Development of technique for assessing urban water security in Depok City

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Abstract. Rapid urbanization, population growth and economic drivers forced megacities, metropolises, and many cities around the world face increasing challenges to manage water security in urban areas. The urban water security (UWS) issues becomes more attracting attention of various parties, especially those involved in planning of supply and allocation of urban water, implementation and operation of urban water management all together with systems and techniques for assessing UWS along with the indicators used. This study aimed to: 1) review the assessment system of accomplishment to meet the needs of clean water in the Depok City by PDAM Tirta Asasta Depok (PDAM TAD) and then comparing with the standard of UWS assessment used by the world’s leading cities, 2) develop and propose technique, criteria and indicators for assessing UWS of Depok City. Performance assessment of PDAM TAD in 2018 for serving drinking water in Depok City by using BPPSPAM Guidelines showed that PDAM TAD is classified as “well company”. However, a new technique together with indicators to assess UWS of Depok City is still needed to develop and propose since BPPSPAM Guideline has not fully covered and resembled the criteria and indicators used to measure UWS used widely by the world’s leading cities.

Keywords: clean water, PDAM Tirta Asasta, urban water security, water security, water security assessment.

1. Introduction
1.1. Background
Over the last few decades, society has become increasingly aware of the vulnerability of urban water security (UWS) [1]. Innovation in UWS is required to address the increasing demand for clean water due to population growth and aggravated water stress caused by water pollution, aging infrastructure, climate change [2] and watershed degradation. Indonesia is one of the countries that have an abundant source of water, but there are still many problems in its use and management. There are two main problems that are crucial. First, there are seasonal variations and inequality in water availability. During the rainy season, some parts of Indonesia experience the extraordinary abundance of water, which results in floods and other damage caused. On the other hand, in the dry season there will be water shortages and drought becomes a disaster in several other regions. Second, the limited amount of water that can be explored and be consumed, while the growing number of Indonesia’s population...
causes the demand for raw water to increase drastically. Clean water is one of the basic needs to support life and various human activities. With an increasingly dense population and improved levels and quality of life, the demand for clean water in urban areas has increased significantly, including Depok City. People who can previously enjoy getting clean water from dug wells have become declining due to the availability of limited land.

Facing the problems and challenges of clean water, the Government of Indonesia has committed that drinking water has become one of the development priorities to achieve development goals. The government’s commitment is proven by the Presidential Decree No. 59 of 2017 concerning Implementation of Achieving Sustainable Development Goals. The Sustainable Development Goals (SDGs) contains 17 points of global development agreement that must be achieved in by 2030, one of which is the sixth point, access to clean water and sanitation, with the aim of ensuring the availability of safe, accessible and sustainable water and clean sanitation for all is a goal. One of the targets to be achieved is in 2030 is achieving universal and equitable access to safe and affordable drinking water for all, where the responsibility is given to several state agencies. One of state agencies is the Regional Government, where the institution is capable of adequate matters, namely the Regional Water Supply Company (PDAM) [3]. Based on data presented by the Central Statistics Agency (BPS), during 2016 - 2018, the percentage of households in urban areas that have access to safe water sources experienced fluctuations, in 2016 amounting to 81.05%, in 2017 amounting to 80.52%, and in 2018 amounted to 81.56% [4].

Depok City has a lot of water resources, mainly water resources originating from artificial rivers and lakes (situ). In general, rivers in Depok City are included in two units of large river areas, namely Ciliwung and CISadane rivers. Depok City also has 25 situ scattered in the east, west and center of the city. The conditions of the whole situ are quite different, but in general many of situ have been declining in their water quality and degrading in their area. Water quality problems are increasingly narrowing alternative water sources that can be utilized by the community. The availability of water is very influential on human being, even water can be one of the factors inhibiting the economic growth of a country. Clean water is one of the basic needs to support life and various human activities. Demand for clean water in urban areas is increasing in water-rich areas, including in the Depok City. Establishment of Local Water Company of Depok City or PDAM Tirta Asasta based on “Depok City Regulation Number 10 of 2011” concerning Establishment of Local Water Company (PDAM Tirta Asasta) Depok City began operating in 2015.

