have an optimum temperature for growth, and has other conditions that suitable to support the aquatic ecosystem living. Based on this, the handling management has been done at this hospital is relatively ineffective to reduce the wastewater turbidity.

Chemical parameter

The analysis results of pH, BOD, COD, and DO from water around the RSUP. Prof. Dr. R.D. Kandou Manado showed that these values generally exceed the quality standard which presented in Table 3.

The degree of acidity characterizes the equilibrium between acidity and alkalinity of the waters. pH is defined as the logarithm of the concentration of hydrogen ions (H) in moles per liter. Pristine water at 25 ºC contains H+ and OH- ions of 10-7 moles per liter, so that the neutral pH of water is 7. If the pH value is less than 7, the water is acidic and if the pH is higher than 7, the water is alkaline (Manik, 2003). Saeni (1989) stated that freshwater pH ranges of 5.0-9.0 where the range of biota can live.

Table 2. Physical parameters of water around RSUP Prof. Dr. R. D. Kandou, Manado

No	Parameter	Unit	Standard	Repetition (Result)		Average	Note
				I	II		
1	Temperature	ºC	30ºC	29.1	25.1	27.1	Q
2	TSS	mg/L	30	32	28	30	Q
3	Turbidity	NTU	30 NTU	36	50	43	NQ

Note: Q = qualified; NQ = notqualified.

Table 3. Chemical parameters of water around RSUP Prof. Dr. R. D. Kandou, Manado

No	Parameter	Unit	Standard	Repetition (Result)		Average	Note
				I	II		
1	pH	-	6.0-9.0	7.13	7.52	7.33	Q
2	BOD	mg/L	30	52	40	46	NQ
3	COD	mg/L	80	144	107	125.5	NQ
4	DO	mg/L	3	3.4	3.0	3.2	NQ

Note: Q = qualified; NQ = notqualified

The pH level in waters around the RSUP Prof. Dr. R.D. Kandou ranges of 7.13-7.52. It means that the aquatic environment conditions around still within the permissible range of quality standards, (pH of 6-9) according to Kep-58/MENLH/12/1995. Novotny & Olem (2009) stated that most aquatic biota are sensitive to pH and prefer about level of 7.0 to 8.5. The pH level highly affects the aquatic biochemical processes, for example the nitrification will stop if the pH is low. Metal toxicity and bioavailability of metals will also increase at low pH. Effendi (2008) stated that bacteria are reproducing well at neutral and alkaline condition, while fungi prefer with low pH (acidic conditions). Therefore, this result shows that pH condition around the hospital environment is still eligible. It is suspected due to the influence of organic waste which derived from hospital then enters to the aquatic environment. In this case, wastewater disposal from hospital contains various alkaline of chemical compounds such as detergents, thus increasing the pH level of the waters.

BOD (Biochemical Oxygen Demand) is amount of oxygen (mg) required to decompose organic matter in one liter of wastewater during the specific period (5 x 24 hours at 20 ºC). Thus the BOD5 value indicates the amount of dissolved oxygen required by microbes to break down or oxidize the contaminants on the water.

The result of BOD5 around RSUP Prof. Dr. R.D. Kandou showed value of 40-52 mg/L. In comparison to the Wastewater Quality Standard for Hospital Activities, the Decree of Minister of Environment No: KEP-58/MENLH/12/1995, with the maximum value of 30 mg/L, the BOD5 found at the observation location is exceeding the standard. Busier activity in hospital will increase the number of organic materials derived, thus the greater burden of pollution into the aquatic environment. This condition causes the highly content of organic materials.

COD (Chemical Oxygen Demand) describes the total of oxygen needed to oxidize chemically the organic materials, both biodegradable and non-biodegradable become CO2 and H2O. In the procedure of COD determination, the oxygen consumed is equivalent to the amount of dichromate which required oxidizing the sample water (Boyd, 1998). Highly COD values indicate the highly oxygen demand which used on chemical oxidation processes. This chemical oxygen demand is also widely used as a measurement of wastewater pollution.

The result of COD around RSUP Dr. R.D. Kandou showed value of 107-144 mg/L. This value exceeds the thresholds permitted by the Wastewater Quality Standard for Hospital Activities (KEP-58/MENLH/12/1995) of 80 mg/L. In comparison to the BOD value, the COD is higher. Thus can be concluded that organic material from hospital wastewater mostly belongs to the type of organic material that takes a long time to be degrade or even non-biodegradable (Saeni 1989).

