Implementation of Water Safety Plans (WSPs): A Case Study in the Coastal Area in Semarang City, Indonesia

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Abstract. An area of 508.28 hectares in North Semarang is flooded by tidal inundation, including Bandarharjo village, which could affect water quality in the area. People in Bandarharjo use safe water from deep groundwater, without disinfection process. More than 90% of water samples in the Bandarharjo village had poor bacteriological quality. The aim of the research was to describe the implementation of Water Safety Plans (WSPs) program in Bandarharjo village. This was a descriptive study with steps for implementations adopted the guidelines and tools of the World Health Organization. The steps consist of introducing WSPs program, team building, training the team, examination of water safety before risk assessment, risk assessment, minor repair I, examination of water safety risk, minor repair I (after monitoring). Data were analyzed using descriptive methods. WSPs program has been introduced and formed WSPs team, and the training of the team has been conducted. The team was able to conduct risks assessment, planned the activities, examined water quality, conduct minor repair and monitoring at the source, distribution, and households connection. The WSPs program could be implemented in the coastal area in Semarang, however regularly supervision and some adjustment are needed.

Keywords: implementation, WSPs program, risk assessment, tidal inundation, coastal area.

1. Introduction
In 2011, tidal inundation (the local term is rob) in the urban area of Semarang affected 1,538.8 hectares. North Semarang is the largest rob-affected area as many as 508.28 hectares [1]. North Semarang consists of 9 villages [2]. Bandarharjo and Tanjung Mas are affected by tidal inundation (rob) that reached 20-60 cm in height. Compare to other villages, Bandarharjo and Tanjung Mas experienced the deepest subsidence, which reached 4 cm/year [3].

Rob influences the quality of clean water in the areas [4]. A study in 2007 showed more than half (59%) of 39 respondents in Bandarharjo village used unsafe water in term of bacteriological quality [5]. Other study revealed 88.9% out of 27 sample water from wells in Bandarharjo had high MPN, a measurement of total coliform [6]. By 2010, people in Bandarharjo started to use deep groundwater (artesian wells). The wells belong to some owners with many customers. Counted 45% out of 20 water samples of deep groundwater were not met the requirement in terms bacteriological quality. Microbial contamination of major urban has the potential to cause outbreaks of waterborne disease [7].

World Health Organization (WHO) has developed guidelines and tools to promote water safety plans (WSPs) to improve the drinking water quality through risk identification, communication,
and management approach using HACCP (hazard identification and critical control points), a tool previous developed and used for food quality control [8]. The WSPs is an instrument in water quality management in floods and natural disasters areas. In this study, tidal inundation (rob) affected area of Semarang was chosen for WSPs implementation.

2. Methodology

2.1. Study design

The location was in RW II Bandarharjo, Semarang is chosen based on initial bacteriological water quality of deep groundwater. Research activities used the framework of WSPs guidelines [8], steps included: introduction of WSPs to community was conducted by presentation and discussion method; the formation of WSPs team building by workshop method; training the team by presentation, exercise, simulation, and field visit method; conduct risk assessment of water safety by WSPs team using tools of WHO; conduct minor repair I after risk assessment; monitoring of water safety risk; minor repair II after monitoring of WSPs field trial in rob area [9]. This work used descriptive study and the data are analyzed by describing both qualitatively and quantitatively [10],[11].

2.2. Introducing WSPs program and team building

The introduction of WSPs was facilitated by Faculty of Public Health, Diponegoro University and WHO representatives of Indonesia which were motivated by the health problem and quality of drinking water in Bandarharjo. Health problems are based on the incidence of waterborne diseases i.e., diarrhea, dysentery, shigellosis, typhoid, and skin problem [12]. These diseases are getting an increase during 2011-2013 as well as lower in clean water coverage. The problem also was supported by a previous study [5],[6] and preliminary study. These data are intended to make problem awareness of the stakeholders. The meeting was held and attended by stakeholders in Bandarharjo, there are village officer, women group, youth group, community empowerment board at the village level, health officer, local government water supply officer, deep groundwater owners, village security group, and the customers. Facilitator and an expert presented the background of a health problem-related water supply in the area as well as discussion. The most important in the meeting was understand the health problem by the stakeholders and made the commitment to them for overcoming the problem. Each participant or group brainstorms and declares the willingness to implement the WSPs program.