PDAM Tirta Asasta is a regional water company in Depok City which is assigned to fulfill and serve clean water needs of the Depok City. The role of PDAM Tirta Asasta is increasingly important because other water sources from well water and water from rain pools are decreasing. PDAM service performance is closely related to the distribution system which is a pipeline network composed of piping, pumps, reservoirs and equipment systems. The need for clean water will increase along with the increase in population. Thus, the distribution system will be more complex and require special handling. Urban water distribution systems are often problematic in terms of quantity, pressure, continuity and water quality [5].

To overcome the threat and problems of water scarcity, appropriate strategies and technologies are needed. The strategy undertaken for the fulfillment of clean water in cities on a sustainable basis is with an assessment system for urban water safety. Strategies are needed by the Depok City to ensure that there will be no shortage of clean water in the future. For this reason, a standard technique for water security assessment is needed. The indicators contained in the water security assessment system can be used as fundamental in good urban water management planning.

At present the City of Depok has an assessment system on the performance of PDAM Tirta Asasta in the supply and service of meeting drinking water needs. The Performance Evaluation Technical Guidelines are prepared by the Agency for the Improvement of Drinking Water Supply Systems in the Ministry of Public Works and Public Housing. The results of the relatively healthy or good assessment obtained in PDAM Tirta Asasta's performance were apparently not representative enough to arrive at an assessment of the urban water security of a city because the parameters and indicators used were
different from those used to assess Urban Water Security in other large cities around the world. Therefore, development of the technique for assessing urban water security is still needed in Depok City. Other reasons to compile techniques and criteria for assessing urban water security in Depok City are the rapid increase in the population of Depok City, the threat of increasing difficulty in obtaining water sources for clean water raw materials, the threat due to global climate change to the provision of clean water. To ensure the fulfilment of urban clean water needs in a sustainable manner, major cities in the world have carried out a comprehensive and continuous assessment system for urban water security. Thus, it is time for Depok City, the nearest city to the Jakarta City to also have an assessment system for urban water security to ensure that there will not be a scarcity of clean water in the future.

1.2. Aim
This study aimed to: 1) review the assessment system of accomplishment to meet the needs of clean water in the Depok City by PDAM Tirta Asasta Depok and then comparing with the standard of UWS assessment used by the world’s leading cities, 2) develop and propose technique, criteria and indicators for assessing UWS of Depok City.

2. Theoretical framework
2.1. Definition and component of urban water security concept
Of the various definitions of water security, there are three general definitions that fit urban conditions, definitions based on the Global Water Partnership, UN-Water, and the World Bank (Gray and Sadoff) [6]. Based on the three general definitions, it can be concluded that the scope of the Urban Water Security concept is about the ease of the community to access clean water, guarantee the sustainability of clean water, guarantee adequate amount of water with good quality, and its benefits for human welfare. The definition of urban water security that is closer to the function of PDAM is the definition of the Global Water Partnership which states that water security, at any level —from the household to the global — means that every person has access to safe enough water, at an affordable cost, to lead a clean, healthy, and productive life, while ensuring that the natural environment is protected and enhanced. The core process in the water cycle is included in the scope of the urban water system, which consists of: water treatment plants, drinking water production, drinking water storage and distribution, treatment, wastewater collection, and discharge [6]. Based on this, the PDAM as the regional water management has an important role in the unity of the concept of urban water security.