Based on laboratory analysis, the value of DO is 3-3.4 mg/L. It showed that the aquatic environment around the hospital was categorized on contaminated. This low level of dissolved oxygen is closely related to the waste derived from hospital's activity. They are in form of organic materials which requires the dissolved oxygen for their degradation process. In addition, the accumulation of pollutants from hospital wastewater also contributes to increase the content of organic materials into the waters, thus reducing the dissolved oxygen levels. The higher level of water pollution causes the lowering of dissolved oxygen, and reducing the type of aerobic organism which can survive in low level of dissolved oxygen. When dissolved oxygen is no longer available, the decomposition of organic matter will be processed by anaerobic microorganisms thus generates a toxic gas of sulfide hydrogen (H2S) and a greenhouse gas methane (CH4).

Biological parameters

Water can be a carrier of pathogenic microorganisms which are harmful to human health. To prevent this damage to spread through the water, it is necessary to control the water contamination. In the water, quantity and type of microorganism content is depending on various factors such as the water sources, nutrient components, toxic components, aquatic organisms, and physical factors. Bacterial testing is the most common indicator to be used, particularly the coliform test and then followed by *E. coli* testing (Fardiaz 2002).

The group of coliform bacteria is a biological indicator in water. Coliform bacteria are commonly found in feces. So their presence in water is not desirable, in terms of aesthetics, hygiene, sanitation and the possibility of a dangerous infection. Various diseases can be spread through the water, especially for stomach illness such as typhoid, paratyphoid, cholera and dysentery (Suriawiria 2010).

Table 4. Biological parameters of water around RSUP Prof. Dr. R. D. Kandou, Manado

No	Parameter	Unit	Repetition	
			I	II
1	Coliform	(10.000/100 mL)	24.10^6	11.10^6
2	*E. coli*	(2.000/100 mL)	15.10^6	18.10^6

The amount of coliform in the aquatic environment around the hospital is 10-14/100 mL. this value is below the quality standard of 10.000/100 mL (KEP-58/MENLH/12/1995). This indicates that it contains low level of organic matter and can be seen from the BOD value which is in average of 1.5 times by the standard value. Because of the organic matter is a life source for microorganisms, thus less organic material will not able to support the rapid growth of coli and coliform. This is in agreement with Suriawiria (2010) who stated that the appearance of pathogenic microbes in the water will be high if the content of organic material in the water is high, due to they will functionally worked to be place and substance for the life source of microorganisms.

Analysis of variance showed that the amount of coliform in the aquatic environment around Prof. Dr. R.D. Kandou was not significantly different ($p > 0.05$). The similar result from by Rumengan (1996), and Tampang (2012) that the native hospital waste were highly contained of coliform. The source of these coliform bacteria came from the feces which disposed from the hospital. The coliform in the aquatic environment is presented in Table 4.

E. coli is a subgroup of the coliform and lives normally in human and animal feces and is often called the fecal coliform. The result showed that *E. coli* is amount of 15.106-18.106/100 mL. This value was exceeded the standard of 10,000/100 mL (KEP-58/MENLH/12/1995). It indicated that the aquatic environment around the hospital was highly contaminated by organic material as a source of microorganism life. This is in agreement with Suriawiria (2010) which stated the appearance of pathogenic microbes in the water will increase if the content of organic substances in water is in high amount. In addition, organic materials will serve both as a place and for the life of microorganisms.

Society perception

Knowledge about organic waste disposal from hospital

Total of 50 respondents was observed about the issue of organic waste from hospital wastewater. Amount of 29 respondents (58%) answered that they knew it, although just in superficial issues like dirty water or smelly water. While 21 respondents (42%) answered that they did not know it (Table 5).

Table 5. Knowledge about organic waste disposal from hospital

Category	Absolut frequency	Relative frequency (%)
Yes	29	58
No	21	42
Total	50	100

Source of information on organic waste disposal from hospital

Respondents were observed where they got the information about the waste pollution. The answer of radio and TV as the source of information was 3 respondents (6%), newspapers and magazines were 6 respondents (12%), neighbors and friends was 11 respondents (22%), local government was 9 respondents (18%), and others (not know) was 21 respondents (42%) (Table 6).

Table 6. Sources of information about organic waste disposal of hospital issues

Category	Absolut frequency	Relative frequency (%)
TV and radio	3	6
Newspaper and magazine	6	12
Local government	9	18
Neighbor and friend	11	22
Others (unknowing)	21	42
Total	50	100

Counseling on environmental pollution issues

According to the respondents, counseling program for the community were never been held. This is also reinforced by interviews from several community leaders.

Social perception of the existence of the hospital around their residence

Society opinion (perception) that the existence of the

hospital has an impact on the pollution of their environment, which is 2 respondents (4%) answered very pollute, 6 respondents (12%) answered polluting, 23 respondents (46%) answered no polluting, and 19 respondents (38%) answered not know (Table 7).

