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Accelerating the Provision of Safe Water Supply in Urban and Rural Areas of Indonesia

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Abstract

Over the past 100 years, the provision of a safe water supply to drink in Indonesia has been slowly progressed with low coverage. The majority of the population does not have access to safe water. Morbidity and mortality of water-related diseases, including diarrhea, are very high. The provision of safe water is not a technological issue but good water management that comprises content, institutional, and communication layer. This paper provided information for strategic and operational decisions to accelerate the provision of safe water services in urban and rural areas. Benchmarking good water management with the characteristics of the water supply location is required to improve the health status of the population, mainly the poor urban and rural areas with limited resources, including time and cost.

Keywords: good water management, infant mortality, safe water

Introduction

Water is a basic human need and forms about 65-90% of the body. Inability to obtain safe water leads to dehydration, as well as susceptibility to various infections and diseases, which potentially culminates in death faster than lack of food. Safe drinking water is free from microorganisms, chemical substances, and radiological hazards which affect quality health. It is culturally appropriate, sensitive to gender, fulfills privacy requirements, and is affordable by all.[1,2] The water rights entitles everyone to access sufficient, safe, acceptable, physically accessible, affordable, and continuous water supply for personal and domestic use. Every individual has the right to a water and sanitation service that is physically accessible within the household, workplace, as well as educational or health institution. The people are rights-holders, while the government are duty-bearers of water service and are expected to guarantee equal water rights without discrimination.[3]

Indonesia has a total population of approximately 276.4 million people, 56.6% in urban and 43.4% in rural areas. The government is responsible for developing policies and strategies to provide water supply services through several ministries. The Ministry of Home Affairs and Public Works is responsible for the urban sector. The Ministry of Health is responsible for water quality monitoring and rural services to a certain extent. The National Development Planning Agency/*Badan Perencanaan Pembangunan Nasional* (Bappenas) is responsible for planning investments, while the Ministry of Industry and Trade is responsible for the regulation of bottled water. The National Water Supply and Environmental Sanitation Working Group/*Kelompok Kerja Air Minum dan Penyehatan Lingkungan Berbasis Masyarakat* (POKJA AMPL) coordinates between departments donors, and other stakeholders. However, it has no legal basis nor secure funding.[4]

The Regional Water Utility Company/*Perusahaan Daerah Air Minum* (PDAM) is owned and controlled by the Regional Authorities (City, District, Province).[5] Among the total 514 cities and districts, 350 have individual PDAMs which primarily supply drinking water with adequate quality and inadequate quantity for the survival and health of the communities. However, the coverage of current PDAM services is very low.[6] The Ministry of Health reported a total of 55,546 water sup-

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ply facilities, and the majority are at medium or low risk of contamination. Among the total sample of 6,221 facilities, 3.97% were contaminated by fecal bacteria in 2019.[7] In 2020, only 18.1% of the population had access to safe drinking water, including 21.3% in urban and 14.4% in rural areas.[8]

The problems considered in this study include "why is the provision of water supply slow and low?" and "how can the current water supply services for both populations in urban and rural areas be accelerated?" This study provided evidence-based information to accelerate the provision of drinking water services in Indonesia.

Issue of Water Supply

In 1900, the Dutch government initiated a drinking water company and developed a water supply system in 1903, which served a total of 1,588 individuals in Surabaya. In 1905, Batavia was selected as the central government and transferred the company to the local government in 1906. The central government initiated a drinking water system that obtains water from Ciomas River without treatment in 1918. After several decades, the Dutch government eventually transferred the drinking water system to the Government of Indonesia (GoI). Since Indonesian independence (1945), the GoI has continued to develop drinking water services for several cities in Java, Sumatra, Sulawesi, and Kalimantan under the funding of the France government. The GoI issued Law No. 5 of 1962 concerning the establishment of Regional Water Utility Company (PDAM).[9] Since the first International drinking water tragedy of 1997 and the United Nations International Drinking Water Decade 1980-1990, Indonesia ensured that 75% of urban and 40% of the rural population had access to safe water with 60 and 40 Litres/person/day respectively in 1990.[10] However, after the decade ended in 1990. At the beginning of the Target 7C of the Millennium Development Goal (MDG 7C), only 9% of the total population had access to safe water (piped on premises), including 25% and 2% of the urban and rural population, respectively. In 2010, the total population increased to 20%, with 36% urban and 8% rural.[11]