According to [6], who developed an assessment system in the urban water security assessment framework, one of the four areas being drinking water and human well-beings (see table 1).

| Dimensions | Indicators | Variables | Units |
|------------|------------|-----------|-------|
| Availability | (total water resources)/(total population) | m³/capita/year |
| | Reused wastewater/production of wastewater | % |
| Diversity | Contribution of alternative water sources | % |
| Water quantity | Contribution of alternative energy sources | % |
| Consumption | (Authorized consumption)/(Total population) | L/capita/day |
| | Non-revenue water | % |
| Reliability | Infrastructure Leakage Index = (Current Annual Real Losses |
### Dimensions

| Indicators | Variables | Units |
|------------|-----------|-------|
| **CARL/ Unavoidable Annual Real Losses UARL** | Metered water (percentage of households whose water consumption is metered) | % |
| **Energy efficiency in the network** | | % |
| **Commercial losses from non-revenue water** | Proportion of drinking water samples meeting WHO and local standards | % |
| **Proportion of samples of wastewater treatment plant meeting WHO and locally applicable quality standard** | | % |
| **Average number of hours/days** | | h/day |

### 2.2. The concept of water scarcity

The most common problems and challenges faced in realizing water security are water scarcity, both in terms of quality, quantity and diversity. One of the causes of water scarcity in tropical countries is climate factors, namely the low rainfall and the long dry season and watershed degradation. Climate change is causing an increasingly devastating clean water crisis. Climate change and the water cycle have caused two extreme conditions, namely an increase in drought that can cause the availability of ground water to decrease naturally and the impact of climate change, which is an increase in water level which results in excess water and worsens the quality of clean water in areas that need clean water. Climate change is changing the quality and quantity of clean water naturally and slowly. Watershed degradation increases surface runoff, decreases infiltration, decreases groundwater reserves and decreases river and lake water quality. In addition to climate and watershed degradation factors, economic growth factors and population also pose challenges to water resource issues in the future. The demand for clean water is not constant, but rather increases with population growth, and changes in social value [7, 8]. In urban areas, the volume of water use depends on the size of the population, and is increasing over time [9, 10].

Water usage and demand on a global level is increasing especially in big cities and emerging cities. Small cities have developed into big cities and big cities have grown into metropolitan cities. Growth in world population and global economic output will have an impact on the scarcity of renewable resources and sharply increase. A further implication of this condition is the emergence of natural resource-based conflicts. According to [11], the problem of water scarcity can be caused by natural factors in the form of arid areas and drought, or caused by humans. Water scarcity caused by humans is produced from various problems namely, pollution, water resource management, and infrastructure. This problem has an impact on water scarcity which causes various problems between rural and urban
communities. Water safety is the availability of water in quantity and quality of health, life, ecosystems, production, and the level of water-related risks that can be accepted by humans, the environment and the economy [12]. The definition of water security according to [13] is the capacity of cities to protect access to sustainable water of adequate quality, acceptable to sustain livelihoods, human well-being, and socio-economic development for its inhabitants and to ensure reasonable protection against water pollution and related damages water, and to build and conserve healthy ecosystems in cities and catchments. Urban water security is the availability of water in urban areas that can be accessed sustainable, has a quantity and quality that meets standards. The concept of urban water security is different from the concept of water security which is more general in its application in urban areas and can be interpreted in various perspectives. This concept introduces indicators that apply to urban water security, and not to water security at the household, state or global level. The essence of urban areas is high population density and dependence on rural areas in the supply of natural resources [14, 15]. Urban areas are generally not able to meet their water supply from within the urban area itself, but are resolved by supplying water resources from outside. UWS differs greatly from a water security at other levels in arrangement of water governance, basically there are several components in an urban water management system [16], namely:

1. Water Raw Material Supply. Based on the quality, quantity, quality standards, sources and quantities of raw water supplies that can be used and can be processed into drinking water. Raw water is sourced from river water, well water and spring water. The supply of raw water used must be in accordance with established quality standards.

2. Water Treatment System. Water treatment techniques, sourced from raw water that is treated with water purification and purification systems, sewage treatment systems, quality control systems 3, water treatment capacity to meet customer demand.

3. Clean Water Distribution. As a distributor of clean water for drinking water and human activities.

4. Management System. Systems related to the level of water loss, the level of customer complaints, the capacity and speed to repair leaks (repair systems) and service systems.

