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Investigation of improvements to city areas of importance to the implementation of clean water

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ABSTRACT

In the context of improving urban areas through clean water services, the provision and distribution of clean water systems are the primary focus of this research. The study aims to identify effective methods to enhance clean water services. Following the PRISMA guidelines for systematic reviews and meta-analyses, the study searched four major databases: Scholar, ResearchGate, Scopus, and Taylor & Francis Online. The search process used relevant keywords such as "clean water services" OR "water distribution systems," OR "water quality improvement" across each database. From 967 articles initially identified, four articles were selected after a rigorous selection process applying inclusion and exclusion criteria. Key findings highlight that the use of sensors to monitor water quality parameters such as pressure, flow, pH, chlorine, and turbidity; the application of the elitist nondominated sorting genetic algorithm (NSGA-II); and active community involvement with government support are effective in improving the quality and distribution of clean water. Further research is recommended to focus on developing more advanced sensor technologies, deeper studies on NSGA-II implementation, strategies to enhance community involvement, policy analyses that support these efforts, and collaborative models involving government, private sector, and communities. Thus, sustained efforts in this research are expected to significantly contribute to improving clean water services in various urban areas.

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Introduction

Access to clean and secure water and sanitation is a fundamental human need and a basic right, as recognized by relevant development theories such as the Maslow motivation and Basic Needs theories (Bowler 1987; White 2020). Water is presently considered one of the most finite natural resources on Earth (Bakker, 2012). Water is essential for the survival of humans, creatures, and vegetation (Storey et al., 2011). Consequently, it is imperative to preserve the purity of potable water. The entire globe is affected by significant issues such as untreated pollution in drinking water sources and inadequate hygiene practices (Herschy, 2012; Prüss-Ustün et al., 2014). The significance of clean and secure water and sanitation in sustainable socio-economic progress is underscored by the United Nations (UN) Sustainable Development Goals (SDGs) requirement for universal access to water and sanitation (SDG6; Nations, 2019). Around 2 billion individuals worldwide consume faces-contaminated water, and 5 to 10 million individuals succumb to water-related illnesses annually (Pule et al., 2017). Presently, a global population exceeding 5% partakes in a daily intake of three litters of water, while the majority of individuals consume a minimum of one litter. Individuals working in hot regions may need to consume up to 16 litters of water daily (Ameer et al., 2017; Popkin et al., 2010). Just 89% of the global population has access to safe and drinkable sources of water (Roy et al., 2021; Van Nevel et al., 2017). In many regions, such as Sub-Saharan Africa, only a portion of the population, ranging from 40% to 80%, has access to clean water (Bain et al., 2014). Furthermore, it is estimated that a staggering 2 billion individuals consume water from sources that are contaminated with E. coli bacteria (Onda et al., 2012). As to the World Health Organization, safe drinking water is a fundamental right for all individuals. However, a staggering 12 billion people throughout the globe lack access to clean drinkable water (WHO & UNICEF, 2021). Water consumption is a vital necessity and a prerequisite for human survival. H2O is indispensable for everyday existence and plays a vital role in the development of communities (Moriasi et al., 2015). Hence, individuals must be always aware of contamination and the integrity of drinking water sources (Seth et al., 2016). By assessing the threats to drinking water safety and public health, one may develop effective strategies and measures for managing water resources (Bilgin & Konanç, 2016).

The water distribution supply schedule is subject to significant variation among various locations; consumers may experience water shortages for several hours or days each week. The supply pattern can be unreliable, variable, or fixed, resulting in significant uncertainty and inconvenience for consumers (Farmani et al., 2021). Various strategies have been devised to effectively implement the intermittent operation of water distribution systems (WDS; Vairavamoorthy et al., 2007). Several of these strategies are intended to alleviate the effects of water scarcity that are the result of unforeseen events, including droughts, pollution incidents, structural damage to the system, or maintenance issues (Simukonda et al., 2018). In the past decade, researchers have conducted a comprehensive examination of the effects and repercussions of intermittency in WDS (Galaitsi et al., 2016; Simukonda et al., 2018). The network's various components are subjected to significant stress due to the intermittent character of the water supply. This stress is the result of the inequitable distribution of water among consumers, the discontinuous operation of devices, and the presence of air volumes inside the pipelines (De Marchis et al., 2015). Accessing water from the WDS is frequently a challenge for consumers who are situated at higher elevations or remote from the source (Ameyaw et al., 2013). The issue of unequal water distribution is exacerbated during periods of supply scarcity.