A team of WSPs was developed after had commitment among the stakeholders to implement WSPs program. The team structure of WSPs consisted of the head of WSPs team (coordinator), secretary, technical unit, monitoring, and evaluation unit, and others were the member. The team of WSPs was legalized under the decree had signed by the head of the Bandarahrjo village office.

2.3. Risk assessment

A semi-quantitative risk matrix had been used to assess the risk. The matrix consists of 5 columns and 5 rows. The columns contain the degree of severity (consequences), whereas the rows contain the appearance or frequency of risk. The description of how to rate the assessment point is as follow a. The frequency of occurrence: once a day (5), once a week (4), once in a month (3), once in a year (2), once in 5 years (1); b. Degrees of severity: no effect (1), a small impact of compliance (2), a medium impact of aesthetic (3), impact on regulation (4), impact (disaster) on public health (5); c. Risk value and degrees of risk: low risk (< 6), medium risk (6-9), high risk (10-15), very high risk (>15) [8],[10], [13]. An instrument for observation and risk assessment consists of items to the risk of contamination of the drinking water supply system. The instrument is in the form of checklist to observe and assess the risk of water supply system: at a source, process, distribution and consumer levels. This instrument is used by the team for assessing the risk.
2.4. Minor repair
Minor repairs are made based on the results of risk assessment and monitoring. This activity was carried out by the WSPs team along with the owners of artesian wells. The provision of materials and tools for minor repairs is done by sharing resources between owners and the WSPs team. Minor repairs included at the source, distribution, or house connection. For example repair of reservoirs, distribution pipes, house connection pipes, and water meters.

2.5. Monitoring of risk
Monitoring was conducted by the WSPs team consisting of health workers, artesian wells owners, security groups, and technical units. Monitoring activities are carried out in accordance with the agreed schedule and used an instrument/checklist. The monitoring team will perform the survey of water supply system ranging from water sources, distribution systems, and households connections that had minor repair and unconfirmed improvements. Monitoring officers observed and recorded if there were damage, leaking pipes, loose pipes, broken pipe, or submerged water meters. The results of the follow-up monitoring activities were discussed with the WSPs team for planning for further improvements [14],[15].

3. Results and Discussion

3.1. Results
In 2011, tidal inundation (the local term is rob) in the urban area of Semarang affected 1,538.8 hectares. North Semarang is the largest rob-affected area as many as 508.28 hectares [1]. North Semarang consists of 9 villages [2]. Bandarharjo and Tanjung Mas are affected by tidal inundation (rob) that reached 20-60 cm in height. Compare to other villages, Bandarharjo and Tanjung Mas experienced the deepest subsidence, which reached 4 cm/year [3].

3.1.1. Introducing of WSPs
Thirty persons participated in this activity, consisted of owners of the deep groundwater, customers/users, the Bandarharjo village officer, staff of local government of drinking water supply system, youth community organization, women organization, technical water sanitation of the village, health officers from primary health care (PHC), and others. First session discussion revealed: (a) WHO and Faculty of Public Health (FPH) Diponegoro University intended to apply Water Safety Plan (WSPs) in rob area of Bandarharjo due to unsafe water in term of bacteriological quality. The purpose was to secure water in order to ensure the water quality; (b) The quality of water in Bandarharjo is deficient as rob and flood contaminate the water; (c) Most residents obtain water from deep ground wells; (d) There are 10 owners of deep ground wells in the area, each serves 50-100 customers; e. Customers of deep groundwater are less informed about water quality they use and will be satisfied if there is a study to determine the quality of their water; (f) Customers want to know how to deal with high pH and acid water, also the management of healthy drinking water; (g) Before implementation of WSPs in Bandarharjo, there would be an examination of the biological quality of 40 water samples; (h) The WSPs needed full cooperation from the owners of deep groundwater; (i) All participants agreed to monitor the quality of deep groundwater.