In line with the National Mid-Term Development Plan 2015-2019 and the Sustainable Development Goal 6.1 (SDG 6.1), the GoI implemented a program for 100-0-100, with a target of 100% access to potable water, 0 slums, and 100% access to sanitation in 2019.[12] At the beginning of the SDG 6.1 in 2016, water coverage increased to 22%, and 29% in 2019. The coverage of the rural population that had access to safe water is low at 2% in 1990 but increased to 5% in 2000, 12.2% in 2015, and 14.4% in 2020.[13,14]

The majority of the population, both in urban and rural areas, are at risk of water-related diseases, including diarrhea, typhoid, dysentery, cholera, dengue hemorrhagic fever, malaria, helminths, and skin infections. In 2016, it was reported that the total diarrhea case was 2,222,109 in 34 provinces, with an average of 80,658. The lowest was 6,337 cases in North Kalimantan, while the highest was 553,063 in West Java.[15] Every year, 4,276 under five years old children die due to diarrhea, contributing to 32% of global deaths. Diarrhea is the leading cause of death among infants from 0-1 year and the second cause among children.[16-18] National data on infant mortality rate and proportion of the population that has access to safe water in both urban and rural areas for 120 years (1900-2020) indicated that the reduction of infant mortality rate is significantly related to the increase in access to safe water (Figure 1).[19,21]

The provision of safe water services is not a technological issue. It is a good water management issue related to government and non-governmental organizations (NGOs), processes, structures, instruments, and levels of commitment. Good water management comprises three

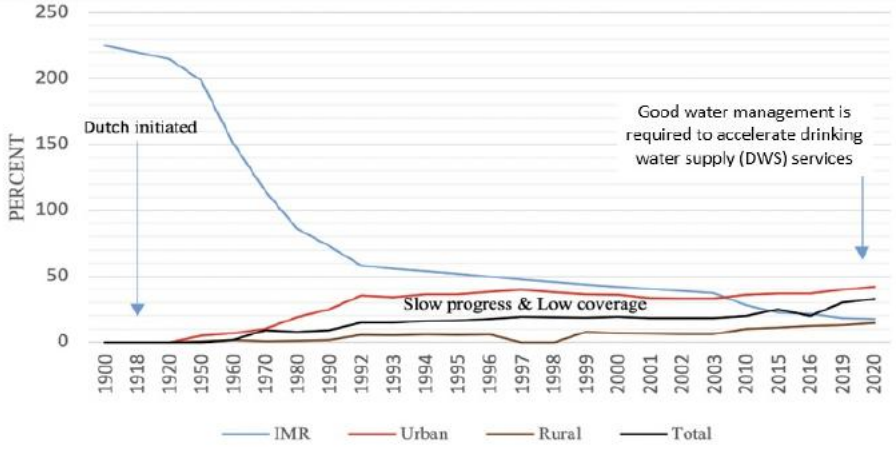


Figure 1. The Population with Access to Safe Water and the Reduction of Infant Mortality Rate 1900-2020,[19,21]

layers; content, institutional, and communication. The content layer refers to knowledge of water systems, experience, and skills to solve the problem. Distinctive knowledge about safe and health effects is considered the main priority of providing water services by all decision makers at the policy, strategy, and operational levels. The institutional layer includes the organization's framework, legal instrument, and financial support. Organization framework, logistics, and management instruments in bureaucratic red tape are very expensive. Financial support from the government is limited and not considered necessary for water supply programs through PDAM compared to the educational and health programs. The communication and cooperation layer involves the public, related stakeholders, transparency, and trust. The communication issue is often due to lack of coordination and partnership with stakeholders, limited integration into the other relevant programs, lack of social-cultural participation, and good governance practice.[22]

The PDAM is the government-subsidized institution responsible for direct the provision of safe water to the urban population. In recent years, the performance has been limited due to inadequate infrastructure and financial support and lack of managerial capacity, and expensive technology, which altogether lead to ineffective services. The Ministry of Public Works and Housing reported that between 2011-2020, the average performance of PDAM was 53.6% and considered healthy, while the others were not fit due to limited safe water services. In 2016, among the healthy PDAMs, 15 served over 100,000 of the population, while others served an average of 10,000 (Figure 2).[23-25]