The public's cognizance of the necessity to safeguard drinking water has consistently increased as a result of the escalating pollution of drinking water resources (Abyaneh, 2014). Nevertheless, conventional water quality detection systems are characterized by a multitude of deficiencies, such as a single measurement parameter, high cost, large volume, and the inability to accomplish long-distance parameter transmission. When a value is submitted, an online assessment system can automatically ascertain whether the local water quality meets the threshold and satisfies the requirements (R. Wang et al., 2018). Nevertheless, the detection of water contaminants was frequently conducted manually in water laboratory facilities in the past (Richardson, 2012). Low-cost, real-time water quality surveillance systems can be advantageous for remote rivers, lakes, coasts, and other water bodies, as per (Demetillo et al., 2019). In particular, the government or city stakeholders can provide clean water services, but there are related parties who take personal advantage by buying and selling clean water.

In order to enhance the overall decision-making process and foster trust among stakeholders, Langsdale & Cardwell (2022) emphasize the importance of establishing trust in the water sector. Morckel & Terzano (2019) examined the Flint water crisis, a scenario in which trust in the state and municipal governments was eroded because officials ignored customers' complaints about the quality of their water for an entire year. The prevailing sense of mistrust resulted in the majority of users abstaining from participating in the planning process, so impeding the city's planning and recovery endeavours. It suggests that a deficit in confidence in the administration may have played a role in the limited involvement.

Although access to clean water and safe sanitation is recognized as a basic human need and a fundamental human right, there are still many challenges that need to be overcome in the distribution and maintenance of water quality. Previous research has highlighted the importance of clean water for the survival and development of communities, as well as the problems arising from contamination and inadequate water supplies. Additionally, although several strategies have been developed to address water scarcity and intermittency problems in water distribution systems, there are still gaps in implementing effective and equitable solutions in various locations. Based on the many studies described previously, it seems that there are no review articles that try to collect references on effective strategies to ensure equitable and sustainable access to clean water in various locations. Then, this research aims to create a systematic literature review regarding effective strategies in ensuring equitable and sustainable access to clean water in various locations, as well as overcoming water distribution and quality challenges faced by various communities.

Method

The method used to write this article is a systematic literature review. The articles analyzed were obtained from search results in four databases as shown in Figure 1, namely: 1) scholar; 2) ResearchGate; 3) Scopus; and 4) Taylor and Francis. When searching the Scholar database using the keywords "Clean water services" OR "Providing clean water" OR "Clean water distribution" OR "Water supply system", the author obtained 540 article search results. When searching the ResearchGate database using the keywords "Clean water services" OR "Providing clean water" OR "Clean water distribution" OR "Water supply system" the author obtained 157 article search results. When searching the Scopus database using the keywords "Clean water services" OR "Providing clean water" OR "Clean water distribution" OR "Water supply system", the author obtained 215 article search results. Then the author searched the Taylor and Francis online database with the keywords "Clean water services" OR "Providing clean water" OR "Clean water distribution" OR "Water supply system", obtaining search results of 55 articles. Search all keywords to find articles related to improving city areas through clean water services or clean water supply or clean water distribution or water supply systems which will be implemented on February 23 2024 at 10.40 local time. After searching the four databases, a total of 967 articles were obtained.

Initial filtering of articles is carried out to see whether there is duplicate content from other articles. After analysis, 378 articles were found that were identical to other articles, so the author cleaned up the references. Titles and abstracts of articles will initially be screened by the following authors, who then verify the inclusion and exclusion criteria and discard any submissions that do not meet the requirements (details Table 1). After looking closely at the titles and abstracts which were not related to improving urban areas through clean water services or clean water supply or clean water distribution or water supply systems, 234 articles remained. Finally, the author filters the remaining articles on the stage by downloading them in their entirety, reading them, and considering their inclusion. After reading all the articles, the author determined that only four articles met the inclusion criteria that the author had previously set.