Second session discussion revealed: (a) local government of drinking water supply system suggested all deep ground wells to be examined. The result then might be used to formulate priorities in WSPs implementation; (b) Purpose of examination was to get an idea of the quality of water from deep groundwater wells. Test results will be used as the basis for the implementation of WSPs. The activity is expected to securing clean water that is adversely affected by rob; (c) This activity aims to undertake efforts to secure the provision of drinking water, through the establishment of WSPs team work together with security systems that have been prepared; (d) Water providers should have a commitment to support WSPs implementation; (e) WSPs team will be formed to monitor the quality of drinking water in
Bandarharjo; (f) The team should approach the deep ground well owners; (g) Training for WSPs team will be held after Idul Fitri.

3.1.2. Preliminary water survey

Preliminary water survey was conducted in order to: (a) describe and identify water supply system of deep groundwater wells in Bandarharjo village; (b) assess the bacteriological parameter (total coliform) for standard requirement; and (c) compare bacteriological quality (total coliform) with the standard of Permenkes No 416/1990. The main parameters of drinking water are total coliform, turbidity, salinity, and pH.

Water supply system in Bandarharjo starts from water provider, upper reservoir, distribution and then used by customers. Most of the water supplies in Bandarharjo village are deep groundwater wells. Water was pumped up from 85 meters down in the ground into higher water reservoir (e.g., 6-20 m). Water reservoir will provide sufficient pressure of water distribution to customers. Water was distributed to customers by using PVC pipe with diameters 4-6 " . The result of observation found that pipe line distribution was frequently drowned by rob. This system is a difference to a local government drinking water supply system.

3.1.3. WSPs team building and training

WSPs team was formed on the first day of training. The team consisted of coordinator, secretary, and field technician, and the members. As consultant was the PHC of Bandarharjo, a local government drinking water supplies system, and deep groundwater owner.

On day 2, Management simulation (exercise) was given on day 1. For effective training WSPs team was divided into three small groups for risk assessment. Group 1 focused on water sources and discussed a condition of the catchment, piping, water tank (upper and bottom reservoir), present of disinfection, surround the area, contamination possibility (Table 1). Group 2 focused on water distribution and discussed a condition of piping, pipe joining, a branch of distribution, contamination possibility (Table 2). While group 3 focused on customers and discussed the condition of water, households connection, water meter, piping, valve, hose, water tank (Table 3).

For the exercise and discussion in the training, a team conducted field visit for measurement of the risk assessment using instrument [8][13]. Risk/hazard occurrence, for example, are pipe leakage, broken pipe, the loose connection of pipe, submerged water meter, broken water meter, no treatment (i.e., disinfection, filtration), lack of cleaning or draining upper a reservoir, no tight cover of the reservoir, sediment in inner pipe.

| Problem               | Hazard                        | Occurrence | Severity | Rank |
|-----------------------|-------------------------------|------------|----------|------|
| Flood tide            | Contamination (salt/smell)    | 5          | 2        | 10   |
| Leakage               | Contamination/germ/smell      | 3          | 2        | 6    |
| Underground pipes     | Leak                          | 1          | 2        | 2    |
| Precipitation         | Soiled water, mossed water    | 4          | 3        | 12   |

Rank: 1. Precipitation/Sediment, 2. Flood tide/rob, 3. Leakage

| Problem    | Hazard               | Occurrence | Severity | Rank |
|------------|----------------------|------------|----------|------|
| Leaking pipe| Contamination of sewage| 2          | 1        | 2    |
| Clogged pipe| Containing moss       | 2          | 1        | 2    |
| Pipe connections| Loose, cracked        | 3          | 1        | 3    |

