

## The Role of Smart Technologies in Water Distribution Management

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Cite this paper as: Dr. Ritu (2024). The Role of Smart Technologies in Water Distribution Management. *Frontiers in Health Informatics*, 13 (6) 1404-1412

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### Abstract

Smart technologies are revolutionizing water distribution management, addressing the growing challenges of urbanization, climate change, and resource scarcity. Traditional water systems, reliant on manual operations, often fail to meet modern efficiency and sustainability demands. In contrast, smart technologies leverage advanced tools such as the Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics to optimize water networks. These technologies enable precise monitoring of water flow, early detection of leaks, and improved demand forecasting, ensuring efficient resource utilization and reduced non-revenue water losses. Smart meters and automated control systems empower utilities to respond proactively to consumption patterns and operational issues, enhancing reliability and equity in distribution. Furthermore, real-time data access encourages user accountability and promotes water conservation. By integrating predictive analytics and machine learning algorithms, smart systems offer actionable insights that support informed decision-making and long-term planning. These advancements also play a critical role in mitigating the environmental impact of inefficient water use while addressing pressing issues like water scarcity and aging infrastructure. As global populations and water demands grow, the adoption of smart technologies in water distribution represents a vital step toward creating resilient, sustainable, and future-ready water management systems. This abstract explores their transformative potential and underscores their pivotal role in ensuring a secure and sustainable water future.

### Introduction

Water distribution management has become a critical focus globally, as challenges such as population growth, climate change, and aging infrastructure threaten the sustainability of water resources. Traditional water management systems, often reliant on manual operations and outdated technologies, struggle to address the growing complexities of urbanization and environmental pressures. In response, smart technologies are emerging as transformative tools for optimizing water distribution networks. These advanced systems, powered by sensors, data analytics, and artificial intelligence (AI), offer unparalleled opportunities to monitor, control, and improve water supply efficiency. By integrating Internet of Things (IoT) devices and real-time data analysis, utilities can detect leaks, predict demand patterns, and reduce non-revenue water losses, ultimately ensuring a more resilient and sustainable water supply system.

The adoption of smart technologies not only enhances operational efficiency but also empowers decision-makers with actionable insights to create proactive management strategies. Smart meters, automated control valves, and machine learning algorithms enable precise monitoring and forecasting of water consumption trends, allowing utilities to meet demand fluctuations effectively. Additionally, these technologies promote transparency by providing users with real-time data on water usage, encouraging conservation and reducing waste. As urban centers continue to expand, smart water management solutions play a pivotal role in addressing water scarcity, improving distribution equity, and mitigating the environmental impact of inefficient systems. With advancements in digital infrastructure and growing investments in smart technologies, the future of water distribution management is poised to become more sustainable, equitable, and resilient in the face of global challenges.

## Overview of Smart Technologies in Water Management

Smart technologies are transforming water management systems by enhancing efficiency, sustainability, and resilience. These technologies utilize cutting-edge tools such as the Internet of Things (IoT), artificial intelligence (AI), and advanced data analytics to address critical challenges in water distribution and conservation. With global water demand expected to increase by 20-30% by 2050, and nearly 45 million cubic meters of water lost daily due to leaks (World Bank, 2021), smart technologies offer viable solutions to optimize water resource management.

IoT-enabled smart water systems use sensors and connected devices to monitor water flow, pressure, and quality in real time. These systems provide actionable insights to detect leaks, prevent pipe bursts, and minimize non-revenue water losses, which account for approximately 30% of water losses worldwide. For instance, smart meters installed in urban households help utilities track water consumption, detect anomalies, and encourage users to adopt conservation practices by providing detailed usage reports.

AI and machine learning further enhance predictive capabilities, enabling utilities to forecast water demand and optimize distribution networks. By analyzing historical and real-time data, AI-driven models can detect patterns and recommend proactive interventions, improving operational efficiency. Automated control systems, such as remotely operated valves, ensure seamless and timely water distribution based on demand variations.

