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RELATIONSHIP BETWEEN HYGIENE AND SANITATION WITH THE BACTERIOLOGICAL QUALITY OF DRINKING WATER DEPOTS IN BALANGAN DISTRICT

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ABSTRACT

Drinking water depots (DWD) continues to increase in line with the dynamics of the community needs to drinking water. DWD water contamination can be caused by factor sanitation hygiene of the DWD. The research have a goal to determine of the relationship sanitary hygiene with bacteriological quality in the DWD. This type of research is observational with cross sectional design. The research population was over all depot of drinking water in Balangan, while sampling by purposive sampling which has been determined based on inclusion and exclusion criteria. The research variables are location, building, production equipment, production process, sanitary facilities and bacteriological quality. The instrument used in this research was the observation sheets and laboratory tests. Data was analyzed by univariate, bivariate analysis using chi square test. The results showed there is no relationship location (p=0.698) with the bacteriological quality, no relationship building (p=0.840) with the bacteriological quality, no relationship of production equipment (p=0.618) with the bacteriological quality, no relationship of production proces (p=0.986) with the bacteriological quality and there is no relationship of sanitation facilities (p=0.515) with bacteriological quality.

KEYWORDS : *Depot Water, Sanitation Hygiene, Bacteriological Quality*

INTRODUCTION

Water is the most important thing in life after air. About three quarters of our body consists of water and no one can survive more than 4-5 days without drinking water. Water is also used for industrial purposes, agriculture, firefighting, recreation, transportation and others [1]. In the developed countries everyone needs water between 6-120 liters per day, while in developing countries, including Indonesia each people need between 30-60 liters of water per day [2]. The need for water in an area will always have preference to rise in line with population growth and improved living standards of the population. Many countries are currently facing public health problems associated with degradation of water quality. Reduced water caused by poor sanitation, and inadequate management of water resources and the environment. in line with the progress and improvement of living standards, the amount of water supply is increasing all the time [3] [4].

The importance of water for health can seen of the amount of water present in organs, such as the blood is 80% water, 15% loss of body weight can lead to death [5] [6] [7]. Drinking water needs of every person varies from 2.1 liters to 2.8 liters per day [8]. Air quality drinking water that meets the health requirements and you can drink, health requirements in question are microbiological, chemical, physical and active radio [9] [10] [11]. Parameter of microbiology is one factor that should receive attention because of the impact of harmful that can cause infectious diseases [12].

Efforts to meet the need for clean water in the community is very varied from the well water through the local water company (PDWD). Along with the rapid advancement of technology that people tend to choose a more practical and considered more hygienes ie bottled drinking water, because of the drinking water produced by the industry through an automated process and is accompanied by quality testing prior to distribution in the public [13]. The existence of Drinking Water Depot (DWD) continued to increase in line with the dynamics of the community needs to drinking water quality and safe for consumption. Although less expensive, not all guaranteed DWD products, especially sanitation. One of the standard of cleanliness and health of water is measured by the presence or absence of *coliform* bacteria as an indicator microorganisms. The indicator microorganisms in the water are evidence that the water was contaminated by the feces of humans or animals and the opportunity for pathogens to get into the water [14].

Hygiene and sanitation is health efforts to reduce or eliminate factors that become causes of the contamination of drinking water and the means used for the processing, storage and distribution of drinking water. Hygiene and sanitation requirements in the management of drinking water at least covering several aspects including raw water, location, equipment, production processes, maintenance of production consciousness and sanitation programs, employee and storage [15] [16].

The study of DWD population in Semarang found 34% depot contaminated with bacteria, so with the results of research conducted in the city of Bogor there are 7% depot contaminated with bacteria from 27 depots studied while research at 35 DWD in Madiun, positive *Escherichia coli* by 8 samples and negative bacteria *Escherichia coli* by 27 samples and there is a relationship between hygiene and sanitation conditions processing room and the cleanliness of the faucet with the number of *Escherichia coli* in drinking water refills [8] [17] [18]. Requirements for the quality of drinking water for the maximum content *of coliform* bacteria allowed is 0/ml sample. Safe drinking water must be free of contaminants consumed by *the* bacterium *Escherichia coli* [19].

