

Evaluation on Water Safety Plan (WSP) in DWSSMG in Gringsing Sub District of Batang Regency

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Evaluation on Water Safety Plan (WSP) in DWSSMG in Gringsing Sub District of Batang Regency

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Abstract—A safe water supply should fulfill quality, quantity, continuity, and accessibility and health requirement. The number of Drinking Water Supply and Sanitation Management Group (DWSSMG) at Village level increases continuously but the management of water security has not fulfilled the requirement. Drinking water scope is still a problem in Batang Regency particularly in five villages in Gringsing Sub District: Lebo (58.29%), Madugowongjati (78%), Sawangan (42.59%), Surodadi (100%), and Tedunan Villages (79.83%). In addition to the decrease in water quality (turbid), the total number of Coliform bacteria exceeds the threshold of standard drinking water quality according to Minister of Health's Regulation No.492/MENKES/PER/IV/ 2010. The objective of research is to find out the map of water safety risk based on quality, quantity, and continuity. The research method used was descriptive semi quantitative one using five-cell risk assessment technique referring to HACCP environmental management system. The sample of research consisted of 45 members of (DWSSMG) and 25 water sample points taken using total sampling technique. The result of assessment on quality-type risk shows 12 risks belonging to very high category, 14 belonging to medium, and 31 belonging to low category, while there is high risk in quantity type in Sawangan Village, 1 very high risk in continuity type in Sawangan Village, and no risk in accessibility type.

Keywords—Water safety plan, Drinking water, Risk Assessment, Hazardous event.

I. INTRODUCTION

Sustainable development goals (SDGs), in point 6.1, state that all States throughout world have agreed to ensure the safe drinking water universally, emphasizing on the importance of structural measure to prevent contamination from occurring in all water supplies. World Health Organization (WHO) introduces 3rd edition of water safety manual called Water safety plan (WSP)¹. Water safety management still becomes a problem in South East Asia, and it does so in Indonesia, where the drinking water safety fulfilling standard quality remains to be big challenge, and the achievement of drinking water health and basic sanitation indicators, according to Ministry of Health, is still below the target (57.82% < 80%)². This condition encourages the feasible and safe drinking water supply to be a strategic issue.

The mandate of Medium-Term Development Plan (RPJMN) in 2020-2024 focuses on three basic frameworks: primary service, economic, and urban infrastructures. Infrastructural development for primary services is directed to bring even development distribution into reality throughout Indonesian areas. Primary service infrastructure that will be constructed involves providing access to feasible, safe, and affordable housing and settlement, access to water and sanitation (liquid waste and rubbish), sustainable groundwater and standard water management. The target of RPJMN in 2020-2024 toward SDGs 2030 is access to feasible water of 75.34% and to plumbing water of 30.45%, while the access to feasible water now, based on National Social-Economic Survey of 2018 is 61.29%, and access to piping in 2018 is 20.29%³.

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Drinking water organization system (*Indonesian: SPAM*) has been governed based on Republic of Indonesia's Government Regulation Number 122 of 2015 stating that the implementation of water supply system organization is conducted by BUMN/BUMD (State/Local Government-owned Enterprises), UPT/UPTD (Technical/Local Technical Service Units), community group or corporation⁴. There are 380 SPAM organizers at regional level, distributed in all Indonesian cities, while there are 28,849 SPAMs at community level, called Drinking Water Supply and Sanitation Management Group (DWSSMG) in Pamsimas Program. There are 4,526 DWSSMGs in Central Java Province and 153 DWSSMGs in Batang Regency.

A safe water supply should meet physical, microbiological, chemical, and radioactive requirements^{5,4}, detailing the parameter of water and supplement needed. An effective consistent method to ensure the water safety is comprehensive risk identification and assessment, as it involves all important measures related to water supply, from source to consumers^{6,7}.

There are five DWSSMGs receiving SPAM construction grant through a Community-Based Water and Sanitation Supply Program (PAMSIMAS) in Lebo Village in 2010, Madugowongjati, Surodadi and Sawangan Villages in 2011, and Tedunan Village in 2019. Three villages use deep well basic water source, Sawangan village uses river as basic water, and Tedunan village uses water source as basic water distributed to consumers. In the last ten years (2010-2020) Lebo village is the one with little access to drinking water (58.29%), Madugowongjati Village (78%), Sawangan Village (42.59%), Surodadi Village (100%), and Tedunan Village (79.83%). In addition, there is a change in water color or quality in Sawangan Village, and there is piping leakage in Lebo, Surodadi, and Sawangan Villages, and there is coliform bacterial contamination > 100 MPN in house plumbing, people complain with itches following using water in Sawangan Village. Considering the preliminary research, the objective of research is to find out the map of water safety risk based on quality, quantity, and continuity, in DWSSMG in Gringsing Sub District area of Batang Regency.