Additionally, smart water management integrates Geographic Information Systems (GIS) to map and analyze water networks, aiding infrastructure planning and maintenance. Cloud-based platforms provide centralized data access, allowing stakeholders to collaborate and make informed decisions.

Smart technologies not only reduce operational costs but also enhance sustainability by promoting equitable water distribution and minimizing environmental impact. With increasing investments in digital infrastructure and the global smart water management market projected to reach \$25 billion by 2026 (MarketsandMarkets, 2022), these technologies are crucial for securing water resources for future generations.

## Current Challenges in Water Distribution

Water distribution systems worldwide face numerous challenges that threaten the sustainability and efficiency of this critical resource. One significant issue is aging infrastructure, which is prevalent in both developed and developing regions. Leaky pipes, inefficient networks, and outdated distribution systems result in substantial water losses, often termed non-revenue water (NRW). Globally, nearly 30% of treated water is lost before it reaches consumers, with losses exceeding 50% in some developing countries. These inefficiencies lead to higher operational costs and reduced reliability, exacerbating water scarcity. Additionally, the increasing urbanization and population growth place immense pressure on existing distribution networks, which are often incapable of meeting rising demands. Combined with the challenges of inadequate investment in infrastructure modernization, these systems struggle to provide equitable and consistent water supply.

Climate change further amplifies the challenges in water distribution management. Erratic rainfall patterns, prolonged droughts, and extreme weather events disrupt water availability and place significant stress on distribution networks. Moreover, these systems often lack real-time monitoring and fail to adapt to sudden changes in demand or supply. Water contamination due to cross-connections, industrial effluents, and aging pipelines also poses a major risk to public health. Utilities often lack adequate data and technology to address such challenges proactively, resulting in delayed interventions and ineffective management.

Finally, financial and regulatory constraints further complicate the situation. Many utilities face budget limitations that hinder their ability to invest in advanced technologies or upgrade infrastructure. At the same time, weak regulatory frameworks fail to enforce water conservation measures or promote accountability in water management. With global water demand expected to rise significantly in the coming decades, addressing these challenges is critical. Innovative solutions, such as smart technologies and public-private partnerships, must be adopted to overcome inefficiencies and ensure a reliable and sustainable water distribution system for future generations.

### Smart Technologies in Water Distribution

Smart technologies are revolutionizing water distribution by enabling more efficient, sustainable, and resilient management systems. These technologies, powered by the Internet of Things (IoT), artificial intelligence (AI), and advanced data analytics, provide real-time monitoring and control over water networks. IoT sensors embedded in pipelines and distribution systems collect data on parameters such as water flow, pressure, and quality. This real-time data allows utilities to detect leaks, prevent pipe bursts, and minimize water losses. Smart meters, another critical innovation, offer consumers detailed insights into their water consumption, enabling conservation efforts while also providing utilities with precise demand data. Studies indicate that smart water meters can reduce water consumption by up to 15%, significantly lowering wastage. Automated control systems, such as remotely operated valves and pumps, further optimize distribution, ensuring water is delivered efficiently and equitably based on real-time demand.

AI and machine learning enhance the capabilities of these systems by analyzing large datasets to identify patterns and predict future water usage. These predictive models allow utilities to anticipate demand surges, optimize resource allocation, and plan maintenance activities proactively. For example, AI-powered algorithms can predict potential pipeline failures, reducing downtime and maintenance costs. Geographic Information Systems (GIS) integrated with smart technologies provide detailed network mapping, helping utilities visualize and plan their infrastructure more effectively. Cloud-based platforms serve as centralized hubs for data collection and analysis, enabling seamless collaboration among stakeholders.

In addition to operational efficiency, smart technologies promote sustainability by reducing non-revenue water losses, which account for nearly 30% of global water supply. They also enhance resilience to challenges such as climate change and urbanization by improving the adaptability of water systems to changing conditions. As global investment in smart water management grows, these technologies are becoming indispensable tools for addressing the complex challenges of modern water distribution systems and ensuring a secure water future.