The GoI has authorized DKI Jakarta Province for 25 years, from 1997 to the PT. PAM Lyonnaise Jaya (Palyja) France and PT. Thames PAM Jaya (TPJ), but have not been able to provide safe water for the urban population.[26,27] The Dutch government has successfully benchmarked from the United Kingdom to provide good quality, low cost, safe, and affordable water for its population. Since 1990, the entire population has had access to low-cost, safe, and quality water supply services. Several donor agencies partnered with government and NGOs in Indonesia and successfully developed appropriate low-cost technology to provide safe water for the rural population. The Cooperation Agency of the Association of Netherlands Municipalities/*Vereniging van Nederlandse Gemeenten* (VNG) International, through Logo South Indonesia, Indonesian Water Utility Company Association/*Persatuan Perusahaan Air Minum Indonesia* (PERPAMSI), local government, and several PDAMs, provided good practices of a dual program for capacity building towards improving drinking water services in Banten, Bogor, and North Sumatra provinces (2005-2008).[27] The government partnered with the World Bank (WB) and Australian Aid to implement Water Supply and Sanitation for Low Income Communities Program/*Program Air Minum dan Sanitasi Berbasis Masyarakat* (PAMSIMAS). The program covered 23,000 villages with an improved water supply to 17.2 million people and access to adequate sanitation facilities for 15.4 million people.[29] Moreover, Bangun Indonesia Foundation, an NGO, partnered with the Simpenan Health Center and local community resources to improve sustainable and adequate water services using low-cost technology of slow sand filter in Kertajaya village funded by the US Agency for International Development (USAID) and VNG International.[30]

During the Coronavirus Disease 2019 (COVID-19) pandemic, the government and mass media encouraged people to frequently wash their hands with soap in running water to prevent coronavirus transmission by direct contact. This is a primary community hygiene practice for preventing and controlling various diseases, including coronavirus.[31] However, low-income people in rural and

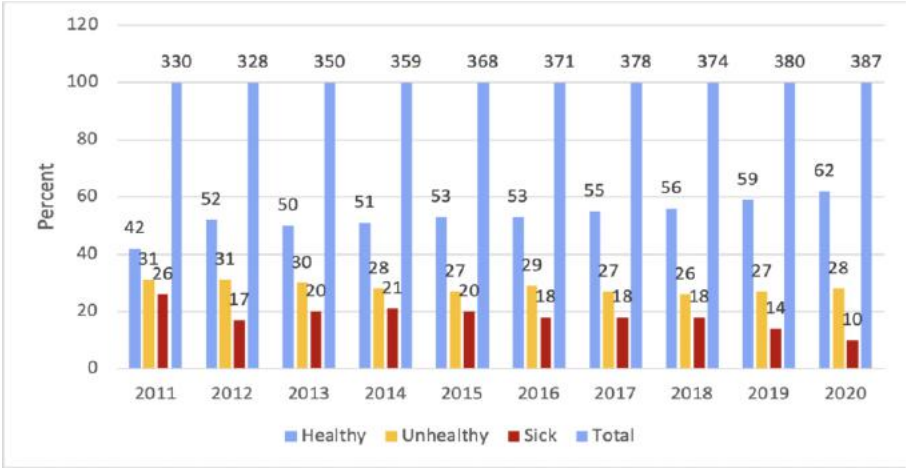


Figure 2. Regional Water Utility Company/*Perusahaan Daerah Air Minum* (PDAM) Status 2011-2020,[23-25]

poor urban areas do not have access to safe running water. The provision of safe water for these individuals is required. Even in urban areas, some public places provide refill running water which might not be safe. Several people prefer the use of hand sanitizer as a disinfectant but not the poor. Given that the coronavirus is not a water-related disease, frequent washing of hands provides benefits for personal hygiene. Several studies reported that 2–10% of COVID-19 cases present diarrhea. Two studies detected viral ribonucleic acid (RNA) fragments in the feces of COVID-19 patients, while one study cultured the COVID-19 virus from a single stool specimen. The COVID-19 virus tends to be persistent in drinking water, feces, and sewage. However, there is no evidence showing that human coronaviruses are present on surface or groundwater sources and transmitted through contaminated drinking water. The government is expected to provide continuous access to sufficient water for the populations living in the most vulnerable conditions, including poor urban and rural areas. The prevention of COVID-19 transmission is not possible without the provision of safe water services for personal hygiene.[32] It is recommended that PDAM be limited to individuals capable of paying water bills and the poor masses affected by the economic crisis. The government is expected to enforce and comply with these essential services. There is a need to accelerate the provision of safe water for urban and rural populations. Good water management is affected by political, social, economic, technological, environmental, and legal factors.