Table 7. Perception of the existence of the hospital around their residence

Category	Absolut frequency	Relative frequency (%)
Highly polluting	2	4
Polluting	6	12
No polluting	23	46
Unknowing	19	38
Total	50	100

Source of pollution of the aquatic environment

Source of the pollution of the water according to the respondents was 21 respondents (42%) answered hospital wastewater, 14 respondents (28%) answered household waste, and 15 respondents (30%) answered not know (Table 8).

Table 8. Source of pollution of the aquatic environment

Category	Absolut frequency	Relative frequency (%)
Hospital wastewater	21	42
Industrial waste	0	0
Domestic waste	14	28
Unknowing	15	30
Total	50	100

Relation of socio-economic conditions and social perception.

Sarwono (2004) stated that socio-economic conditions such as age, education level, occupation, and income were related to the social perception. The result of statistic calculation using Chi-square (Walpole, 1997) indicated that socio-economic conditions were associated with the social perceptions of organic waste disposal from hospital wastewater in aquatic environments, which presented in Table 9.

Table 9 shows that the analysis relation between age and social perception are highly significant ($p < 0.01$). It means that the age differences of the community effected on the differences of their perceptions. The age group of 25-55 years and >55 years were more sensitive than the age of <25 years. This is closely related to life experience, which is the older age will has more experiences, thus their perception about the organic waste of the hospital wastewater in the aquatic environment is more based on the experiences of their life.

Analysis relation between education and social perception are significant ($p < 0{,}05$). This indicates that the level of formal education has a significant relationship with the public perception. In other words, the level of formal education affects the public perception of the organic waste disposal from hospitals in aquatic environments. Related to the knowledge through formal education, the higher level which has more knowledge leads the perception and understanding about this issue.

Relation analysis between the occupation and the social perception are not significant ($p > 0.05$). This indicates that the type personal occupation does not affect their perception about organic waste disposal from hospitals in aquatic environments.

Relation analysis between household income and social perception are highly significant ($p < 0{,}01$). The higher household income leads more negative perceptions. In this case, the higher income leads people to reach the information (by accessing electronic media or newspapers) regarding the effect of organic waste disposal from hospitals in aquatic environments.

Relation analysis between the house distance and social perception are highly significant ($p < 0.01$). In this study, people whose home with 100 meters distance from the hospital has more negative perception than people whose home with over 100 meters distance. It is because the closer distance from hospital is most affected by the pollution.

Relation analysis between staying period and social perception are highly significant ($p < 0.01$). This indicates that the different period leads to the different perceptions organic waste disposal from hospital in aquatic environments. In this study, group of 1-10 years staying period are more sensitive than group of <1 year and >10 years.

CONCLUSION

The water around RSUP Prof. Dr. R.D. Kandou Manado is lightly contaminated by organic waste disposal from hospital.

Social perception of organic wastewater disposal from hospitals around their residence is negative (bad perception), it means that people assume that the aquatic environment has been polluted by organic wastewater from hospital.

Table 9. Statistic calculation related to socio-economic conditions and social perceptions about organic wastewater disposal from hospital in aquatic environments

Socio-economic condition	Category	Social perception				Signification	
		NK	NP	LP	HP	χ^2_{htg}	P
Age	< 25	1	2	8	10	18.857**	
	25-55	5	7	45	30		0.005
	> 55	1	2	3	6		
Formal education level	ES	0	0	5	0		
	JHS	1	6	20	12	19.890*	0.019
	SHS	5	6	28	15		
	College	1	1	8	12		
Occupation	PNS/ABRI	1	1	6	2		
	Employee	5	7	26	6		
	Businessman	5	9	15	14	16.843ns	0.260
	Farmers and laborers	1	6	7	2		
	Retired	1	1	5	0		
Income/month (Rp)	< 450.000	5	4	25	8		
	450-900.000	4	5	25	19	18.808**	0.005
	> 900.000	2	5	15	3		
House distances	< 100 m	6	6	35	20		
	100-200 m	6	4	10	7	44.741**	0.000
	> 200 m	6	8	7	5		
Staying period	< 1 yr	2	2	8	6		
	1-5 yrs	6	6	17	8	25.254**	0.003
	6-10 yrs	1	6	12	7		
	> 10 yrs	3	2	25	9		

Note: NK = not know; NP = no pollution; LP = light pollution; HP = high pollution; ns = not significant 0.05;
* = significant at 0.05; ** = highly significant at 0.01.

Relations between the existence of hospital to socio-economic conditions are:

1. Formal education affects the social perception of the organic wastewater disposal from hospital in aquatic environments;
2. Type of occupation does not affect the social perception of the organic wastewater disposal from hospital in aquatic environments;
3. The higher household income leads more negative perceptions of the organic wastewater disposal from hospital in aquatic environments;
4. People whose home with 100 meters distance from the hospital has more negative perception than people whose home with over 100 meters distance;
5. Different staying period lead to different perception of the organic wastewater disposal from hospital in aquatic environments.