Rank: 1. Pipe connections, 2. Clogged pipe, 3. Leaking pipe
Table 3. Result of the group 3 for working discussion component system at customer level

| Problem                              | Hazard          | Occurrence | Severity | Rank |
|--------------------------------------|-----------------|------------|----------|------|
| Has a salty taste                    | Diseases, germs | 5          | 2        | 10   |
| Soiled water (dirty)                 | Itching, diarrhea | 5          | 2        | 25   |
| Smelly water                         | Respiratory problem | 1          | 2        | 2    |
| Broken pipe                          | Clogged water   | 5          | 3        | 15   |
| Blackout                             | Water does not flow | 3          | 3        | 9    |
| Water faucet has a moss plant        | Germs           | 4          | 3        | 12   |
| Sediment in the pot after boiling water | Kidney stones  | 4          | 4        | 16   |
| Reservoir rarely drained             | Mosquito larvae appears | 4          | 5        | 20   |

Rank: 1. Soiled water (dirty), 2. Reservoir rarely drained, 3. Sediment in the pot after boiling water

On day 3, module 8-11 (adapted from WHO training module) was delivered [16]. The activity consisted of formulating the plan of action and explaining a plan of action after training. Plan of action which comes from participants was dissemination/socialization water safety plan to the community and WSPs team legality (decree) from the head of Bandarharjo village. Explanation of plan of action included measuring a parameter and doing sanitation survey in Bandarharjo village and explaining the description of WSPs implementation after training. The plan of action was made by the WSPs team and lead by the coordinator of WSPs and the result in Table 4. In addition, Table 5 for handling the emergency response.

Table 4. Result of the working discussion for plan of action due to result in table 1, 2, and 3

| Hazard                        | How (what to do?)            | Person in charge          | When                | Cost (rupiahs) |
|-------------------------------|------------------------------|---------------------------|---------------------|----------------|
| Sediment                      | Cleaned/ drained             | Owner of deep groundwater well | 1 year, 1 times    | 200,000        |
| Pipe connections              | Pipe replacement             | Owner of deep groundwater well | Incidental        | 100,000        |
| Soiled water (dirty)          | Complain to owner, place a filter | Owner of deep groundwater well | Incidental        | 25,000         |

Table 5. Result of the working discussion for handle emergency condition at the source, distribution, and customer

| At the source                  | How to handle?               |
|-------------------------------|------------------------------|
| - Condition of source fine    | Check behind of water meter, if the water ticket comes out and we can see the result then we can place it normally |
| - Condition of distribution fine |                              |
| - Trouble came from customer: soiled water (dirty), trouble on water meter |                              |

| At the distribution            | How to handle?               |
|-------------------------------|------------------------------|
| - Leakage on pipe connection  | - Replace                    |
| - Unstable machine            | - Repairmen                  |
| - Blackout                    | - Call state power company   |
| - Flood tide                  | - Cleaned                    |
| - Leaking pipe crashed by truck | - Replace/check how severe the broken pipe |
| - Dirty reservoir             | - Be elevated                |
| - Broken pipe                 |                              |
| - Submerged sewer pipe        |                              |

At the customer How to handle?
- Trouble in water meter
- Soiled water (dirty)

- Open the water meter and clean it
- Check water source. If it is fine then it might be the reservoir and distribution pipe had a clogged
- Cleaned through high pressure flushing

3.1.4. Examination of water and risk assessment of water safety by WSPs team

In term of pH and salinity, all water sample qualify the standard, yet two of them exceed turbidity standard (> 25 mg/liter). Eighty percent of water sample at customer level did not meet specified standard according to Decree of Ministry Health of Republic of Indonesia number 416/1990, which is maximum 10/100 ml water sample. Water quality does not require BOD parameter. The BOD examination was performed to estimate a possibility of pipe leakage, loose connections, or water contamination by sewer or tidal inundation, also possibility sedimentation in inner pipe. In addition, from the results of our spot check by cutting distribution pipeline, we found in the inner wall of the pipe has a lot of stick impurity deposition.