II. METHOD

The processes used in this study were initial observation, interview, and water quality testing in 25 critical points in

five villages of Gringsing Sub District. Five (5) sample points were taken from each water reservoir, distributed water, and house plumbing in all villages using HACCP method, i.e. by analyzing the hazard with identification control point, and evaluating and controlling significant hazard to food security⁸. Water safety hazard was identified from the result of interview and questionnaire distributed to DWSSMG in Gringsing Sub District area of Batang Regency, Indonesia by applying Water Safety Plan model (WHO)⁷.

This research employed descriptive semi-quantitative case study with matrix approach and five-cell risk assessment for applying technical information and regulation^{9,10,11}. Different color background of categories representing the consequence severity is illustrated in table 1. With this semi-quantitative assessment, controlling measure can be controlled from the time when hazard occurs. The risk can be categorized by identifying the potential incidence and evaluating its consequence severity, as illustrated in table 2. Intersection is determined by hazard needing attention immediately. Risk should be assessed to distinguish the bigger hazardous event from the smaller one, so that the order of risk management priority can be developed and documented. It is important because despite many contaminants that can degrade water quality, not all hazards need the same attention⁷. The determination of risk size facilitates the process of evaluating a risk improving program, by seeing the change of risk score. The risk size is classified into four categories: very high category with risk score ≥ 15 , high category with risk score = 10-15, and low category with risk score < 6.

To develop the map of water safety risk in DWSSMGs in Gringsing Sub District of Batang Regency, ARC GIS 10.3 software was used. This mapping is intended to facilitate both organizers and stakeholders of *Dinas Cipta Karyadan Permukiman* (Work Creation and Settlement Service) to conduct building and to make policy. The result of identification is the portrait and condition of water safety in DWSSMG in Gringsing Sub District in 2020. Condition of water safety is classified into some colors: green or mild risk with score of 0-1, moderate risk with score of 2-4, and high risk with score of 5-9. The higher the risk of water safety, the more hazardous is it to human health and it should be dealt with immediately and the organizer should improve water supply.

Table.1 Matrix of Water Risk Assessment

Probability of incidence	Risk severity					Color definition	
	Very small	Small	Medium	Big	Very big		
Scale	1	2	3	4	5		
Almost always	5	5	10	15	20	25	1-5 low (green)
Often	4	4	8	12	16	20	6-9 medium (yellow)
Moderate	3	3	6	9	12	15	10-15 high risk (orange)
Small	2	2	4	6	8	10	≥16 very high (red)
Very Small	1	1	2	3	4	5	

Table.2 Water risk assessment scale

Incidence Probability Scale		
1	Very rarely	More than once a year
2	Rarely	Once a year
3	Moderately	Monthly
4	Frequently	Weekly
5	Almost always	Daily
Risk Severity Scale		
1	Very high	Undetected effect
2	High	Affecting aesthetically the water, but it is still consumable
3	Medium	Affecting aesthetically the water, and making the water having taste and odor, and unsafe
4	High	Resulting in illness among people
5	Very high	Resulting in sudden death

III. RESULT

Risk assessment in this study involves water supplying system existing in five villages in Gringsing Sub District of Batang Regency of Central Java Province. Hazard identification and water safety risk assessment are conducted on the water coming from water source in reservoir, pipe, distribution, and plumbing in five villages in Gringsing Sub District of Batang Regency as illustrated in Figure 1.