DWD very rapid growth in Balangan within 5 (five) years, but based on the results of monitoring conducted by the Department of Health also Balangan at the end of 2014 through the water sample collection and examinations at 33 DWD, there are 20 pieces or 60.6% were water bakteriologisnya quality processed products that are not eligible because they contain *coliform bacteria.* The presence of *coliform* bacteria in the processed water DWD is an indicator of pollution. DWD contamination in water can be caused by factors such DWD sanitation hygiene. Therefore, the objective of this study was to analyze the relationship between hygiene and sanitation with bacteriological quality of DWD in Balangan. It is hoped the information from this study helpful in improving the application of hygiene and sanitation system of DWD future.

METHOD

The design of this study using cross sectional study, data collection is done in the same time with a different subject. This type of research is observational study to analyze the relationship between variables to be studied is the variable quality of sanitation and hygiene with bacteriological quality DWD in Balangan.

The population in this study were all DWD in Balangan 2015 as many as 50 pieces. The sample in this study is the number of DWD taken by purposive

sampling 41 pieces, obtained by inclusion criteria, ie long effort depot is already more than a year and the exclusion criteria the owner or person in charge of the depot willing depot used as objects of research. The research variables consist of independent variables ie location, buildings, production equipment, production processes, sanitation facilities and hygiene sanitation as a whole, while the dependent variable is bacteriological quality.

Instruments in this study is the observation sheet DWD sanitation and hygiene for bacteriological quality checks in the form of the presence of *Escherichia coli* bacteria in drinking water using a double tube. Collecting data by observing a DWD and sampling the water, then the water samples sent for examination water quality to laboratory.

Data analysis was performed in this study using univariate and bivariate analysis techniques. Univariate analysis performed on each of the variables used in the study, with reference to the data obtained from the research. The bivariate analysis done by the correlation between the independent variables with the dependent variable used in the study. Appropriate statistical test used for bivariate analysis in this research is *Chi Square* test.

RESULTS AND DISCUSSION

Univariate analysis conducted on hygiene and sanitation DWD with the variables that describe the condition of the location, construction, production equipment, production processes and sanitation facilities as well as the bacteriological quality of drinking water DWD. Results of hygiene and sanitation conditions DWD presented in Table 1.

Table 1. Hygiene and Sanitation Conditions of Depot Water Drinking

No	Condition	Locations		Building		Production equipment		Production process		Sanitary facilities	
		F	%	F	%	F	%	F	%	F	%
1	Good	28	68	13	32	32	78	26	63	13	32
2	Enough	0	0	18	44	0	0	0	0	18	44
3	Less	13	32	10	24	9	22	15	37	10	24
Amount		41	100	41	100	41	100	41	100	41	100

From the observation of the 41 DWD obtained conditions of DWD locations, 13 (32%) into the category of less, DWD 0 (0%) in the category of enough and 28 (68%) into good category. Building conditions to obtain 10 DWD (24%) into the category of less, 18 DWD (44%) in the category of enough and 13 DWD (32%) into good category. Production equipment conditions obtained 9 DWD (22%) into the category of less, DWD 0 (0%) in the category of enough and 32 DWD (78%) into good category. Production process conditions obtained 15 DWD (37%) into the category of less, 0 DWD (0%) in the category of enough and 26 DWD (63%) into good category. Condition sanitation facilities obtained 10 DWD (24%) into the category of less, 18 DWD (44%) in the category of enough and 13 DWD (32%) into good category. Results of research for bacteriological quality conditions are presented in Table 2.

Table 2. Bacteriological Quality of Drinking Water Depot

No.	Bacteriological Quality of Drinking Water Depot	Frequency	Presentation (%)
1.	Qualify	30	73
2.	Not qualify	11	27
Amount		41	100

From the results of laboratory examination of water samples obtained 30 DWD (73%) into the category of qualify and 11 DWD (27%) into the category are not qualify. Testing hypotheses about the relationship between the location and the bacteriological quality of the DWD are presented in Table 3.

Table 3. Relationships location with Bacteriological Quality DWD

		Bacteriological Quality				Total	%	*p-value*
		Not qualify	%	Qualify	%			
Locations	Less	4	31	9	69	13	100	0, 698
	Good	7	25	21	75	28	100	

Based on the statistical test results in Table 3, from 13 DWD to the location is less, there are 4 DWD (31%) were not qualify and 9 DWD (69%) qualify for the bacteriological quality and from 28 DWD with the conditions of the location is good, there are 7 DWD (25%) were not qualify and 21 DWD (75%) qualify for the bacteriological quality requirements. From the results of the chi square test were conducted on the condition of the location of the bacteriological quality of DWD obtained p value of 0.698. It can be expressed brought no relationship between the condition of the location with the bacteriological quality of DWD in Balangan.