Field risk assessment in previous study [17] ranged from sourcing, processing, distribution, households connection (costumer). A very high degree of risk at source system (risk value = 25), caused by the presence of holes (space) between lid and reservoir. In term of turbidity, a reservoir has a high degree of risk (risk value = 15) due to the existence of dust, moss, and spore contaminants. At processing system, we found a very high degree of risk (risk value = 25) due to no physical or chemical treatment. At distribution system, we obtained a high degree of risk (risk value = 15). It because of sediment in inner pipe and loose of connection. At costumer/household system, we observed connection pipes, water-meters, and faucets in the houses, and it obtained a very high risk (risk value = 25).

WSPs team gave priority to the handling improvement of drinking water supply systems, based on categories of very high and high degree of risk. The priorities include: at the source, the reservoir tub cover less dense and dirty water reservoir; in processing, the lack of primary disinfection treatment (based on initial measurements which given total coliform exceeded the standards); on the customer system, the priority is to water meter which submerged by rob, sewer water, or soil undercurrent.

3.1.5. Corrective action plan and minor repair I: after risk assessment

Hazard event at source system: (1) Little space between tub and cover allows contamination from dirt or dust; (2) Dirty tub. Corrective action would be made a concrete of tub cover by WSPs team and owner. Draining and manufacture of concrete tubs cover by owner. Hazard event at processing system: (1) Bacterial contamination (coliform total); (2) Performing disinfection should be done socialization. Disinfection uses chlorine by a technician from the officer of local water drinking water supply system Semarang. Before disinfection so do socialization by health officers on advantages and disadvantages of disinfection. Hazard event in distribution pipe system: sediment in inner pipe. Hygienic reasons for maintaining the internal cleanliness of pipework. The method used to clean the dirt is flushing. This is the simplest of the pipe-cleaning techniques. Hazard event at customer system: Water meter was submerged by trench/gutter and tidal inundation. The submerged pipe was elevated by giving additional pipe so that it will not re-submerge by tidal inundation by WSPs team and customer.

The budget plan had been prepared and cistern cap/cover foundry design which conducted by WSPs team and expert designer. Concrete thickness approximately 10 cm in total (two cisterns) which approximately 12 m². Concrete framed with steel with a concrete slab 2.5-3 meters long and 50 cm wide which were arranged in rows. Further, on it cast with concrete. Two manholes 60x60 cm were built to simplify for monitoring the water, cleaning, and drainage the cisterns. In addition, to easing climbing up to the cistern, iron stairs with a height of 7 meters were made.

Implementation of the foundry was conducted on November 26, 2013, which was supposed to do in the first week of November 2013. This setback/tardiness due to bad weather (rain and rob) which means it didn’t support for a foundry. Implementation of foundry involves WSPs team along with competent personnel to perform casting/foundry.
Repairs also carried out on the exhaust pipe or pipes to drain along with the faucet, so that can be opened and closed when done the draining. As it is known that the cistern tank has not drainage since it was made (almost ten years). From observations when drained it clearly be seen dirty brown sewage on the ground floor, tub/cistern and walls. Dewatering was done by the owner of the wells and executed a week after casting/foundry. It appears that the inner wall of tub/cistern was very dirty, dark brown colored, so as the water in the tub. Dewatering was conducted on November 30, 2013.

For improvement in the system of water processing, before the disinfection socialization to as many as 25 heads of households (consumers) who subscribe to the deep ground well belongs to the owner (Mrs. Warsi) were carried out. Socialization is intended to inform that deep ground well water were possibly contaminated, therefore it is necessary to perform disinfection treatment in order to make people understand that water is contaminated with bacteria would be harmful to health. Socialization was carried out by sanitarians from Primary Health Care and WSPs team. Information of benefit and disadvantage of the water processed by disinfection (chlorination) were given in socialization.

Depletion/dewatering on the distribution pipe was done by cutting the tip of the end of distribution pipe. There were 3 distribution pipes. After the cutting, it is very noticeable that the water coming out of the distribution pipes was very dirty. To ensure that all the impurities in the water in the pipe have been carried out, the pipes were stamped at the end of the pipe so that all the dirt out of the pipe wall. Before it, first, we opened the faucet distribution from above tub/cistern, so that the flow coming out of the distribution pipeline is quite strong, so it will be able to flush the dirt that was in the pipelines. The time required for cleaning/flushing pipeline distribution approximately 30 minutes. After 30 minutes streamed clearly, the water that comes out of the distribution pipes has been very clear. In addition to performing flushing, also carried off the connecting distribution pipe those loosen. The activity was conducted on December 7, 2013.