Recommendations based on result of the study are following:

1. There must be wastewater processing by the hospital management before it is discharged into the environment;
2. Considering of small required land, low sludge generated, some chemicals needed, simpler operation and maintenance process and relatively low cost, 4-6 hours processing with up to 85-99% efficiency, and less number of operational personnel, so wastewater processing for RSUP Prof. Dr. R.D. Kandou Manado should use a physical and biological treatment system with aeration and supported by activated sludge equipment.
3. Wastewater management of hospital should be supported by facilities and infrastructure which appropriate to hospital conditions, including the enforcement of regulations and counseling to raise the hygiene, safe and comfortable awareness.

REFERENCES

Boyd, C.E. 1998. Water Quality in Warmwater Fish Ponds. Auburn University Agricultural Experiment Station. Alabana. 4th Printing

Chen, B., Yang, Y., Liang, X., Yu, K., Zhang, T. and Li, X. 2013. Metagenomic profiles of antibiotic resistance genes (ARGs) between human impacted estuary and deep ocean sediments. *Environ Sci Technol*. 47(22) : 12753-12760.

Depkes, 1995. Decree of Minister of Environment No. 58/ MENLH/12/1995. Quality Standard of Wastewater from Hospital Activities. Environmental Impact Control Service, Public Health Department, Jakarta [in indonesian].

Effendi, H. 2008. Review of Water Quality for Management of Resources and Aquatic Environment. Kanisius, Yogyakarta, ID. [in Indonesian]

Fardiaz, A. 2002. *Water and Air Pollution.* Kanisius, Yogyakarta. [in Indonesian]

Hamid, E.N. 2001. *Wastewater Management at Ulin Banjarmasin Hospital, South Kalimantan.* (Thesis). Postgraduate Program. University of Indonesia. Jakarta. [in Indonesian]

Kendeigh, S. C. 1975. *Ecology with Special Reference to Animal and Man.* Prentice-Hall, New York.

Lay, B.W. 2009. *Analysis of Microbes in the Laboratory.* Raja Grafindo Persada, Jakarta, ID. [in Indonesian]

Manik, K.E.S. 2003. *Environmental Management.* Djambatan. Jakarta. [in Indonesian]

Moersidik, S. S. 2010. Waste Management. Methods and Technology of Hospital Waste Management. Research institutions of UI, Jakarta, ID. [in Indonesian]

Novotny, V. and H. Olem. 2009. Water Quality Prevention, Identification, and Management of Diffuse Pollution. Van Nostrans Reinhold. New York.

Prescott, G.W. 1995. Freshwater Algae. The Picture Key Nature Series Brown Company Publishing. Iowa.

Riani, E. 2012. *Climate change and aquatic biota life (Bioaccumulation of hazardous and toxic materials and reproduction).* IPB Press, Bogor, 216 pp. [in Indonesian]

Riani, E., Sudarso, Y. and Cordova, M.R. 2014. Heavy Metals effect on unviable larvae of *Dicrotendipes simpsoni* (Diptera: Chironomidae), a case study from Saguling Dam, Indonesia. *International J. AACL Bioflux.* 7 (2) : 76-84.

Rumengan, G.S. 1996. *Management of Clinical Wastewater of Hospital.* Sint Carolus. Jakarta. [in Indonesian]

Saeni, M.S. 1989. Environmental Chemistry. Center for Inter-University Studies of Life Science, Bogor. [in Indonesian]

Sarwono, S.W. 2002. Individual Social Psychology and Social Psychology Theories. Jakarta: Balai Pustaka, Jakarta. [in Indonesian]

Spellman, F.R. 2003. *Handbook of Water and Wastewater Treatment Plant Operations*. Lewis Publishers. Washington DC. pp.575

Stockbridge, R.B., Lewis, C.A.Jr., Yuan, Y. and Wolfenden, R. 2010. Impact of temperature on the time required for the establishment of primordial biochemistry, and for the evolution of enzymes. *Proc Natl Acad Sci USA*. 107(51) : 22102-22105.

Sugiharto. 1997. *Basic of Wastewater Management.* UI Press. Jakarta. [in Indonesian]

Suriawiria, U. 2010. *Microbiology in Water.* PT. Alumni, Bogor. [in Indonesian]

Tampang, B.L. 2012. *Organic Waste Analysis for the Design of Wastewater*. Treatment at Hospital of Prof. Dr. V.L. Ratumbuysang, Manado. Research institution of University of Manado. [in Indonesian].

Walpole, R.E. 1997. *Introduction to Statistic*. Gramedia Pustaka Utama. Jakarta. 516 pp. [in Indonesian].