In the literature, [17] observe four different focuses when researchers define and study water security: it is about water such that we are increasing economic welfare, enhancing social equity, moving towards long-term sustainability, or reducing water-related risks. For a new framework for urban water system to be become fully established industrialized countries and to serve as a water management model in developing countries for future, sweeping changes that engineers and managers of urban water system approach the planning, design, and operation or urban water infrastructure [1]. Multiple perspectives of UWS stated by [17] are presented in figure 1.

![Figure 1. Multiple perspectives of Urban Water Security (After Cook and Bakker (2012) in [17])](image-url)
2.3. Indicators of UWS Assessment of Singapore and Hongkong [18]

Indicators of UWS Assessment of Singapore and Hongkong proposed by [18] look similar but slightly different. Indices, indicators and Sub-indicators for Singapore are presented in table 2, while for Hongkong is presented in table 3.

Table 2. Indicators UWS of Singapore [18]

| Indices  | Indicators                  | Sub-Indicators                                          |
|----------|-----------------------------|---------------------------------------------------------|
| Resources| Availability                | Water resources per capita                               |
|          | Diversity                   | Contribution of alternative sources                      |
| Access   | Water treatment buffer      | Volume sold/treatment capacity                            |
|          | Water supply coverage       | % of population with piped water supply                  |
|          | Sustainability              | Cost recovery ratio utility                               |
|          | Affordability               | Average bill as % of average household income             |
| Risks    | Flood risks                | Articles on flooding in local media                      |
|          | Health risk                 | Coverage of sewerage network                             |
|          | Potable water               | No. of potable water contamination incidents             |
|          | Supply continuity           | Households with continuous water supply                  |
| Governance| Strategic planning        | Score                                                    |
|          | Disaster management         | Score                                                    |
|          | Regulation                  | Score                                                    |

Table 3. Indicators UWS of Hong Kong [18]

| Indices  | Indicators                | Sub-Indicators                                         |
|----------|---------------------------|--------------------------------------------------------|
| Resources| Water resource availability| Total water resource availability/capita               |
|          | Quality                   | Proportion of water intake at Grade 2 Level             |
|          | Resistance to variability | Storage capacity/capita                                 |
|          | Diversity                 | Contribution of alternative sources                     |
| Access   | Water treatment capacity  | Demand/Treatment capacity                               |
|          | Coverage                  | Households with piped water supply                      |
| Risks    | Flood frequency           | Major flooding black spots                              |
|          | Flood damage              | Casualties                                              |
|          | Health risks              | Coverage of sewerage network                            |
|          | Supply continuity         | Customers with 24-h supply                              |
| Governance| Strategic planning        | Score                                                   |
|          | Disaster management       | Score                                                   |
|          | Regulation                | Score                                                   |
3. Methods
The method used in this study was desk study or literature study by using secondary data. Firstly, is to review the assessment of PDAM Tirta Asasta Performance of 2018 based on Guidelines from BPPSPAM. The assessment of performance of PDAM Tirta Asasta in 2018 is based on Regulation of The Minister of Public Works and Public Housing Number 18/PRT/M/2007 which is written as Guidelines on Performance Assessment of PDAMs by the Supporting Agency for the Development of Drinking Water Supply Systems (BPPSPAM). Data were collected from PDAM Tirta Asasta. The principle, indices, indicators and sub indicators were used to assess the performance of PDAM Tirta Asasta then was compared to data and information collected from open sources, including the case cities’ official websites, published plans, documents, and articles from rebutting journals about principles, indices, and indicators that are used to assess UWS for other cities in the world.

The last is to develop and propose techniques, criteria, indices, and indicators for assessing UWS for Depok City based on the standards of other cities in the world [18] and adapted to the local conditions of Depok City.