Improvements to the customer were elevated and replacement water meter submerged pipe sewer, water and soil were not done yet, because after the double-checked there were still in good condition (data/information less valid). To do so, there were re-assessment and observation (December 2, 2013) to the whole household connections (approximately 73 customers), to look at the risks that are likely for more. In addition, it is intended to recalculate the need for tools and materials used to repair and time estimate. The problem is when there is no customer list of an owner for certainty. The observation and reassessment were done by WSPs team Bandarharjo village.

From observation and re-identification observed from 70 customers on Monday, December 2, 2013, there were 9 water meters submerged land and water from sewerage. It also made improvements in the household connection. Activities of household plumbing repair connection and water meter elevation performed on Saturday, December 7, 2013. Distribution pipe flushing is done after the entire water meter level and household connections have been repaired.

3.1.6. Monitoring and minor repair II

On December 27, 2013, WSP team observed and monitored 20 customers. There were 2 leaky connection pipes, 1 submerged pipe that connected to a water meter, 1 submerged water meter, 4 leaky faucets, 1 leaky indoor pipe, and 1 submerged indoor pipe. As for indoor reservoir, which is generally in the form of a bucket, there were 4 reservoirs in turbid condition.

Next monitoring was held on December 28, 2013. WSP team found showed 3 leaky/seeped faucets, 1 broken faucet, 3 rushed of a water meter, 1 leaky pipe, and 2 turbid reservoirs. Further water safety monitoring was held on December 30, 2013. Almost all equipment was in good condition. WSP team found showed only 1 broken faucet. Monitoring on January 2-4, 2014 found one turbid reservoir. The rest were all in good condition (water meter, pipes, and faucets).

Other than at customer level, monitoring was also performed at a water source and distribution level, both by observation. WSPs team found a cover of a reservoir, a concrete cover, was in good condition, clean and no crack observed. Pipes and faucets for leaching were also in good condition and properly function, as well as a pipe from a reservoir for distribution. Pipes of distribution, which have been cleaned or flushed with water, remains in good condition and tight. Besides, an owner has cleaned
floor at the water point that previously mossy and slippery. The result of observation showed water in the reservoir was very clear (bottom of the reservoir could be seen). The physical quality of water obtained from the reservoir also clear, tasteless, and odorless.

Before conducting minor repairs coordination have been carried out between WSPs team and owner of deep ground wells. This activity was done by identifying distribution pipeline that was leak/rupture. Repair leaky pipes and faucets by replacing faucets/cellaphane tape or glue that has been separated. Elevate a water meter level by replacing the pipe and cellaphane tape and replaced the broken one with a new water level meter. Similarly, the distribution pipe and connection pipe that loose were replaced and gluey. Pipes were submerged with litter/soil replaced with new pipes. This work was done by the WSPs team and owner of deep ground wells.

Observation result showed that during rainy season and flood, the casing is not cemented submerged by floods. Therefore, to prevent contamination of the casting is done by providing cement, sand, and bricks. On monitoring and observation also obtained the result that many distribution pipes are submerged soil, water sewer, and trash. Therefore, it needs efforts to prevent damage and contamination as well as the monitoring of the distribution pipe by replaced and elevated distribution pipes that submerged soil, sewers and garbage. Distribution pipes that replaced had a 3 " as much as 60 rods and distribution pipes with size ¾ " as much as 4 rods, including pipe connection 'T' and gluing using cellaphane tape and glue.

Searching of leaking distribution pipes requires quite a long time (2 weeks); this is because most of the distribution pipes submerged in the soil and submerged sewer, and garbage. The searching of leaking pipe has been done for 3 times, involving owners, WSPs team and from Faculty of Public Health Diponegoro University. During observation, it was found cover water reservoir (manhole) was rusty and corroded. Based on that, need efforts to do the painting so that it has a protection from rust.