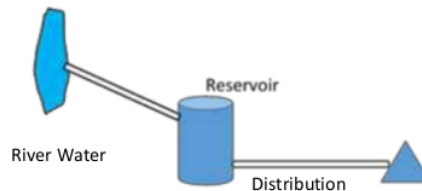



Fig.1. Plumbing System in Sawangan Village, Gringsing Sub District, Batang Regency, 2020

Table 3. Assessment of Water Safety Risk in Surodadi Village, Gringsing Sub District, Batang, 2020

No	Type of Hazardous event	Risk Assessment	Color Definition	Risk category
A Type of Quality K1				
1	Primary Water Source of Reservoir			
	a) Color Change in reservoir	4		Low
	b) Sediment on the bottom of reservoir	4		Low
	c) Fecal Contamination	9		
	d) Pathogenic contamination	2		Low
	e) Frequently dirty reservoir	2		Low
2	Water source in distribution pipe			
	a) Water leakage on distribution pipe	9		Medium
	b) Opened unplanted pipe on the ground	4		Low
	c) Non-hygienic plumbing handling	4		Low
	d) Water contamination due to leaked pipe	9		Medium
3	Water source in consumer plumbing			
	a) Total coliform contamination in house plumbing faucet	16		Very High
	b) Installation leakage in pipe meter	4		Low
	c) Poor quality of product or accessories	4		Low
	d) Poor quality of house plumbing installation	4		Low
B Type of Quantity K2				
1	Decreased basic water flow rate	4		Low
2	A large volume of domestic waste entering basic water source	4		Low
3	A large amount of weeds covering basic water tapper	4		Low
4	The change of water quality and quantity in rainy season	4		Low
C Type of Risk Continuity K3				
1	Water flows for 20 - < 24 hours	1		Low
2	Water flows for 8 - < 24 hours			
3	Water flows for 4 - 5 hours			
4	Water does not flow for a (1) day			
5	Water does not flow for > a (1) day			
D Type of Accessibility Risk K4				
1	Water price is < 1% of people's income	1		Low
2	Water price is 1-4% of people's income			
3	Water price is 4-6% of people's income			
4	Water price is 6-8% of people's income			

No	Type of Hazardous event	Risk Assessment	Color Definition	Risk category
5	Water price is >8 % of people's income			

Table 4 Assessment of Water Safety Risk in Tedunan Village, Gringsing Sub District, Batang Regency, 2020

No	Type of Hazardous event	Early risk assessment	Color definition	Category
A Type of Quality K1				
1	Reservoir basic water source			
	a) Color change in reservoir	4		Low
	b) Sediment on the bottom of reservoir	4		Low
	c) Fecal contamination	9		Medium
	d) Pathogenic contamination	2		Low
	e) Frequently dirty reservoir	2		Low
2	Water source in distribution pipe			
	a) Water leakage in distribution pipe	9		Medium
	b) Opened unplanted pipe in the ground	2		Low
	c) Not-hygienic plumbing management	2		Low
	d) Water contamination due to leaked pipe	3		Medium
3	Water source in consumer plumbing			
	a) Total Coliform contamination in house plumbing faucet	16		Very High
	b) Installation leakage in pipe meter	4		Low
	c) Poor quality of product or accessories used	4		Low
	d) Poor quality of house plumbing	9		Medium
B Type of Quantity K2				
1	Decreased flow rate of basic water	4		Low
2	A large volume of domestic waste entering basic water source	4		Low
3	A large amount of weeds covering basic water tapper	4		Low
4	The change of water quality and quantity in rainy season	9		Medium
C Type of Risk Continuity K3				
1	Water flows for 20 -< 24 hours	1		Low
2	Water flows for 8 - < 24 hours			
3	Water flows for 4 – 5 hours			
4	Water does not flow for a (1) day			

No	Type of Hazardous event	Early risk assessment	Color definition	Category
5	Water does not flow for > a (1) day			
D	Type of Accessibility Risk K4			
1	Water price is < 1% of people's income	1		Low
2	Water price is 1-4% of people's income			
3	Water price is 4-6% of people's income			
4	Water price is 6-8% of people's income			
5	Water price is >8 % of people's income			

Table 5. Assessment of Water Safety Risk in Madugowongjati Village, Gringsing Sub District, Batang Regency, 2020

No	Type of Hazardous event	Early risk assessment	Color definition	Category
A	Type of Quality K1			
1	Primary Water Source of Reservoir			
	a) Color Change in reservoir	4		Low
	b) Sediment on the bottom of reservoir	4		Low
	c) Fecal Contamination	6		Low
	d) Pathogenic contamination	4		Low
	e) Frequently dirty reservoir	4		Low
2	Water source in distribution pipe			
	a) Water leakage on distribution pipe			
	b) Opened unplanted pipe on the ground	6		Low
	c) Non-hygienic plumbing handling	4		Low
	d) Water contamination due to leaked pipe	4		Low
3	Water source in consumer plumbing	4		Low
	a) Total coliform contamination in house plumbing faucet			
	b) Installation leakage in pipe meter	9		medium
	c) Poor quality of product or accessories	2		Low
	d) Poor quality of house plumbing installation	4		Low
B	Type of Quantity K2			
1	Decreased flow rate of basic water			medium
2	A large volume of domestic waste entering basic water source	4		Low
3	A large amount of weeds covering basic water tapper	4		Low
4	The change of water quality and quantity in rainy season	4		Low
C	Type of Risk K3			