The results of research in the field, from 7 DWD which its location condition was good, everything is not near areas/landfills/dirt, not near the buildup of second-hand goods/hazardous/toxic (B3), no point hiding/breeding of insects, small animals, rodents, etc around DWD, not near the system drains poorly (pooled and open) and there are no puddles or swamps around DWD but do not have sanitation facilities in the form of covered containers, hand washing with running water and soap, so the potential for contamination by bacteriological able to dial that is not hygienic at work such as not washing hands before serving customers that due to the unavailability hand-washing facilities. Whereas from 9 DWD which its location condition was less, although there are hiding places/breeding of insects, small animals, rodents etc around DWD but found no rats, flies or cockroaches plasticity in the building, so it does not pose a risk of contamination bacteriological through rats, flies and or cockroaches.

Determining the location of the depot should avoid the risk of contaminants. The location DWD must be free of pollution originating from dust around depot, the area where the sewage/garbage, where a buildup of junk, hiding/breeding of insects, small animals, rodents, water drains system and other places that could be expected to result in contamination [19]. Based on the results of research in the district of Medan Helvetia in 2012 from 12 DWD are not qualify for location, 91.3% did not meet the bacteriological quality requirements [20].

This study is in line with research in Demak in 2014 stating that there is no relationship between the number of coliform with drinking water depot sanitation. The location is part of its DWD sanitation, but not coincide with the results of research Munthe [20], which states that there is a relationship between DWD location with the bacteriological quality. The location is near the puddles and swamps, near the sewage and garbage, as well as close to the hoarding of goods used or hazardous substances toxic (B3), means near to the sources of pollution that may affect the bacteriological quality of water production. Testing hypotheses about the relationship between the building and the bacteriological quality of the DWD are presented in Table 4.

Table 4. Relationship Building with Bacteriological Quality of DWD

		Bacteriological Quality				Total	%	*p-value*
		Not qualify	%	Qualify	%			
Building	Less	3	30	7	70	10	100	0, 840
	Enough	4	22	14	78	18	100	
	Good	4	31	9	69	13	100	

Based on the statistical test results in Table 4, from 10 DWD to the building conditions is less, there are 3 DWD (30%) were not qualify and 7 DWD (70%) qualify for its bacteriological quality and from 18 DWD to the building conditions is enough, there are 4 DWD (22%) were not qualify and 14 DWD (78%) qualify for its bacteriological quality, as well as from 13 DWD with the conditions of the building is good, there are 4 DWD (31%) were not qualify and 9 DWD (69%) qualify for its bacteriological quality. From the results of chi square test were conducted on the condition of the building with the bacteriological quality of DWD obtained p value of 0.840. It can be expressed brought no relationship between the condition of the building with the bacteriological quality of DWD in Balangan.

The results of research in the field of 4 DWD the condition of the building is good, all the items observations ranging from floors, walls, roofs, ceilings, layout, lighting, ventilation and humidity of the air to meet the requirements but not have sanitation facilities such as hand washing, and not equipped with running water and soap, so the potential for contamination by bacteriological be able to dial that is not hygienic at work such as not washing hands before serving customers that due to the unavailability means washing hands, while from 7 DWD that bulding conditions is less, although the requirement wall watertight, flat surface, smooth, not slippery, not crack, not absorb dust, and easy to clean, and the bright and sunny colors is not met, but the lighting is bright enough to work, not blinding and evenly distributed and no rats, flies and or

cockroach plasticity in the building, so it also does not pose a risk of bacteriological contamination by rodents, flies or cockroaches.

One of the factors affecting the quality of water produced by a water depot was building and its parts, it must be maintained and sanitation follow regularly and periodically [21]. Sanitary of building covering floors, walls, roofs, ceilings, doors, spatial and others. DWD buildings are not maintained feared the dust in the air can directly contaminate drinking water, and when the dust contains bacteria that can cause pollution and affect the bacteriological water quality of the DWD results processed. This study is in line with the results of research in Semarang which indicates that there is no relationship between the cleanliness condition of the building with the presence of bacteria [22]. Testing hypotheses about the relationship between the production equipment and bacteriological quality of DWD are presented in Table 5.