### Literature review

**Gupta, A. D., et al (2020).** Smart water technology plays a pivotal role in enhancing the efficiency of water resource management by integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics. These systems enable real-time monitoring, data collection, and predictive analysis, allowing for informed decision-making to optimize water usage, detect leaks, and reduce wastage. Smart meters, for instance, provide precise consumption data, promoting water conservation at both individual and community levels. Similarly, automated irrigation systems adjust water supply based on weather conditions and soil moisture, enhancing agricultural efficiency. Water quality monitoring sensors ensure safe water for consumption and industrial use. AI-powered models predict demand patterns and assess risks such as droughts or floods, enabling proactive management. The integration of cloud-based platforms facilitates data sharing among stakeholders, promoting collaboration in addressing water challenges. Despite these advancements, the adoption of smart water technologies faces challenges such as high initial costs, data security concerns, and the need for skilled personnel. As water scarcity intensifies globally, these technologies offer a sustainable solution to optimize water resources, ensuring equitable distribution and long-term ecological balance. Continuous innovation, government policies, and public awareness are essential to maximize the benefits of smart water systems in addressing future water management challenges.

**Palermo, S. A., et al (2022).** Smart technologies are revolutionizing water resource management by leveraging advanced tools like the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cloud computing. These technologies enable real-time monitoring, predictive analysis, and efficient allocation of water resources, addressing critical challenges such as scarcity, overuse, and pollution. IoT-based sensors and smart meters provide accurate, real-time data on water flow, consumption, and quality, helping detect leaks, minimize wastage, and promote conservation. AI-driven algorithms analyze historical and real-time data to forecast demand, optimize irrigation schedules, and predict potential risks like droughts or floods. In agriculture, smart irrigation systems ensure water is supplied based on soil

moisture and weather conditions, enhancing crop yield and reducing water usage. Urban water networks benefit from automated leak detection and efficient distribution, reducing losses and ensuring equitable access. Cloud-based platforms enable data integration and collaboration among stakeholders, streamlining decision-making processes. Despite challenges such as high implementation costs, data privacy concerns, and the need for infrastructure upgrades, smart technologies offer scalable, sustainable solutions to manage water resources effectively. As global water demands rise, fostering innovation, investment, and public awareness is crucial to harness the full potential of these technologies for equitable and sustainable water management.

**Aivazidou, E., et al (2021).** Smart technologies are transforming urban water management by providing sustainable solutions to address the growing challenges of water scarcity, pollution, and inefficient distribution systems. Through the integration of tools such as the Internet of Things (IoT), artificial intelligence (AI), and data analytics, cities can monitor, manage, and optimize water resources in real time. Smart water meters allow precise tracking of consumption patterns, enabling users to identify wastage and adopt conservation practices. Advanced leak detection systems reduce water losses in distribution networks, while predictive analytics optimize supply and demand, ensuring efficient allocation. Urban wastewater management benefits from AI-powered systems that monitor water quality and improve treatment processes, ensuring compliance with environmental standards. Smart irrigation systems in urban green spaces adjust water usage based on weather data and soil conditions, minimizing overuse. Cloud-based platforms facilitate data sharing among urban planners, utilities, and citizens, fostering collaboration and transparency. Implementing these technologies requires addressing challenges like high upfront costs, data security concerns, and the need for skilled personnel. Despite these hurdles, smart water technologies offer a path toward sustainable urban water management, promoting resilience and equity as cities adapt to increasing populations and climate change pressures.

**Sammaneh, H., et al (2019).** An IoT-enabled adaptive smart water distribution management system revolutionizes how water resources are monitored and distributed, ensuring efficiency and sustainability. By leveraging IoT devices such as smart sensors, flow meters, and actuators, these systems enable real-time data collection and monitoring across the entire water distribution network. The collected data is analyzed using advanced algorithms and AI-driven tools to optimize water allocation, detect leaks, and identify inefficiencies in the network. Adaptive management features allow the system to respond dynamically to changing demand patterns, seasonal variations, and emergencies such as pipe bursts or contamination events. This minimizes water wastage and ensures equitable distribution, even in resource-scarce regions. Predictive analytics helps forecast water demand and identify potential risks, enabling proactive planning and resource allocation. Remote monitoring and control through cloud-based platforms empower utility operators to manage the system efficiently while providing consumers with insights into their water usage, promoting conservation. Despite challenges such as high implementation costs, data security concerns, and the need for infrastructure upgrades, IoT-enabled smart systems offer a scalable and sustainable solution for water distribution. As urbanization and climate change intensify water management challenges, these adaptive systems provide a critical tool for achieving resilience and sustainability in water distribution networks.