Discussion

The goal of water supply services is to increase the population's health status by reducing water-related diseases. The objective is to provide access and use of safe water for domestic purposes, including drinking, cooking, washing utensils, and other needs. Safe water is not only meant to meet the physical, chemical, and bacteriological criteria but also easily accessible, affordable, and fulfills SDG 6.1.[33]

Alternative Water Supply

Urban Areas

The Dutch government developed a drinking water supply system for several years through benchmarking from the United Kingdom. Between 1850 and 1990, people used water from vendors and had access to safe water. Recently, the government policy has changed due to the development in the knowledge of water quantity and quality, humidity, culture, and technological changes integrated into the supply system. In early 1850, a private water supply system was developed without environmental pollution and was expanded. in 1880 to serve more populations and increase the public health status of the people. In 1910, the water supply system was considered to be critical and needed more funding. It became a business commodity in 1950. The key success factors of the public water supply system include public policy, private sector participation, understanding the importance of water and health, willingness to pay, as well as the technology integrated into the framework of adequate good water management.[34]

This also applies to Indonesia, where each individual, household, profit, and non-profit organization need safe water for different purposes. Water is a basic human need and is essential for life, health, and the environment. The basic human value determines people's attitude and behavior, needs, and willingness to buy water.[35] The PDAM and several private sectors have taken water supply as a business commodity, but the services are still limited. Also, the government budget is limited, but benchmarking lessons from the Dutch government are suitable for accelerating the development of innovative good management for water supply, achieving the target of the SDG 6.1 and the general health of the population.

Technology Choice

Various countries, including the Netherlands, such as Duin & Water, and World Waternet. Surface water from the river passes through softening process by adding Na(OH), reduction of chemical pollution with activated carbon; open oxidation, pass through the rapid sand filter (RSF) and slow sand filter (SSF), produce safe water collected in the water collection tank, aerated with free oxygen, then pumped to the water reservoir through the piping system. Finally, safe water is then distributed to the population in the targeted areas. The Dutch government replaced 200 with 10 water companies using biosand filtering technology water treatment plants to serve all the population in the country. The application of this system is described in the Dunea Duin & Water company (Figure 3).[36]

Rural Areas

Various models of water supply systems have been developed through local government and NGOs funded by donor agencies, including USAID, German Agency for Technical Cooperation/*Deutsche Gesellschaft für Technische Zusammenarbeit* (GTZ), the United Nation International Children's Emergency Fund (UNICEF), WB, Asian Development Bank (ADB), Canadian International Development Agency (CIDA), and Japan International Cooperation Agency (JICA). Different sources were used for water intake, including stream, river, spring water, dam, and rainwater, using simple and low-cost technology to provide safe and sustainable water for domestic purposes. The selected water supply system technology was integrated into strategic and program