Table 5. Relations Production Equipment with the Bacteriological Quality of DWD

		Bacteriological Quality				Total	%	*p-value*
		Not qualify	%	Qualify	%			
Production equipment	Less	3	33	6	67	9	100	0, 618
	Good	8	25	24	75	32	100	

Based on the statistical test results in Table 5, from 9 DWD to the production equipment conditions is less, there are 3 DWD (33%) were not qualify and 6 DWD (67%) qualify for its bacteriological quality and from 32 DWD with the production equipment conditions is good, there are 8 DWD (25%) were not qualify and 24 DWD (75%) qualify for its bacteriological quality. From the results of chi square test were conducted on the condition of production equipment with the bacteriological quality DWD obtained p value of 0.618. It can be expressed brought no relationship between the condition of the production equipment with the bacteriological quality of DWD in Balangan.

The results of research in the field of 8 DWD the condition of the production equipment is good, all the machinery and equipment that is in direct contact with water made of food grade, have tubs or tanks for the storage of raw water, raw water tub/tank/reservoir closed and shielded, there is a tube filter and it is possible to do system back washing, there is more than one micro filter (μ) with the size of the stages, there equipment sterilization, such as ultra violet and or ozonation or disinfection equipment other function and no facilities washing and rinsing the bottle (gallons) but the layout does not consist of conference processing, storage, sharing / provision, and the visitor reception area/consumer mixes with other goods, this allows consumers to enter into DWD, so the water DWD can be contaminated with consumers, and no sanitation facilities in the form of a closed trash and hand washing facilities with running water and soap, while from 6 DWD which conditions its production equipment is less, although there are no facilities washing and rinsing the bottle (gallon) but in the production process of filling the bottle (gallon) in a closed room and disinfection equipment is still in the life/not expired, so although initially there was bacteria in the water, but after going through the bacteriological disinfection process will die all.

In theory there is a relationship between the production equipment with the bacteriological quality. Machinery and equipment directly related to raw materials or end products must be cleaned and maintained regularly, thus contaminating the final product. Equipment was instrumental in processing the raw water to be drinking water, equipment conditions were not good will cause processing is not optimal. The treatment process is not optimal may cause bacterial contamination [23]. Machinery and equipment used by DWD must be treated periodically according to the type of device and when expired, they must be replaced in accordance with the technical provisions. Surface equipment is in contact with the raw materials and drinking water should be clean and sanitized every day. Surfaces in contact with drinking water must be free of crust, oxidation and other residues. The filling and closing must be sanitary, done in a hygienic room. The behavior has not been obedient in the maintenance by the person causing bacteria content in the treated water is still there [24].

This study does not consistent with the study conducted by Munthe, that there is a relationship tools and supplies of DWD with bacteriological quality [20]. Handling and drinking water processing facilities is not good, then refill drinking water quality is still in doubt, because it can be contaminated with pathogenic microbes [25]. So maintenance of drinking water treatment equipment is also a cause bacteria contamination [2]. Testing hypotheses about the relationship between the production process and the bacteriological quality of DWD are presented in Table 6.

Table 6. Relationship Production Process with the Bacteriological Quality of DWD

		Bacteriological Quality				Total	%	*p-value*
		Not qualify	%	Qualify	%			
Production process	Less	4	27	11	73	15	100	0, 698
	Good	7	27	19	73	26	100	

Based on the statistical test results in Table 6, from 15 DWD to the production process is less, there are 4 DWD (27%) were not qualify and 11 DWD (73%) qualify for its bacteriological quality and from 26 DWD with the conditions of the location is good, there are 7 DWD (27%) were not qualify and 19 DWD (73%) qualify for its bacteriological quality. From the results of chi square test were conducted on the condition of the production process with bacteriological quality of DWD obtained p value of 0.698. It can be expressed brought no relationship between the condition of the production process with bacteriological quality of DWD in Balangan.