No	Type of Hazardous event	Early risk assessment	Color definition	Category
1	Water flows for 20 -< 24 hours	1		Low
2	Water flows for 8 - < 24 hours			
3	Water flows for 4 – 5 hours			
4	Water does not flow for a (1) day			
5	Water does not flow for > a (1) day			
D	Type of Accessibility Risk K4			
1	Water price is < 1% of people's income	1		Low
2	Water price is 1-4% of people's income			
3	Water price is 4-6% of people's income			
4	Water price is 6-81% of people's income			
5	Water price is >8 % of people's income			

Tabel.6. Assessment of Water Safety Risk in Sawangan Village, Gringsing Sub District, Batang Regency, 2020

No	Type of Hazardous event	Color Definition	Category
A	Type of Quality K1		
1	Primary Water Source of Reservoir		
	a) Color Change in reservoir	16	Very High
	b) Sediment on the bottom of reservoir	16	Very High
	c) Fecal Contamination	9	Medium
	d) Pathogenic contamination	16	Very High
	e) Frequently dirty reservoir	16	Very High
2	Water source in distribution pipe		
	a) Water leakage on distribution pipe	16	Very High
	b) Opened unplanted pipe on the ground	16	Very High
	c) Non-hygienic plumbing handling	9	Medium
	d) Water contamination due to leaked pipe	4	Low
3	Water source in consumer plumbing		
	a) Total coliform contamination in house plumbing faucet	16	Very High
	b) Installation leakage in pipe meter	16	Very High
	c) Poor quality of product or accessories	4	Low
	d) Poor quality of house plumbing installation	9	Medium
B	Type of Quantity K2		
1	Decreased basic water flow rate	16	Very High
2	A large volume of domestic waste entering basic water source	9	Medium
3	A large amount of weeds covering basic water	4	Low

No	Type of Hazardous event	Color Definition	Category
	tapper		
4	The change of water quality and quantity in rainy season	16	Very High
C Type of Risk Continuity K3			
1	Water flows for 20 -< 24 hours	1	Low
2	Water flows for 8 - < 24 hours		
3	Water flows for 4 – 5 hours	16	Very High
4	Water does not flow for a (1) day		
5	Water does not flow for > a (1) day		
D Type of Accessibility Risk K4			
1	Water price is < 1% of people's income	1	Low
2	Water price is 1-4% of people's income		
3	Water price is 4-6% of people's income		
4	Water price is 6-8% of people's income		
5	Water price is >8 % of people's income		

Table.7 Assessment of Water Safety Risk in Lebo Village, Gringsing Sub District, Batang Regency, 2020

No	Type of Hazardous event	Color Definition	Category
A Type of Quality K1			
1	Primary Water Source of Reservoir		
	a) Color Change in reservoir	9	Medium
	b) Sediment on the bottom of reservoir	16	Very High
	c) Fecal Contamination	4	Low
	d) Pathogenic contamination	4	Low
	e) Frequently dirty reservoir	4	Low
2	Water source in distribution pipe		
	a) Water leakage on distribution pipe	9	Medium
	b) Opened unplanted pipe on the ground	16	Very High
	c) Non-hygienic plumbing handling	6	Medium
	d) Water contamination due to leaked pipe	6	Low
3	Water source in consumer plumbing		
	a) Total coliform contamination in house plumbing faucet	16	Very High
	b) Installation leakage in pipe meter	4	Low
	c) Poor quality of product or accessories	4	Low
	d) Poor quality of house plumbing installation	4	Medium
B Type of Quantity K2			

No	Type of Hazardous event	Color Definition		Category
		Value	Color	
1	Decreased basic water flow rate	4	Green	Low
2	A large volume of domestic waste entering basic water source	4	Yellow	Medium
3	A large amount of weeds covering basic water tapper	4	Green	Low
4	The change of water quality and quantity in rainy season	4	Green	Low
C Type of Risk Continuity K3				
1	Water flows for 20 -< 24 hours	1	Green	Low
2	Water flows for 8 - < 24 hours			
3	Water flows for 4 – 5 hours			
4	Water does not flow for a (1) day			
5	Water does not flow for > a (1) day			
D Type of Accessibility Risk K4				
1	Water price is < 1% of people’s income	1	Green	Low
2	Water price is 1-4% of people’s income			
3	Water price is 4-6% of people’s income			
4	Water price is 6-8% of people’s income			
5	Water price is >8 % of people’s income			