3.2. Discussion

3.2.1. Introducing of WSPs program.

It is not easy to adopt new programs or innovations (i.e., WSPs) by a community. This is due to various educational background, culture, experience and socio-economic conditions [18],[19]. People will be willing to accept new programs or innovations if they feel they need or get benefit [20]. However, it needs a good socialization and it is one of the diffusion mechanisms [21].

Before introducing the WSPs program to the community, the community needs to be shown or informed about the health problems they face. The several considerations to decide the priority in health problem based on magnitude, severity or important or seriousness, and benefit [22]. The introducing of health problems to the community is very important because some members of the community may not aware of any health problems in the region. Some inhabitants did not realize that quality of drinking water is important, it was revealed in the discussion. To convince the community of the importance of water quality requirements, we present the results of research related to water quality in the region to the representative community. To stimulate a collective sense of belonging to drinking water among community members as they confront the significant problem about contaminated water and its negative impacts on the customers [23]. Based on Ministry of Health Republic of Indonesia regulation No. 416/MEN-KES/SK/IX/1990, a maximum number of total coliform allowed is 10/100 ml sample (piping water) and 50/100 ml sample (non-piping water). Seven out of 20 wells in Bandarhajo had a poor hygienic condition (>50/100 ml) in term of bacteriological quality. This scientific perspective introduced important to the drinking water quality and triggers community to protect the drinking water [24].

The introducing of WSPs program was also to communicate the value of drinking water (i.e., reduce future water borne disease) to increase people’s awareness of the importance of this work [25]. Therefore this program is based on the quality of drinking water.
The first step to a pre-trigger community is selecting community who concern with the problem. The representative community would be respected people with skills who provide services like village midwives, community leaders, religious leaders, teachers, youth, and women [23]. Coordination should be done before the training and aimed to keep a commitment. High committed to the team in the program is a key success of WSPs. Manager's performance on the job and the team members' technical background and commitment are most critical for project success [26].

3.2.2. WSPs team building and training
The WSPs team included a representative the communities group, government sector, and private sector and at many levels of knowledge and experience within the small community. At the initial stage to identify the people who have experience in community activities were selected by village officer that well-known the people in the area. Members of the WSPs team have varying work, education and social backgrounds, such as sanitation, youth group, deep ground or artesian wells owners, women's groups, urban community empowerment agencies, village officials, community protection officer, health cadres, the local government of drinking water supply system, and community leaders. The characteristics of WSPs team are levels of education ranged from elementary school to higher education, gender (16 males and 8 females), and age (20-60 years old) which were distributed in each of RWs in Bandarharjo village. It is expected that with various backgrounds and levels the community will strengthen the work of a team. High-performance partnerships employ practice designed to ensure they get the right people and resources (i.e., resources, skills, and expertise) on board and it will reduce the financing burden [27],[28]. The WSPs implementation is also taken into account the flexibility and adapted to local needs [16]. An initial investment of time and resources can be characterized as a mutual selection process [29]. Assess people’s capacities for collaborative work is important due to their technical abilities and scientific [30]. Although they may have a level of knowledge and experience in water supply system, by delivering the training module of WSPs, they had the same knowledge and perspective.

The WSPs team was legalized by decree of village office to increase commitment, clear their role, involvement, and responsibilities such as coordination of all activities, water quality monitoring, pipe checking (i.e., at the source, distribution, and household connection), monitoring of supply system of drinking water. The team could be in a large or small team, but the principles of the team are shared goals, clear roles, mutual trust, effective communication, and measurable processes and outcomes [31]. Building the team is the efforts to increase the likelihood that effective WSPs programs will be sustained and it may be developed with individuals, groups, teams, organizations, inter-organizational coalitions, or communities [32].