4. Results and Discussion
4.1. Depok City conditions related to water security
4.1.1. General conditions of Depok City
Depok City is a city in West Java Province with an area of 20,029 hectares consisting of 11 districts and 63 villages. Depok City is a lowland to an undulating area with an elevation between 50-140 meters above sea level and the slope majority is less than 15%. In 2018, total population of Depok City was 2,254,513 people. Depok City has a tropical climate and has two seasons, rainy and dry. The rainy season occurs in September-February and the dry season occurs in March-August [19]. The climate that affects is a tropical climate with winds blowing from north to south at a speed of 15 km / h and average rainfall of 3,000 mm/year. Depok City has at least 3 (three) main rivers and 24 small rivers that flow through Depok City from south to north. The three major rivers play a role in the small rivers that are covered in their respective watersheds. The three main rivers are the Angke Pesanggrahan Watershed, the Cikeas Cileungsi watershed and the Ciliwung watershed. Especially the Ciliwung watershed which has the largest watershed coverage area compared to other watersheds. Some lakes are upstream river branches, and river cliffs are found by springs with small water discharge, and the flow is not continuous. The spring used for the Depok city clean water is taken from Bogor Regency which is a large river upstream that flows to the North. In addition to the springs, the source of water for Depok City comes from surface water sources. Depok City has many potential water sources including surface water sources (rivers, setu) and deep wells.

4.1.2. PDAM Tirta Asasta Depok
PDAM Tirta Asasta is one of the Depok City regional companies engaged in the field of clean water services for the city of Depok. Based on Law No. 23 of 2014 concerning Regional Government, Law No. 15 of 1999 concerning the Establishment of the City of Depok, and Regional Regulation No.10 of 2011 concerning the establishment of the City of Depok PDAM, PDAM Tirta Asasta was inaugurated as one of the Regional Owned Enterprises (BUMD) owned by the City of Depok. Previously, Depok City had access to clean water through PDAM Tirta Kahuripan, Bogor Regency. In 2013 the city government of Depok inaugurated PDAM Tirta Asasta as a BUMD owned by the City of Depok.

PDAM Tirta Asasta Depok City in 2018 service coverage or serve about 18.15% of the total area of the City of Depok with several customers around 60,361 inhabitants (PDAM Tirta Asasta 2018). The number has increased from 2013 which serves 1.9% of the population of Depok City and continues to increase every year. PDAM Tirta Asasta in 2018 has served 32 (thirty-two) regions spread across Depok City.
Table 4. PDAM Tirta Asasta general data.

| Num | Description                        | Unit          | Number      |
|-----|------------------------------------|---------------|-------------|
| 1   | Total Population                   | People        | 2,254,513   |
| 2   | Total Population in the Service Area | People        | 1,853,862   |
| 3   | Number of Population Served        | People        | 409,166     |
| 4   | Service Coverage                   | %             | 18.15       |
| 5   | Number of Customers                | People        | 60,361      |
| 6   | Consumption of Average Water       | m³/cust/month | 19.96       |
| 7   | Average Water Rates                | Rp/m³         | 8,720       |

Source: PDAM Tirta Asasta

4.2. Review of assessment of PDAM Tirta Asasta Depok performance

Basic techniques and calculation to assess performance ration of PDAM Tirta Asasta Depok in 2018 by using Guideline of BPPSPAM is presented in table 5.

Table 5. Formula for calculating wellness rating according to BPPSPAM

| Indicator                        | Weight | Performance Formulas | Category                      |
|----------------------------------|--------|----------------------|-------------------------------|
| Financial Aspect (A)             | 0.25   | A*0.25+              | Well (Total Value: > 2.8)     |
| Service Aspects (B)              | 0.25   | B*0.25+C*0.35+D*0.15 | Unwell (Total Value: 2.2 - 2.8) |
| Operational Aspect (C)           | 0.35   |                      |                               |
| Human Resources Aspects (D)      | 0.15   |                      | Sick (Total Value: < 2.2)     |

Source: Technical Guidelines on PDAM Performance of the Ministry of Public Works and Public Housing or BPPSPAM (year?)

Financial aspects consist of Return of Equity, Operating Ratio, Cash Ratio, Billing Effectiveness and Solvency. Service aspects involve Scope of Technical Services, Customer Growth, Complaint Settlement Rate, Customer Water Quality, and Domestic Water Consumption. Operational aspects contain Production Efficiency, Water Loss Rate, Operating Hours of Service, Water Pressure on the Customer Connection, and Replacement of Water Meter. While Human resources aspects comprise Ratio of number of employees/1000 customers, Employee Training Ratio, and Employee Training Load.