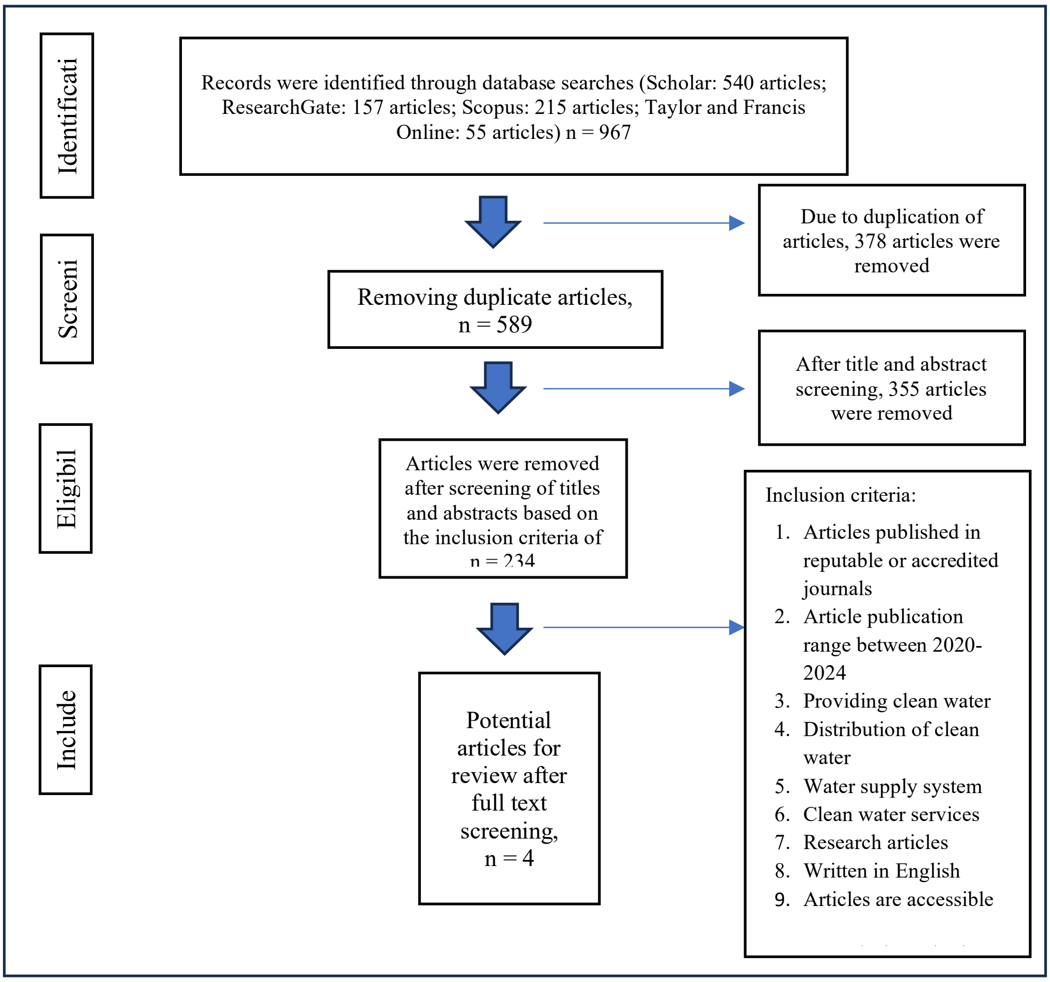

Figure 1. Flow diagram of the PRISMA study selection process

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Articles published in reputable or accredited journals	1. Articles published by international journals that are not reputable or accredited
2. Article publication range between 2020-2024	2. Articles published other than 2019-2024
3. Providing clean water	3. The published article does not use clean water supplies
4. Distribution of clean water	4. The published article does not use clean water distribution
5. Water supply system	5. The published article does not use a clean water supply system
6. Clean water services	6. The article published does not provide clean water services
7. The type of article is an original research article	7. Review articles, conference papers, books, book chapters, repositories
8. Articles written in English	8. Non-English writing articles
9. Full text articles can be downloaded	9. The text article is incomplete and cannot be downloaded

Results and Discussions

In this section, the results of the research are explained and a thorough discussion is provided. The results can be presented in the form of images, graphs, tables and other article search results from four databases, 967 articles were obtained and after passing initial to final screening they met the article inclusion criteria, totaling four articles. Table 2 will describe the number of authors, year of publication, journal name, publisher, and journal category. Meanwhile, Table 3 will outline the results of the article analysis regarding author, approach, research objectives, method: research design, data analysis, and research results.