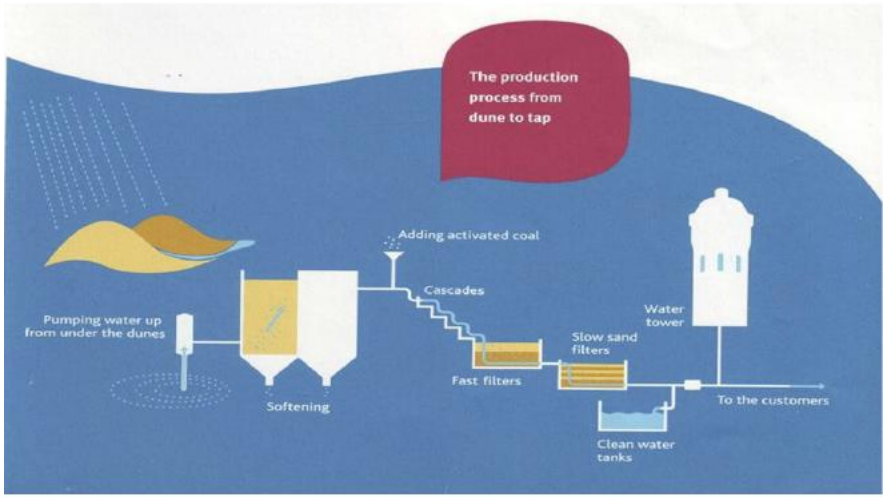


Figure 3. Water Treatment Plant of Dunea Duin & Water,[36]

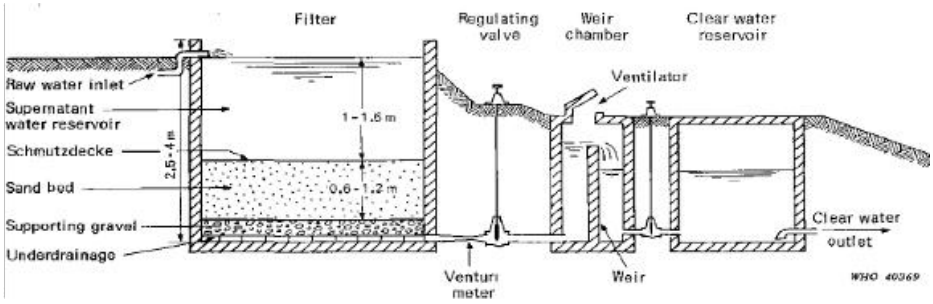


Figure 4. Diagram of Slow Sand Filter in WHO (1974),[39]

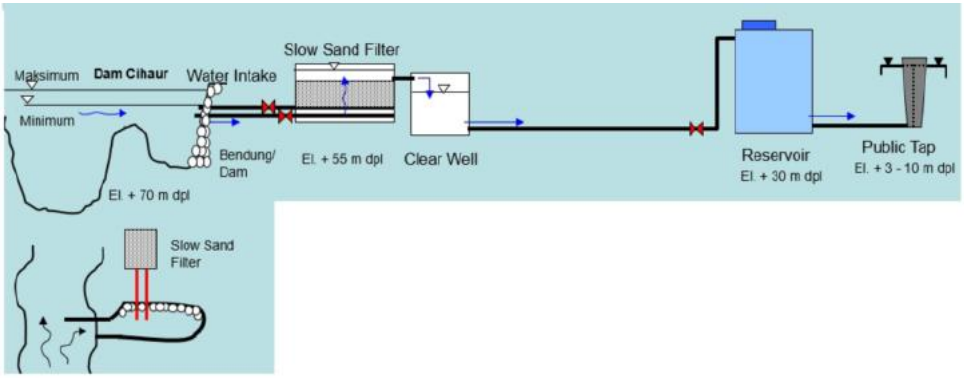
management. The strategic level includes analysis, direction, and formulation, which altogether provide a strategic plan as the guideline for program management. The program level includes analysis of the problem, objective, alternative, and stakeholder to plan for project development and implementation. Management development strategy and program require accurate and complete data through research to integrate the selected technology into the management before a wide-scale implementation.

Simple Technology: Slow Sand Filter (SSF)

This water biological filtering system consists of a cemented tank, gravel, and sand of suitable sizes. The system filters surface water through a simple biological process technology that is cheap and effective in producing safe water that meets the physical, chemical, and biological parameters of the WHO Drinking Water Quality Standard and the Ministry of Health.[37] During the SSF filtering process, microorganism in the water reservoir develops a thin layer "*Schmutzdecke*" made of complex protein cells, carbohydrates, diatoms, algae, bacteria, and zooplankton. This layer kills pathogens through "biological flocculation" and develops toxins that kill or remove viruses and bacteria in raw water. The physical SSF uses local components, including raw water intake, reservoir, sand bed, supporting gravel, and drainage with the right size of measurement depending on the need of water services.