By using BPPSPAM Guidelines, the assessment results of the performance of PDAM Tirta Asasta Depok are presented in Table 6. Since the total score of PDAM Tirta Asasta Depok reached 3.92 (from maximum of 5), the performance of PDAM Tirta Asasta Depok is classified at a health level and therefore “well company”.

Table 6. Health level assessment according to BPPSPAM

| Indicator                        | Rating Result | Weight | Score | Final Result |
|----------------------------------|---------------|--------|-------|--------------|
| Financial Aspect (A)             |               |        |       |              |
| 1. Return of Equity (ROE)*       | 6.56          | 0.05   | 3     | 0.15         |
| 2. Operating Ratio (OR)*         | 0.08          | 0.05   | 3     | 0.15         |
| 3. Cash Ratio*                   | 1,773.43      | 0.05   | 5     | 0.25         |
| 4. Billing Effectiveness         | 98.12         | 0.05   | 5     | 0.25         |
| 5. Solvency                      | 2,780.2       | 0.05   | 5     | 0.15         |
| Total Value of Financial Aspects | 0.95          |        |       |              |
| Service Aspects (B)              |               |        |       |              |
| 1. Scope of Technical Services*  | 15.99         | 0.05   | 1     | 0.05         |
| 2. Customer Growth (% per year)  | 5.46          | 0.05   | 2     | 0.10         |
| 3. Complaint Settlement Rate     | 97.31         | 0.025  | 5     | 0.125        |
### Indicator Rating Result

| Indicator                                      | Rating Result | Weight | Score | Final Result |
|-----------------------------------------------|---------------|--------|--------|--------------|
| 4. Customer Water Quality                      | 140.82        | 0.075  | 5      | 0.375        |
| 5. Domestic Water Consumption                  | 16.97         | 0.05   | 2      | 0.10         |

**Total Value of Service Aspects** 0.75

### Operational Aspect (C)

| Indicator                                      | Rating Result | Weight | Score | Final Result |
|-----------------------------------------------|---------------|--------|--------|--------------|
| 1. Production Efficiency                      | 70.42         | 0.07   | 3      | 0.21         |
| 2. Water Loss Rate                            | 29.30         | 0.07   | 4      | 0.28         |
| 3. Operating Hours of Service *               | 24.00         | 0.08   | 5      | 0.40         |
| 4. Water Pressure on the Customer Connection *| 96.98         | 0.065  | 5      | 0.325        |
| 5. Replacement of Water Meter *              | 23.87         | 0.065  | 5      | 0.33         |

**Total Value of Operational Aspects** 1.55

### Human Resources Aspects (D)

| Indicator                                      | Rating Result | Weight | Score | Final Result |
|-----------------------------------------------|---------------|--------|--------|--------------|
| 1. Ratio of number of Employees / 1000 Customers* | 4.44          | 0.07   | 5      | 0.35         |
| 2. Employee Training Ratio *                  | 93.28         | 0.04   | 5      | 0.20         |
| 3. Employee Training Load *                  | 5.17          | 0.04   | 3      | 0.12         |

**Total Human Resource Aspect Values** 0.67

**Total Value of All Aspects** 3.92

* The self-assessment done by PDAM Tirta Asasta Depok (2018)

However, the assessment results based on the BPPSPAM Guidelines do not include indicators from several aspects which are widely used to assess UWS in cities in developed countries (as presented in Table 2 and Table 3) and proposed by [6]. PDAM’s health level assessment is different from the framework of drinking water and human well-being assessment by [6]. Health assessment from BPPSPAM has aspects that tend to more merely on service assessment, whereas the assessment framework for UWS prepared by [6] focuses on water as an object distributed. The comparison of the two is presented in Table 7.