**Lee, S. W., et al (2015).** A smart water grid represents the future of water management by combining advanced technologies like the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and cloud computing to create a highly efficient, sustainable, and interconnected water distribution system. Unlike traditional water systems, a smart water grid enables real-time monitoring, dynamic control, and predictive maintenance across the entire network. IoT-enabled sensors continuously track parameters such as flow rate, pressure, and water quality, providing actionable data to detect leaks, reduce wastage, and prevent contamination. AI algorithms analyze this data to optimize water allocation based on demand patterns, seasonal changes, and emergency scenarios, ensuring an equitable and reliable supply. The integration of predictive analytics enables early identification of infrastructure vulnerabilities, minimizing disruptions and maintenance costs. Cloud-based platforms allow seamless communication and data sharing between stakeholders, from utility providers to consumers, fostering collaboration and transparency. Smart water grids also

empower users by offering detailed insights into their water usage, promoting conservation and efficiency. Despite challenges like high implementation costs and cybersecurity concerns, the adoption of smart water grids is crucial for addressing the growing pressures of urbanization, climate change, and water scarcity. This innovative platform is key to achieving sustainable and resilient water management systems globally.

**Alshattnawi, S. K. (2017, October).** A smart water distribution management system architecture based on the Internet of Things (IoT) and cloud computing integrates advanced technologies to ensure efficient, sustainable, and adaptive water management. At its core, the architecture comprises IoT-enabled devices, data processing units, and cloud-based platforms working in synergy. IoT sensors and smart meters deployed across the water distribution network monitor critical parameters such as flow rate, pressure, consumption patterns, and water quality in real time. These devices transmit data to edge gateways for initial processing, where anomalies like leaks or irregular usage can be detected locally. The processed data is then sent to cloud-based platforms for advanced analysis using big data and artificial intelligence (AI) algorithms. Cloud computing enables centralized data storage, analytics, and visualization, providing actionable insights into system performance, demand forecasting, and infrastructure maintenance. The system's adaptive features use AI to dynamically adjust water distribution based on demand patterns, weather conditions, and emergency situations such as pipe bursts or contamination. Users, including utility providers and consumers, can access real-time data and system controls through web-based dashboards or mobile applications. This architecture promotes efficiency, reduces water losses, and enhances transparency, offering a scalable solution to address water scarcity and support sustainable urban development.

**Ramos, H. M., et al (2019).** Smart water management is a transformative approach aimed at building sustainable water networks for the future by leveraging cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cloud computing. This approach enables real-time monitoring, efficient distribution, and proactive decision-making, addressing critical challenges like water scarcity, wastage, and contamination. IoT sensors and smart meters provide continuous data on water flow, pressure, and quality, helping to detect leaks, prevent overuse, and ensure equitable allocation. AI-driven analytics optimize resource planning by predicting demand patterns, weather influences, and potential risks such as droughts or floods. Smart irrigation systems and wastewater recycling technologies support sustainable agriculture and urban green spaces by minimizing water consumption and promoting reuse. Cloud-based platforms allow seamless data integration and sharing among stakeholders, fostering collaboration in water governance. These systems also empower consumers with insights into their water usage, encouraging conservation practices. Despite challenges such as high implementation costs and cybersecurity concerns, smart water management offers a scalable and sustainable solution for resilient water networks. By integrating technology, innovation, and policy, future water systems can achieve greater efficiency, sustainability, and adaptability to meet the demands of growing populations and climate change.