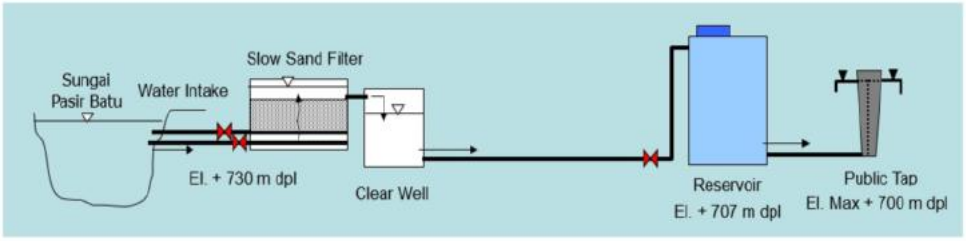
Basically, the filtered water passes through an aeration tank, and then a clean reservoir for distribution as described in Figure 4.[38,39] In practice, the development of the SSF system involves local men, women, children, human resources, uses gravity without fossil energy or chemical disinfectants, and is not expensive. Although several people consider it as an old method, this is not true as various developed countries such as the Netherlands have continued to successfully use this technology.

Bangun Indonesia Foundation partnered with the Simpenan Health Center, PDAM Sukabumi, Environmental Service Program, and Logo South Indonesia to develop a low-cost water supply system using SSF technology in Cisantri Sub-village coastal, Cijangkar Mountain, and Citemen inland area. The project was



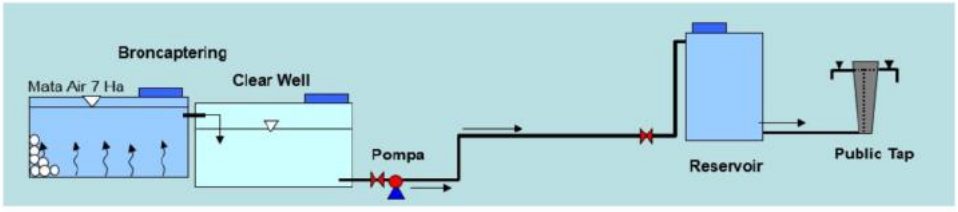
Notes: *Maksimum*: Maximum, *Bendungan*: Dam
Intake water from stream passes through slow sand filter (SSF) tank, stores in clear well, distributes through high-density polyethylene piping (HDPE) piping system to a reservoir, public tap, and house connections.

Figure 5a. Sub-village Cisantri in a Coastal Area,[30]



Notes: *Sungai* Pasir Batu: Pasir Batu River
Intake water from stream passes through slow sand filter (SSF) tank, stores in clear well, distributes through high-density polyethylene piping (HDPE) piping system to a reservoir, public tap, and house connections.

Figure 5b. Sub-village Citemen in the Mainland Area,[30]



Notes: *Mata Air*: Spring Water, *Pompa*: Pump
Intake water from water spring is collected via broncaptering, pumps, and distributes through high-density polyethylene piping (HDPE) system piping system to a reservoir, public tap, and house connections.

Figure 5c. Sub-village Cijangkar in a Mountain Area,[30]

funded by the VNG International and USAID (2008-2009), while the water sources include stream, dam, and spring water which are passed through the SSF tank, producing safe water collected in a clean tank. The water flows through a high-density polyethylene piping system (HDPE) using gravity energy to reach the public hydrant and house connection. Due to the spring water location in the lowland of the tea plantation under the sea level, a diesel pumping machine is used to lift the water to the reservoir and finally to the public hydrant and house connection. Populations in the three sub-villages had access to and utilized safe water from the low-cost sustainable supply for domestic purposes.

This water supply system shows coordination among government institutions, private sectors, and civil society organizations (CSOs), including NGOs and community which scales up to other areas. Figure 5 describes the water supply system using low-cost technology of slow sand filter for the population in three sub-villages; Cisantri (5a), Citemen (5b), Cijangkar (5c), of Kertajaya Village, Sukabumi.[30] Since 2010, most people in the sub-villages have had access to adequate and sustainable water services. Water is obtained and treated from the dam in Cisantri, stream in Citemen, and spring water in

Cijangkar. Water services monitoring in 2015 and 2018 indicated that the population of three sub-villages in Kertajaya Village, Sukabumi had access to adequate water services.