Table 7. The comparison of the health assessment DPAM by BPPSPAM and assessment framework of UWS by Alboenge et al [6]

| Assessment Framework [6] | Health Level Assessment PDAM (BPPSPAM in [6]) |
|--------------------------|-----------------------------------------------|
| Dimensions               | Aspect Indicators                              |
| Water quantity           | Availability Financial Return of Equity (ROE)  |
|                          | Diversity Financial Operation Ratio (OR)       |
|                          | Consumption Financial Billing Effectiveness    |
|                          | Reliability Financial Solvency                 |
| Water quality standards  | Wastewater treatment plants Operational        |
| Adequacy and equity      | Drinking water quality Production efficiency   |
|                          | Average supply time Domestic water consumption |
|                          | compliance with minimum Operating hours of service |
4.3. **Technique Proposed for Assessing Urban Water Security of Depok City**

After studying the condition of Depok City, BPPSPAM and the results of the latest study on the UWS in various cities in the world, Technique proposed and indicators can be used to assess UWS of Depok City is presented in table 8. After selecting 20 indicators, an assessment of each of these indicators is then carried out. Scoring is done using a score of 1 (very bad) to 5 (very good). Thus, the maximum value for the 20 indicators is 100. If the total value is less than 80, indicating that the performance has begun to be aware of. In addition to the total value or score, comprehensive assessment and analysis and special attention must be carried out on indicators whose value is less than 3 (medium).

### Table 8. Indicators proposed for assessing urban water security of Depok City

| No | Indices            | Indicators                          | Sub-indicators | Unit   |
|----|--------------------|-------------------------------------|----------------|--------|
| 1. | Resources          | Availability                        | Water resources per capita | l       |
|    |                    | Sufficiency                         | Level of fulfilment (quantity) | %       |
|    |                    | Quality of water                    | Proportion to produced water | %       |
|    |                    | Resistant to variability            | Storage capacity/capita | ml      |
|    |                    | Pattern of supply                   | Continuity of supply | %       |
|    |                    | Diversity and alternative sources   | Contribution of alternative sources | %      |
| 2. | Production and     | Water supply coverage               | Per cent of population covered | %      |
|    | Distribution       | Sustainability                      | Cost recovery ratio utility | %       |
|    |                    | Water treatment buffer (capacity)   | Volume sold/treatment capacity | %       |
|    |                    | Continuity of supply to customers   | Number of discontinue supply to costumers | No |
| 3. | Management         | Effective and efficient management  | Loss level on distribution | %       |
|    |                    | Capacity and rapidity to repair     | No. of leakage and complaints solve less than 12 hours | %       |
|    |                    | leakage (repairing system)          | Application of information management system | %       |
|    |                    | Application and updating supporting tool | Application of early warning system | %       |
|    |                    | Application of tool to protect and serve costumers | |
| 4. | Risk               | Water treatment system and sewerage network | Coverage of sewerage network | Score |
|    |                    | Barrier to supply continuity        | No. of underserved costumer | No.     |
|    |                    | Lack of governance support          | Negative intervention and luck of useful support of (local) government | Score |
|    |                    |                                     | Too high average bill as per cent | %       |
### Table 1: Indicators and Sub-indicators

| No | Indices | Sub-indicators | Unit |
|----|---------|----------------|------|
|    | Affordability | of average household income |      |
|    | Potable water | Number of potable water contamination incidents | No. |

5. Conclusion

Based on BPPSPAM Guidelines, the total score of PDAM Tirta Asasta Depok reached 3.92 (from maximum of 5), meaning that the performance of PDAM Tirta Asasta Depok is on health level and classified as "well company". However, the assessment results are based on the BPPSPAM Guidelines cannot be used to assess UWS for Depok City. The BPPSPAM Guidelines did not use indices and indicators of UWS that were used as UWS assessment standards that are widely used in other cities around the world.

Considering the local conditions of Depok City, the performance assessment of PDAM Tirta Asasta by using BPPSPAM Guidelines and the principles, indices, and indicators used by other cities in the world, the UWS for Depok City assessment techniques and indicators have been successfully developed. The assessment system can be tested and then implemented to assess the urban water security of Depok City in the future.

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