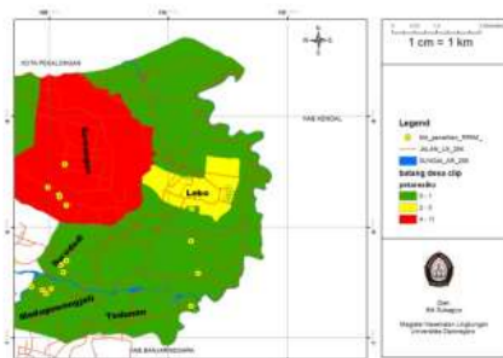


Fig.2: Map of Water Safety Risk in DWSSMG in Gringsing Sub District of Batang Regency in 2020

IV. DISCUSSION

Drinking water, based on Minister of Health Regulation No.492/Menkes/PER/IV/2010 about the requirement of drinking water quality is the one passing through processing activity or without processing activity that complies with health condition and is drinkable. Meanwhile, safe water access is defined as household using feasible water source, in which water source is located either inside or outside the house (in the house

yard), available anytime it is needed, and the quality of water used complies with the requirement of water quality in Indonesia¹². Water Safety Plan is intended primarily to ensure quality, quantity, continuity, and accessibility.

The result of water safety risk assessment in Surodadi Village presented in Table1 shows very high category (red) in house plumbing in the presence of Coliform 85 MPN/100 MI bacterium. It is because there is water meter leakage in house plumbing. Coliform is a class of

Enterobacteriaceae bacterium. This class is defined as aerobic or optionally anaerobic. Total coliform is used to find the effectiveness and integrity of water processing. At certain condition, Coliform can proliferate in water distribution system¹³. Standard piping water quality, based on Permenkes No. 492 of 2010 about drinking water quality, is 0 MPN/100 ml⁵. Meanwhile, the margin of standard clean water quality allowed based on Permenkes No. 32 of 2017 is 50 MPN/100 ML¹⁴. The presence of pathogen and Coliform bacteria 85 MPN/100 MI in house plumbing indicates unqualified water quality. It will affect indirectly the health. The result of assessment indicates Medium risk category (yellow), in which there are distribution pipe leakage and contamination in the leaked pipe.

The result of assessment on water safety risk in Tedunan Village, as presented in Table 2, shows 1 (one) very high risk category with score = 16, meaning that there is *Coliform* 132 MPN/100 ml in house plumbing, 4 (four) medium risk categories in reservoir water source due to contamination, distribution pipe leakage, and contamination due to leaked pipe and poor quality of house plumbing installation, and 8 (eight) low risk categories. The contamination of *Coliform* bacterium in house plumbing is because the standard water source used is the one coming from mountains. Disinfection and chlorination processes have not been conducted yet by DWSSMG, so that water supply from water source is distributed directly to consumers. This condition enables bacteria coming from manure to enter it. The presence of pathogenic and *Coliform* bacteria indicates unsafe water quality⁵.

The assessment in Madugowongjati Village found 1 (one) medium risk category in total *Coliform* bacterial contamination of 39 MPN/100 ml in consumer's plumbing or the end of SR. The presence of total coliform bacterium in piping installation is because of no water processing and disinfecting activity, thereby leading bacteria to potentially grow later. In this study, water safety plan (WSP) is defined as an attempt of securing water, either qualitatively or quantitatively. Quality aspect includes contamination prevention, while quantity aspect includes service accessibility to consumers.