Conclusion

The majority of the Indonesian population has no access to safe water due to slow and low coverage of supply services over the past 100 years. Morbidity and mortality of water-related diseases such as diarrhea are very high. The acceleration of safe water services is required to improve the population's health status, especially in poor urban and rural areas. The usual method of water management requires a long period and is expensive. A good water management approach is needed at the policy and strategic levels, while benchmarking strategy is recommended at the operational level.

Good management benchmarking for water supply from the Netherlands's water company to the urban areas is appropriate. The application of a combined rapid and slow sand filter water treatment plant technology and the Dunea Duin & Water, Water-Net, is inexpensive. Also, the low-cost technology of slow sand filters utilized in Cisantri, Citemen, and Cijangkar Sub-villages of Kertajaya Village, Sukabumi is appropriate, cheap, and acceptable. In addition, water governance is recommended to be integrated into the related sector in the rural areas.

Abbreviations

Bappenas: *Badan Perencanaan Pembangunan Nasional* (National Development Planning Agency); POKJA AMPL: *Kelompok Kerja Air Minum dan Penyehatan Lingkungan Berbasis Masyarakat* (Working Group on Water Supply and Sanitation); PDAM: *Perusahaan Daerah Air Minum* (Regional Water Utility Company); GoI: Government of Indonesia; MDGs: Millennium Development Goal; SDG: Sustainable Development Goal; NGOs: Non-Governmental Organizations; Palyja: PT. PAM Lyonnaise Jaya; TPJ: PT. Thames PAM Jaya; VNG International: *Vereniging van Nederlandse Gemeenten*; PERPAMSI: *Persatuan Perusahaan Air Minum Indonesia* (Indonesian Water Utility Company Association); PAMSIMAS: *Program Air Minum dan Sanitasi Berbasis Masyarakat* (Water Supply and Sanitation for Low Income Communities Program); WB: World Bank; USAID: United States Agency for International Development; COVID-19: Coronavirus Disease 2019; RNA: Ribonucleic Acids; RSF: Rapid Sand Filter; SSF: Slow Sand Filter; GTZ: *Deutsche Gesellschaft für Technische Zusammenarbeit*; UNICEF: United Nations Children's Emergency Fund; ADB: Asian Development Bank; BCIDA: Canadian International Development Agency; JICA: Japan International Cooperation Agency; HDPE: High-Density Polyethylene; CSOs: Civil Society Organizations.

Ethics Approval and Consent to Participate

Not Applicable

Competing Interest

The authors have no conflict of interest.

Availability of Data and Materials

The datasets used and analyzed during the current study are available in the official government document and the internet.

Authors' Contribution

SS contributed to the overall review, analysis, and writing of the article, while SSG contributed to data collection, review, and plot data. Furthermore, BS contributed to the selection of strategic changes, benchmarking, and scaling up the lessons while SW provided operational best practices in rural areas. GS contributed to the review of the statistical data and plot data testing.

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References

1. Children's Prize. Why water is a basic human need. Children' Prize Foundation; Built using WordPress and the Mesmerize Theme 2021; 2021.
2. Menteri Kesehatan Kesehatan Republik Indonesia. Keputusan Menteri Kesehatan Republik Indonesia nomor 907/Menkes/SK/VII/2002 tentang syarat-syarat dan pengawasan kualitas air minum. Jakarta: Departemen Kesehatan Republik Indonesia; 2012.
3. United Nations. A/RES/64/292. General assembly. Sixty-fourth session. Agenda item 48. The human right to water and sanitation. Resolution adopted by the General Assembly on 28 July 2010; 2010.
4. Badan Perencanaan Pembangunan Nasional. Kebijakan nasional pembangunan air minum dan penyehatan lingkungan berbasis masyarakat. Jakarta: Bappenas; 2003.
5. Presiden Republik Indonesia. Undang-Undang Republik Indonesia nomor 5 tahun 1962 tentang perusahaan daerah; 1962.
6. Kusmayadi, R. Chair Indonesia water supply association. Water supply in Indonesia towards SDGs. Presented in International Forum at JWWA. Saitama, Japan: General Assembly and Conference: 2015.
7. Kementerian Kesehatan Republik Indonesia. Profil kesehatan Indonesia tahun 2019. Jakarta: Kementerian Kesehatan RI; 2020.
8. National Water & Sanitation Information Services. Kualitas air minum rumah tangga di Indonesia dinilai dari kontaminasi bakteri E Coli. Nawasis; 2021.
9. Irman J. Kebijakan dan strategi pengembangan air minum; 2011.
10. O'Rourke, E. The international drinking water supply and sanitation decade: dogmatic means to a debatable end. Water Science and Technology. 1992; 26 (7-8): 1929-39.
11. Patunru AA. Access to safe drinking water and sanitation in Indonesia. Special Research Article on Health Policy. Asia & the Pacific Policy Studies. 2015; 2 (2): 234-244.
12. Kementerian Pekerjaan Umum dan Perumahan Rakyat. Tentang pro-