Moreover, the WSPs team should have the strong leadership and community participation (i.e., deep groundwater owner) to ensure program sustainability. The collaboration between community, the member of the team and team leader of WSPs will reinforce the teamwork. Shortell et al [33], collaboration tend to develop a committed core leadership that helps to create and consistently of objectives, tasks, projects, and programs. Community member enables to take control, maintenance, and sustainability of the water facilities and eliminate barriers and effective participation in water supply system [34]. The members of the team were fully involved in the planning, implementation, operation, and maintenance of water supply facilities in the area [35].

Module 1-6 (adapted from WHO training module) was delivered on day 1 training [36]. In the training, the team members were divided into a large and small group to ease delivered the materials. In the large group generally explained the material of module and discussion, while in the small group for exercise, field visit, and working in a team. It was expected more effective to deliver the training module and increased relationships. According to Steinert, there are 12 tips in which small-group teaching can become more effective and more enjoyable. In the small group, teaching is to promote understanding, critical thinking and problem solving to enhance communication skills and to foster self-directed learning [37]. Effective results of working group discussion, exercise, field visit, and simulation can be seen in Table 1,2,3,4, and 5. This mixed method makes the participants not bored, fun, and productive [38], because of little explanation from the facilitator and or an expert, then the participants work with
the tools already provided. In addition, this way makes it easier for participants to understand the WSPs materials, to conduct simulations, field trips, or working group.

The participants able to identified the problem, hazard, and made priorities the problem at the source, distribution, and customer of water supply system. The working group discussions were guided by facilitators from Faculty of Public Health Diponegoro University and WHO representatives as an expert to ensure the effectiveness of training. Participants were also able to make simulation the planning and budgeting at small scale to tackle the problems at routine and emergency conditions. The role of the leader of a small group is important to directing and clarifying the discussion [39],[40].

3.2.3. Water quality
The local government drinking water supply system consists of intake of raw water, physical and chemical treatment, distribution and household connection (customers). Complete water treatment included screening, coagulation, sedimentation, filtration, disinfection, and distribution [41]. However, the minimum requirement for artesian wells (deep groundwater) is disinfection. One way to disinfect water is using chlorine. A very effective disinfection using chlorine kills bacteria, viruses, and protozoa such as Giardia and Cryptosporidium [42].

3.2.4. Risk assessment and corrective action plans
At customers (households) level, we observed connection pipes, water meters, and faucets in the houses, and it obtained a very high risk (risk value = 25) [17]. Concrete tubs cover will protect the water in a reservoir from dirt or feces from the wild animal. The fecal coliform source includes wild and domestic animals feces, which can be spread by the wind [43].

Problems that often occur in the distribution system, among others, the presence of microbial growth and biofilm, cross connection, backflow, rusty and aged, contamination during service and nitrification [44]. Deposits material in the inner of distribution system was removed by flushing because this method is the cheapest and simplest methods for removing of loose deposits [45]. Even this method also has disadvantages of the quite large amount of water used and unsuitability for large diameter pipes to achieve the desired the flushing velocity. The flushing involves the discharge of water from pipes, generally through hydrants and washouts, to generate velocities in the pipe capable of removing accumulated material and biofilms inside the pipe and attached to its walls. Although there are no reports of health effects directly attributed to deposits in pipes, they do provide conditions for the proliferation of microorganisms and animals [46]. Flushing can be obtained periodically to minimize deposits in the distribution system, including microbial [47].

The water meter assembly must be fully supported with a minimum ground clearance of 150 mm, and should not be greater than 300 mm from the finished ground level to the base of the water meter assembly. On a case by case basis consideration will be given to varying the height of the water meter up to a maximum of 1.5 m. Water meters must not be located within garages, roof cavities, ceiling spaces or inside pits [48],[49].

Monitoring in accordance to identified the drinking water supply system which not work properly and so be fixed and prevent contamination. Treated drinking water quality monitoring would be able to inform of potential contamination of drinking water [50].

4. Conclusion
The WSPs programs could be implemented by the WSPs team in the coastal area of Semarang city. The team able to identified risks of the drinking water supply system and the actions were taken to make improvements to the water supply system. The minor repairs were done by sharing resources. However, there is still need to provide assistance to the WSPs team and educate community for the sustainability of the WSPs program.
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