In Sawangan there are 8 (eight) very high risk categories, 4 (four) of which are found in primary water source of reservoir (the change of water color in reservoir, sediment on the bottom of reservoir, pathogenic contamination, and frequently dirty reservoir), 2 (two) in distribution pipe water source (distribution pipe leakage and opened pipe), and 2 (two) in consumers' plumbing system (total coliform contamination and pipe meter installation leakage). Three (3) medium risk categories are

found including 1 (one) risk in reservoir water source (fecal contamination) 1 (one) in distribution pipe, and 1 (one) in consumers' plumbing system due to less hygienic pipe installation. The result of identification and investigation on plumbing system along with the management indicates that color change event often occurs in reservoir during rainy season, basic water source coming from the river without processing activity is the main cause of it. Such condition is illustrated in figure 2. Primary water distribution system streams the water directly from the river to reservoir to be flowed through distribution pipe then to the customers. This condition is in line with IWA's study finding that water catchment coming from both plantation and forest affects negatively the quality of water¹⁵. It also results in sediment inside water reservoir. WHO's guide¹⁰ of 2017 states that surface water processing system should be able to achieve less than 0.03 NTU before disinfection⁷. The quality water source is controlled to prevent the condition and utilization degradation from occurring that will harm the health¹⁴.

The next event is the opened pipe (score = 16) in distribution pipe and plumbing pipe is on opened and unplanted position. This condition increases the risk of broken pipe and *Coliform* bacterial contamination in drinking water source. The unplanted pipe is due to piping installation not complying with the required quality standard. The requirement of healthy use for hygiene and sanitation mentions that the pipe should be implanted safely and there may not be cross connection to liquid waste pipe on land surface¹⁴. Water safety plan includes several aspects, among others: (1) collection or storage, (2) Processing Unit, and (3) Distribution unit constituting piping system distributing water from the processing unit to customer¹³. The system existing in Sawangan Village is different from the one recommended by World Health Organization (WHO), in which there is no water processing activity that will harm the consumers' health.

Table 6 presenting the result of assessment on water safety risk in DWSSMG in Sawangan Village represents the condition of water supplying system today in Gringsing Sub District area of Batang Regency, and it can occur in other regions. About 11 hazardous events (risks) occur in Sawangan Village belonging to quality, quantity, continuity, and accessibility categories. This condition should be controlled and prevented immediately, in order to provide an alternative method to deal with the hazard and the risk, one of which is through validating the alternative controlling measure⁷. This measure is taken to remove or to reduce risk and hazardous event in water supply system to ensure the safe water supply. The procedure of control should be arranged well in order to be reference to the organizer or DWSSMG. A list containing

some constraints or choices can serve as a useful reserve to a failed measure in order to deal with the hazardous event and the risk successfully. The result of observation on water quality in five Villages in Gringsing Sub District shows that the distribution system has not been equipped with some treatment before reaching the consumers. The good water safety system, according to WHO (world Health Organization)'s guidelines should includes source, treatment, distribution, and consumer¹⁶.

As presented in Table 1, the risk can be identified in some stages by its probability and severity¹⁷.

4.1. Analysis of Water Safety Quantity Risk in DWSSMG in Gringsing Sub District of Batang Regency in 2020

In this subsection, the analysis on quantity-type risk is conducted based on Table 6. Out of five DWSSMGs existing in Gringsing Sub District, one in Sawangan village shows the decreased water supply in both rainy and dry seasons, in which water flows only 4-5 hours a day, and basic water supply coming from river existing in the forest cannot meet the customers' need for water. The customers also inform that water flows in the evening and the morning only, with alternating system. There are 904 DWSSMGs beneficiaries in Sawangan village. The Minister of Internal Affairs' Regulation about technical guidelines and procedures of regulating water tariff in drinking water local company number 23 of 2006 mentions that the need for water is 60 liter/person/day¹⁸. In this case, the organizer cannot meet the required quantity to suffice the consumers' need. In such condition, people should meet their need for water by getting water individually from the water source existing in the forest, in which the water safety cannot be ensured. The authors also recommend the village government to support the fulfillment of water need using Village fund or by applying for the Regency Allocation fund.

4.2. Risk Analysis of Water Safety in Continuity Category in DWSSMG in Gringsing Sub District of Batang Regency in 2020

Continuity, in this subsection, is defined as water flowing continuously anytime without alternating system¹⁹. The result of identification on five DWSSMGs in Gringsing Sub District shows that only the one in Sawangan Village experiences water flowing discontinuously to the customers. DWSSMG officer also informs the water's flowrate incapable of meeting the customers need for water, 60 liter /person/day¹⁸. Meanwhile, the condition of water supply flows for 20-<24 hours per day, belonging to safe category, in Surodadi, Lebo, Tedunan, and Madugowongjati Villages. The constraint found in Sawangan Village is related to water flow rate and supply that cannot meet the customers' need for water. It is

because of the uncertain river water source existing in the forest and used by the farmers to irrigate the farm. Primary water source of river belongs to unfeasible basic water source category. Inadequate water supply will potentially lead to water contamination¹⁰. This condition should be resolved by increasing basic (primary) water source to supply the community as customers.