gram kota tanpa kumuh (Kotaku); 2017.
13. World Bank. Water supply and sanitation in Indonesia turning finance into service for the future. Water and Sanitation Program; 2015.
14. United Nations Children's Fund. Progress on drinking water, sanitation and hygiene; 2019.
15. Kadim M. Cholera updates in Indonesia; 2017.
16. United Nations Children's Fund. Water, sanitation and hygiene; 2016.
17. United Nations Children's Fund Data. Monitoring the situation of children and women. Indicator profiles. Infant mortality rate. UNICEF; 2021.
18. World Health Organization. Preventing diarrhea through better water, sanitation and hygiene. Exposures and impacts in low and middle-income countries. WHO Library Cataloguing-in-Publication Data; 2014.
19. United Nations Children's Fund. The state of children in Indonesia; 2020.
20. United Nations-World Population Prospects. Indonesia infant mortality rate 1950-2019. World Population Prospects; 2019.
21. World Bank. Indonesia: expanding access to clean water for the rural poor; 2019.
22. Hoogsteen KJ, van der Kolff G, Ruijter JA. Public private partnership for efficient and sustainable water supply development in Indonesia. Water Practice & Technology. 2008; 3 (1).
23. Kementerian Pekerjaaan Umum dan Perumahan Rakyat. Buku kinerja PDAM. Laporan Hasil penilaian kinerja PDAM 2017; 2017.
24. Limbong HM. Indonesia PPP projects in water supply sector; 2019.
25. Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR). Direktur Air Minum: 148 PDAM di Indonesia Berkinerja Kurang Sehat. PU-net. February 19, 2021; 2021.
26. Lanti A, Varis O, Tortajada C, Altinbilek D. Regulatory approach to the Jakarta water supply concession contracts. International Journal of Water Resources Development. 2006; 22 (2).
27. Ismowati M. Profile of Pam Jaya and private partners in clean water supply Jakartan (case study year 1998-2012). KnE Social Sciences; 2018.
28. VNG International. Cooperation program Netherlands and Indonesia. Logo South Country program Indonesia. Best practices in PDAMs through twinning 2005-2008. Capacity building towards improvement in drinking water services in Banten Province, Bogor and North Sumatra Provinces. The Hague Netherlands; 2008.
29. World Bank. PAMSIMAS: responding to the water and sanitation challenges in rural Indonesia; 2014.
30. Bangun Indonesia Foundation, Partnership BIF, ESP, VNG, HC, local community Kertajaya Village, Sukabumi Project for improving water supply services in Kertajaya Village, Sukabumi West Java Province Funded by: VNG International and USAID; 2018.
31. World Bank. The impact of COVID-19 on the water and sanitation sector; 2020.
32. World Health Organization. Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance. March 19, 2020; 2020.
33. United Nation. Goal 6: ensure access to water and sanitation for all; 2021.
34. Zetland D, Colenbrander B. Water civilization: the evolution of the dutch drinking water sector. Leiden University: Scholarly Publications; 2018.
35. Van der Kerk A, Wwterweel JW, Havekes H, Teeuwen B. Opportunities for water governance in Indonesia. A government quick scan under the Indonesian-Dutch water management cooperation; 2013.
36. Dunea Duin &Water. Betrouwbaar en lekker drinkwater. Hoe wordt uw drinkwater gemaakt? Duinwaterbedrijt Zuid-Holand; 2020.
37. World Health Organization. Guidelines for drinking-water quality. WHO Geneva; 2008.
38. Slow Sand Filter. Frequently asked questions regarding slow sand filters; 2016.
39. Huisman L, Wood WE. Slow sand filtration. Geneva: World Health Organization; 2012.