Table 2. Number of authors, years, and journal categories used in research

Number of Authors	Publication Year	Journal name	Publisher	Journal quality
4	2024	J. Water Resour. Plann. Manage	American Society of Civil Engineers (ASCE) library	Quartile 1
3	2024	International Journal of Public Health Science (IJPHS)	Intelektual Pustaka Media Utama (IPMU)	Quartile 4
1	2024	AQUA — Water Infrastructure, Ecosystems and Society	IWA Publishing	Quartile 2
2	2024	Sustainable Water Resources Management	Springer International Publishing	Quartile 2

Table 3. Search article matrix results related to improving city areas through clean water services

Author	Title	Research purposes	Method	Data analysis	Result
Ayyash et al. (2024)	Optimal Operation of Intermittent Water Supply Systems under Water Scarcity	This study presents a heuristic approach for sectorizing and optimum operation of intermittent water supply (IWS) systems under water scarcity conditions.	RD: heuristic method and NSGA-II	The elitist nondominated sorting genetic algorithm	The results of the application of optimization for the optimal operation of nonvectorized and sectorized networks highlight the potential of improving both equity and pressure uniformity of the IWS system.

Author	Title	Research purposes	Method	Data analysis	Result
Rahim et al. (2024)	Online water quality monitoring: a case study in the umbulan drinking water supply system, East Java, Indonesia	This study aims to evaluate water quality periodically by measuring water parameters such as pH, chlorine and turbidity for 30 days using an online system and portable unit.	RD: Sensor values (pressure, flow, pH, chlorine, and turbidity) at the Offtake Station were collected by the data logger before being sent to Using a virtual private network (VPN)	Scada Human Machine Interface (HMI)	The average parameter value of the results of online daily monitoring for a month for the pH parameter was a minimum 6.92, a maximum of 7.46, a minimum turbidity of 0.08 nephelometric turbidity unit (NTU) and a maximum of 0.94 NTU. While the residual chlorine minimum of 0.29 mg/L and a maximum of 0.58 mg/L.
Bombade (2024)	Challenges in developing trust in the rural drinking water supply systems	The study aims to utilise the learnings from the trust research to empirically understand the factors shaping the trustful relationship between the stakeholders in India's rural drinking water sector.	RD: qualitative approach, where data collection relies on detailed descriptions of the on-ground events/observations and interviews	Thematic analysis	The users' participation or engagement with the VLSBs is sought by giving a prominent role to the community since the sector reforms. In this participatory approach, the users and the service providers are directly accountable to each other for service delivery and its payments.
Gyau Baffour Awuah & Bijimi (2024)	Discovering the core stakeholders in the Nigerian urban water supply system	This study examines Nigerian's urban water supply system and the extent of the interests of the stakeholders to identify the core stakeholders as an input towards facilitating sustainable water resources management in the country based on a survey of urban water supply experts in the country.	RD: systematic literature review	Descriptive	The study concludes that whilst the engagement of all stakeholders is good for sustainable water resources management in Nigeria, engagement, and involvement of the 15 core stakeholders is paramount to the sustainable and successful operations of the country's urban water supply system.

RD: research design

The focus of this research is the importance of improving urban areas through clean water services or the provision of clean water or distribution systems or the provision of clean water. This research aims to identify useful methods for improving clean water services or clean water supply or distribution systems or clean water supply. This study used four main databases: Scholar, ResearchGate, Scopus, and Taylor and Francis online to search the literature. They used PRISMA guidelines for systematic reviews and meta-analyses. A rigorous selection process was used to select four articles as the final result from the 967 articles found from the exhaustive search. The main findings from this literature review show that to improve clean water services or clean water supply, several effective approaches are the use of sensors to measure pressure, flow, pH, chlorine, and water turbidity; application of the elite nondominant genetic algorithm (NSGA-II); as well as active community involvement and government support in maintaining and developing clean water services. Sensor values are used to monitor water quality and distribution in real-time, ensuring that the water distributed meets established quality standards.