4.3. Risk Analysis on the WSP's Accessibility in five DWSSMGs in Gringsing Sub District of Batang Regency in 2020

This subsection identifies and presents the result of interview with the members of DWSSMG leadership in five corresponding villages, with the average water price of IDR 1,000/m³ and the result of interview with the representatives of customers indicating that the price is cheap and they should pay IDR25,000-IDR30,000 for water. The authors also conduct a survey of water price in PDAM (Drinking Water Local Company) and finds that the water price in five villages is still less than IDR2500/m³, meaning that water users in five villages (Surodadi, Tedunan, Sawangan, Madugowongjati, and Lebo) still can pay the price of water managed by KPSPAM.

4.4. Environment-Based Disease Incidence Condition in Puskesmas Gringsing 2 Area

Water-waste is a disease resulting from poor water cleanliness and becomes a problem because the water available is not sufficient for washing purpose. This disease often develops in mountain area, including typhus, scabies, ear and eye infections¹. Considering the information acquired from sanitarians of Puskesmas Gringsing 2, *Gastritis* and *Dermatitis* belong to 10 top diseases in the area²⁰. Gastritis incidence occurs mostly on November, and toward rainy season.

4.5. The Control of Water Safety Risk incidence in five DWSSMGs in Gringsing Sub District of Batang Regency in 2020

The control of risk incidence is the follow up of the result of identification of risk incidence. Each incidence can occur more than once. From the database of incidence, the probability scale of hazardous event can be found. The more frequently the incidence occurs, the larger is the probability scale of incidence. Each hazardous event also has risk severity, either highly severe or mild. The more severe the effect of hazardous event risk, the larger is the risk severity scale.

From table 20, it can be seen that considering the control of risk in five DWSSMGs in the villages in Gringsing Sub District of Batang Regency, controlling measure should be taken on Sawangan Village with 8

water safety risks belonging to high category. This incidence will affect water safety and people's health.

Risk control in Surodadi Village was implemented to 2 high-category risks needing immediate resolution: 1) broken water meter, and 2) the presence of coliform bacterium in house plumbing. These two high-category risks were followed-up by the organizer of DWSSMG in Surodadi Village by communicating the damage and the cost of water meter purchasing to the customers, but it has not been purchased yet because unavailable fund. The broken water meter incidence leads to water leakage potentially enabling the external bacteria to enter into it. It is indicated with the sample containing *Coliform* bacterium 85 MPN/100 ml. The controlling measure taken over the presence of bacteria in DWSSMG so far has not used disinfection or chlorination yet, because of limited knowledge and fund. The determinants of successful water safety implementation are technical capacity development, public participation, and monitoring and verification²¹. In addition, the controlling measures taken are to drain reservoir periodically, and to repair the leaked pipe plumbing. Such condition is in line with previous study²² finding the presence of coliform bacterium in reservoir and plumbing, because no regular disinfection and draining processes are conducted.

Risk controlling measures taken in Tedunan Village are similar to those in Surodadi Village. One (1) incidence is found where there is *Coliform* bacterium in reservoirs 1 and 2, and house plumbing, with scores of 468 MPN/100 ml, 132 MPN/100 ml, and 108 MPN/100 ml, respectively. Supply chain of water source without disinfection process potentially results in *Coliform* bacteria in house plumbing. Disinfection of basic water source is not conducted due to limited knowledge and fund, so that the controlling measures taken are to repair the leaked tools. Chlorine chemical administration is intended to kill bacteria or hazardous microorganisms contained in the water. Household water disinfection in developing countries is conducted to maintain the residual concentration of water and to protect the customers from post-maintenance and storage contamination, using hypochlorite 0.5% and 0.1%. The recommended dose of free chlorination is 2 mg/liter for clear water (turbidity < 10 nephelometric unit) and 4 mg/liter for turbid water (turbidity > 10 nephelometric unit), and residual chlorine of 0.2 – 0.5 mg/liter⁷, but it is still becomes the topic of discussion for DWSSMG team as it is related to funding and human resource. Coordination is also established with Puskesmas (Public Health Centers) in Gringsing Sub District, concerning the supervision of water safety that has been done by conducting laboratory test on water periodically.