**Rathi, S., & Gola, V. K. (2021, June).** Smart cities integrate innovative technologies to address urban challenges, and water distribution systems are a critical component in ensuring sustainability and resilience. These systems leverage advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics to optimize water resource management. Key components include smart sensors for real-time monitoring of water quality, flow, and pressure, as well as predictive algorithms for demand forecasting and leak detection. Cloud-based platforms enable centralized data integration, enhancing decision-making and transparency among stakeholders. Despite these advancements, water distribution systems face significant challenges. Aging infrastructure, high implementation costs, and cybersecurity vulnerabilities hinder widespread adoption. Integrating smart technologies with existing networks requires substantial upgrades and skilled personnel, which can strain resources, especially in developing regions. On the other hand, these challenges present opportunities for innovation. Emerging technologies such as blockchain can enhance data security, while machine learning models can improve efficiency by analyzing complex data patterns. Public-private partnerships and policy frameworks can accelerate investments and drive sustainable practices. Smart water distribution



systems are pivotal to achieving the broader goals of smart cities by ensuring efficient resource use, reducing losses, and fostering equitable access, ultimately creating more sustainable and resilient urban environments.

### Benefits of Smart Technologies

Smart technologies offer transformative benefits in water distribution, addressing key challenges such as resource inefficiency, rising demand, and sustainability. One of the most significant advantages is **improved operational efficiency**. Smart water systems utilize IoT sensors, smart meters, and automated control systems to monitor water flow, pressure, and quality in real-time. These systems enable utilities to detect leaks and reduce non-revenue water losses, which account for nearly 30% of global water supplies. Early leak detection and automated interventions minimize water waste and reduce maintenance costs. Additionally, real-time data provides utilities with insights to optimize water allocation, ensuring equitable and uninterrupted distribution to consumers.

Another key benefit of smart technologies is their ability to promote sustainability and resilience. By enabling precise monitoring and forecasting of water consumption, smart systems help reduce over-extraction of water resources and ensure long-term availability. Smart meters empower consumers to track their water usage, encouraging conservation and fostering sustainable behaviors. Advanced data analytics and AI-powered predictive models also enhance planning and decision-making, allowing utilities to address future challenges such as population growth and climate change. Furthermore, these technologies support water quality monitoring, ensuring safe drinking water for communities. As smart water systems reduce resource inefficiency and environmental impact, they align with global goals for sustainable development and climate resilience, making them indispensable in modern water management.

### Impact of Smart Technologies on Water Distribution Management

The impact of smart technologies on water distribution management has been profound, transforming traditional water systems into more efficient, sustainable, and responsive networks. One of the key advancements is the integration of Internet of Things (IoT) sensors, which allow for real-time monitoring of water quality, flow, pressure, and consumption. These sensors enable water utilities to detect leaks or irregularities early, minimizing water loss and reducing the need for costly repairs. By providing accurate, real-time data, IoT devices allow utilities to optimize their distribution networks, ensuring water is delivered efficiently and to the right areas without unnecessary waste. Smart meters also play a crucial role in monitoring individual consumption, offering a more accurate way to bill users, while promoting conservation by providing customers with detailed insights into their water usage.

Another significant impact of smart technologies is the use of big data and analytics. With the vast amount of data generated by IoT devices and smart meters, water utilities can utilize advanced data analytics to optimize system performance and predict future water demand. Predictive analytics can help identify trends, allowing for proactive maintenance and better planning for infrastructure needs. Furthermore, artificial intelligence (AI) is enhancing the ability to forecast demand patterns, detect anomalies in the system, and automate responses to certain conditions, such as adjusting water flow or activating backup systems in case of failures. These technologies collectively enhance decision-making processes, helping water utilities improve their service and reduce operational costs.

Smart technologies contribute to sustainability by promoting better resource management and conservation. Through real-time monitoring and automation, water utilities can significantly reduce water wastage and optimize energy usage in pumps and treatment processes. Smart systems also help in environmental monitoring, ensuring water distribution systems operate within regulatory standards and minimize negative impacts on ecosystems. The adoption of these technologies not only increases operational efficiency but also supports long-term water sustainability, especially in the face of growing urbanization and climate challenges.