Water intake is essential for the survival of organisms. The daily water requirements fluctuate based on factors such as physical activity, age, health conditions, and environmental influences (Kotlarz et al., 2018). Presently, a global population exceeding 5% partakes in a daily water intake of three litters, while the majority of individuals consume a minimum of one litter. Individuals working in hot regions may need to consume as much as 16 litters of water each day (Ameer et al., 2017; Popkin et al., 2010). Just 89% of the global population has access to safe and drinkable sources of water (Roy et al., 2021; Van Nevel et al., 2017). In many regions, such as Sub-Saharan Africa, only a fraction of the population, ranging from 40% to 80%, has access to clean water (Bain et al., 2014). Furthermore, it is estimated that around 2 billion individuals consume water from sources that are contaminated with E. coli bacteria (Onda et al., 2012). As to the World Health Organization, the right to obtain safe and drinkable water is universal. However, a staggering 12 billion individuals around the globe lack access to clean drinking water (WHO & UNICEF, 2021). Water consumption is a vital necessity and a prerequisite for human survival. Water is important for daily existence and is vital for the development of communities (Moriasi et al., 2015). Hence, individuals must remain always aware of contamination and the security of drinking water supplies (Seth et al., 2016). By assessing the threats to drinking water safety and health, one may develop strategies and measures for effectively managing water resources (Bilgin & Konanç, 2016). Drinking water damage has occurred to different extents due to the fast rise of industry and economy, water pollution, water shortages, and contamination of rivers and lakes (A. Wang et al., 2017). Thus, it is imperative to protect the potable water. A multitude of researchers are diligently striving to tackle the problem of escalating water pollution through the monitoring and preservation of water quality (Zulkifli et al., 2018). The contamination of drinking water resources has become more serious, leading to a steady increase in public awareness regarding the need of protecting drinking water (Abyaneh, 2014). Nevertheless, traditional water quality detection systems suffer from several drawbacks, such as exorbitant costs, bulky size, limited capability for long-range parameter transmission, and the capacity to monitor only a single parameter. By utilizing an online assessment system, it is possible to instantly ascertain if the local water quality fulfils the necessary criteria and surpasses the minimum standard when a value is provided (R. Wang et al., 2018). Previously, water pollutants were often detected manually in water laboratory facilities (Richardson, 2012). Demetillo et al. (2019) state that inexpensive, real-time water quality monitoring systems can be advantageous for remote rivers, lakes, beaches, and other water bodies.

The implications of this research are extensive and substantial in the context of enhancing urban areas by enhancing pure water services. The efficacy and effectiveness of water distribution systems can be considerably enhanced through the implementation of advanced technology, such as the use of sensors to measure water quality parameters such as pressure, flow, pH, chlorine, and turbidity. The implementation of this technology facilitates real-time monitoring, which facilitates the rapid identification of water quality issues and the immediate implementation of corrective measures. Furthermore, the implementation of the elite non-dominant genetic algorithm (NSGA-II) in the management of water distribution systems can contribute to the equitable and effective optimization of water distribution, a critical factor in regions that are currently experiencing water scarcity. Additionally, prior research has demonstrated that the mutual trust and responsibility that can be fostered by active community participation in the management of clean water services. The sustainability of the water distribution system can be enhanced by providing training and education programs to the community regarding the significance of water quality preservation and their participation in the decision-making process. It is imperative that the government provide support in the form of infrastructure development and supportive policies. The government must allocate sufficient funds and resources to update and maintain clean water infrastructure, and it must also guarantee that current policies are in alignment with initiatives to enhance water quality and distribution. Furthermore, this research underscores the significance of collaboration among a variety of stakeholders, such as the private sector, society, and government. Good cooperation can assist in surmounting the obstacles encountered in the provision of pure water and guarantee that the solutions implemented are sustainable and highly effective. This research also implies the necessity of additional research to continue the development and testing of new technologies and methods to enhance pure water services. Continuous research and development will guarantee that the quality and distribution of water can be enhanced in accordance with the evolving requirements and obstacles encountered.

Conclusions

The results of the study from the articles reviewed confirm that to improve clean water services or the provision of clean water, several effective approaches are the use of sensors to measure pressure, flow, pH, chlorine and water turbidity; application of the elite nondominant genetic algorithm (NSGA-II); as well as active community involvement and government support in maintaining and developing clean water services. Sensor values are used to monitor water quality and distribution in real-time, ensuring that the water distributed meets established quality standards. The results of the study suggest that future research should concentrate on the development of more advanced and cost-effective sensor technologies, as well as in-depth investigations into the application of the elite non-dominant genetic algorithm (NSGA-II) in a variety of water distribution contexts. Additionally, research must investigate strategies to enhance community engagement, analyse policies that promote clean water services, and analyse models of successful collaboration among the government, private sector, and communities. It is anticipated that this method will enhance the quality and distribution of pure water in a sustainable manner in a variety of communities.

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