The results of research in the field of 7 DWD that production process is good, all DWD did dewatering and washing tub/tank/reservoir of raw water at regular intervals up to 3 months once, do the back washing system periodic, microfilter and disinfection is still in the life/ not expired and filling the bottle (gallon) in a closed room but the layout was not made up the room processing, storage, sharing/provision, and the visitor reception area/consumer and mingled with other merchandise, allows consumers enter into DWD, so water DWD could be contaminated with the consumer before, plus not have the sanitation facilities in the form of a closed trash can and hand washing facilities with running water and soap, while from 11 DWD process of production is less, although did not dewatering and washing tub/tank/reservoir of raw water at regular intervals up to 3 months once but tub/tank/reservoir of raw water enclosed and protected, there is a tube filter and it is possible to do back washing system, there is more than one micro filter (μ) with a size of tiered, and there are sterilization equipment, such as or ultra violet and ozonation and disinfection equipment or other functions that even if there is caused by bacteria that are not drained or washed the tank, after from the tank water still through several stages of the process again which function to kill bacteria.

In the normal production of drinking water necessary to evaluate the drinking water treatment plant on a regular basis to improve the quality of the output, so that the necessary cleaning drinking water treatment efforts so that the produced water has a removal efficiency of high free from bacterial contamination [27] [28]. The processing drinking water depot refill drinking water are not entirely done automatically so can affect the water quality, thus the quality still needs to be studied in order to safeguard water quality [29]. In addition, if the processing is less than optimal can cause presence of bacterial contamination [23].

This study is consistent with research Maharani, that there is no relationship between drinking water treatment process with bacteriological quality of drinking water refill with p value 0.655 [30]. But on the contrary the result of research conducted Asfawi states that there is a significant relationship between the processing refill drinking water with bacteriological quality with value (p-value = 0.035) [31]. Testing hypotheses about the relationship between the sanitary facilities and the bacteriological quality of the DWD are presented in Table 7.

Table 7. Relations Sanitary Facilities with Bacteriological Quality of DWD

		Bacteriological Quality				Total	%	*p-value*
		Not qualify	%	Qualify	%			
Sanitary facilities	Less	2	20	8	80	10	100	0, 698
	Enough	4	22	14	79	18	100	
	Good	5	39	8	61	18	100	

Based on the statistical test results in Table 7, from 10 DWD to the sanitary facilities is less, there are 2 DWD (20%) were not qualify and 8 DWD (80%) qualify for its bacteriological quality and from 18 DWD to the sanitary facilities is enough, there are 4 DWD (22%) were not qualify and 14 DWD (78%) qualify for its bacteriological quality, as well as from 18 DWD with the sanitary facilities is good, there are 5 DWD (39%) were not qualify and 8 DWD (61%) qualify for its bacteriological quality. From the results of chi square test were carried out on the building sanitation facilities with bacteriological

quality DWD p value obtained for 0840. It can be expressed brought no relationship between the condition of sanitation facilities with bacteriological quality of DWD in Balangan.

The results of research in the field of 5 DWD the condition of the sanitary facilities is good, all of which have access to showers and latrines although home owner/manager that is about DWD, no sewerage that flow smoothly and closed and there is a hand basins that include flowing water but governance space does not consist of conference processing, storage, sharin /provision, and the visitor reception area/consumer and mingled with other merchandise, allows consumers enter into DWD, so the water DWD can be contaminated with consumers before, while from 8 DWD the condition of the facilities sanitation is less, although there is sewerage that flow is not smooth and transparent manner and there was no trash-covered, but no rats, flies and cockroaches or plasticity in the building, so it does not pose a risk of bacteriological contamination by rodents, flies or cockroaches.

Depot drinking water should have access to sanitation facilities such as hand basins that include running water, soap and sewerage, adequate bins and closed, sewage (wastewater) and no access to a toilet [19]. The sanitary facilities are not working optimally as drains clogged with garbage, housing and environmental conditions are crowded with septic tank conditions were not good, they cause water pollution [32]. This study does not consistent with the research conducted in the city of Manado and Bitung, with p = 0.032 then there is a significant relationship between sanitation facility with *Escherichia coli* contamination [33].

CONCLUSION

The location is not related to quality of bacteriological water on the DWD, the condition of the building is also not related to quality of bacteriological water on DWD, equipment production is not related to the bacteriological quality of drinking water in the DWD and the production process is also not related with the quality of the bacteriological water on DWD, and sanitation facilities not related to the bacteriological quality of drinking water in the DWD.

Expected to be further research to determine the relationship of other variables in the hygiene and sanitation with bacteriological quality of drinking water such as raw water and employee hygiene or DWD operator.

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