Risk control in Sawangan Village of Gringsing Sub District, Batang Regency is conducted over 8 (eight) risks belonging to high category. 1) Sediment on the bottom of reservoir is controlled by scheduling the reservoir draining routinely by technical team or operator. It is intended to reduce pathogen or dirt contained in reservoir. Water supply coming from the river and streamed into reservoir without processing activity potentially leads to poor quality of water. It can be seen from the result of quality test on the sample water shown in table 9.

The result of bacteriology test on water in Sawangan Village shows that from the five sampling points in water source, the turbidity is found (136 NTU), and *Coliform* bacterium of 396 MPN/100 ml is found in reservoir, it surpasses the threshold, leakage is found in house plumbing, and *Coliform* bacteria is found in all sampling points with the score surpassing the threshold. It does not meet the requirement specified in Minister of Health's Regulation No.492 of 2010 about water quality, 0 MPN/100 ml⁵.

The control of water safety risk in DWSSMG in Gringsing Sub District of Batang Regency is presented in detail in table 9.

Village	Hazardous Event	Controlling Measure	Correcting Measure
Surodadi	Broken water meter in SR	Repairing and changing water meter in house plumbing	Having not been conducted yet, waiting for fund
	<i>Coliform</i> bacterium found in reservoir and reservoir and SR	Draining reservoir periodically	Not conducted routinely yet
Tedunan	E.Coli and total <i>Coliform</i> in reservoirs 1 and 2, and house plumbing.	Installing injection for chlorination in reservoir 2	Not conducted yet due to limited human resource and fund
Sawangan	Sediment on the bottom of reservoir	Constructing basin before putting it into reservoir, and draining the reservoir routinely	Not conducted yet due to limited fund as it needs much fund

Village	Hazardous Event	Controlling Measure	Correcting Measure	Village	Hazardous Event	Controlling Measure	Correcting Measure
	Pathogenic contamination in reservoir	Preparing screen or filter on catching tub or bar screen	Not conducted optimally yet optimal		Opened unplanted pipe on distribution installation	Repairing pipe and covering the pipe in order to be planted into the ground	Has been conducted less optimally
	Manure in reservoir	Preparing screening on catching tub and constructing tub to process the water before distribution	Using cloth to refine the water		Coliform bacterial contamination in leaked distribution installation	Repairing piping plumbing correctly	Routine examination on water quality at least once in 6 months.
	Broken pipe in plumbing installation	Repairing and connecting the pipes	Having been conducted not optimally related to the esthetics of plumbing		Coliform bacteria in the broken house plumbing h	Repairing house plumbing	Routine examination of water quality at least once in 6 (six) months
	Opened pipes	Repairing and covering the opened pipe	Not conducted yet because some pipes are still opened and broken around the road				
	E.Coli and Coliform bacteria in water source and house plumbing	Routinely reservoir draining and chlorination injection	Injection and chlorination have not been conducted yet due to limited human resource and fund				
Lebo	Sediment on the bottom of reservoir	Draining and injecting and chlorinating or disinfecting routinely	Draining has been conducted, but chlorination injection has not been				

Considering the evaluation ¹² in risk control as shown in table 9 and referring to World Health Organization (WHO)'s handbook of water safety plan of 2017, the next stage is evaluating and monitoring the team⁷. Due to limited research period, evaluating and correcting measures have not been taken yet to reduce the water safety risk in DWSSMG in Gringsing Sub District of Batang Regency in this research in 2020, but it is put into recommendation section. The effort of correcting the result of identification and risk assessment should be done well and mitigated correctly, as a measure to reduce water safety risk.

V. CONCLUSION

The map of water safety risk condition in DWSSMG in Gringsing Sub District of Batang Regency in 2020 indicates that Sawangan Village belongs to high risk category, Lebo to Medium, and Tedun ¹¹ Surodadi, and Madugowongjati to low risk category. Quality, quantity, and continuity conditions of drinking water in Sawangan Village belong to high risk category that will harm the health, while to ensure the water safety, DWSSMG should take some correcting measures: a) repairing the basic water source for drinking water processing, b) scheduling reservoir draining periodically, c) providing filter on catching tub, d) repairing the connection in distribution and plumbing pipes, e) chlorination in reservoir, and f) increasing basic water source. Meanwhile, the correcting

measures taken in Lebo Village are: a) scheduling reservoir draining, b) disinfection or chlorination, c) training for reinforcing WSP in DWSSMG.

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