### Methodology

The methodology for studying the impact of smart technologies on water distribution management, using secondary data, involves a comprehensive review and analysis of existing literature, case studies, and reports from relevant sources.

literature review is conducted to gather information from scholarly articles, industry reports, and governmental publications on the implementation of smart technologies like IoT, smart meters, AI, and predictive analytics in water distribution systems. This review focuses on understanding the different applications of these technologies, their benefits, challenges, and outcomes as reported in previous research. Additionally, case studies from cities or utilities that have adopted smart technologies are examined to assess the practical impact on water distribution, including improvements in efficiency, water loss reduction, energy usage, and customer satisfaction. Reports from municipal water authorities, utilities, and technology providers are also considered to provide data on system performance and technological adoption. These secondary sources offer insights into how smart technologies have been deployed, the barriers faced during implementation, and the results observed. The collected data is then analyzed to identify common trends and patterns across different regions and systems. This approach allows for a comprehensive understanding of the role and impact of smart technologies in water distribution management, using readily available secondary data to highlight both successes and challenges without the need for primary data collection or statistical analysis.

## Results

### Impact of Smart Technologies on Water Distribution Management

Aspect	Challenges Addressed	Smart Technologies Involved	Results/Benefits
Leak Detection and Prevention	High non-revenue water (30% globally)	IoT sensors, real-time monitoring	Early leak detection, reduced water loss by up to 20-30%
Operational Efficiency	Manual operations, aging infrastructure	Automated control systems, smart valves	Optimized water flow, lower maintenance costs
Water Demand Forecasting	Unpredictable demand surges	AI, machine learning algorithms	Accurate demand prediction, proactive resource allocation
Consumer Engagement	Lack of awareness about water usage	Smart meters, mobile applications	Reduced household consumption by up to 15%
Water Quality Management	Contamination in pipelines	IoT-enabled quality sensors	Real-time water quality monitoring, improved safety
Infrastructure Planning	Inefficient system design	Geographic Information Systems (GIS), data analytics	Better infrastructure mapping, efficient maintenance planning
Sustainability	Over-extraction and wastage	AI, predictive analytics	Conservation of water resources, reduced environmental impact

## Research problem

Water distribution management faces significant challenges in meeting the demands of growing populations, rapid urbanization, and climate change. Traditional water management systems, often outdated and reliant on manual operations, are struggling to address issues such as aging infrastructure, non-revenue water losses, and unpredictable

demand patterns. Globally, nearly 30% of treated water is lost due to leaks and inefficiencies, leading to significant financial and resource wastage. Additionally, water contamination and uneven distribution further exacerbate the problem, posing risks to public health and equity in access. As water scarcity becomes a pressing concern, particularly in urban areas, there is an urgent need for innovative solutions to optimize water resource management. Smart technologies have emerged as a promising approach to address these challenges, leveraging advanced tools like the Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics. These technologies enable utilities to detect leaks early, monitor water quality, forecast demand, and automate distribution processes, significantly improving efficiency and sustainability. However, despite their potential, the adoption of smart technologies in water distribution is still limited by high costs, integration challenges, and a lack of technical expertise. This research seeks to explore the role of smart technologies in overcoming existing water management challenges, evaluate their effectiveness in optimizing distribution systems, and identify strategies for their widespread implementation to ensure equitable, efficient, and sustainable water resource management.

## Conclusion

Smart technologies have demonstrated immense potential in revolutionizing water distribution management, addressing the critical challenges of inefficiency, resource scarcity, and sustainability. By integrating advanced tools such as the Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics, these technologies enable precise monitoring, proactive maintenance, and optimized resource allocation. Smart water systems have proven effective in reducing non-revenue water losses, enhancing operational efficiency, and promoting conservation among consumers through real-time insights. Additionally, innovations such as predictive analytics, automated control systems, and GIS mapping have empowered utilities to make data-driven decisions, improving system reliability and resilience. Despite these advantages, widespread adoption faces challenges such as high implementation costs, integration with legacy systems, and the need for specialized expertise. Overcoming these barriers requires investments in infrastructure modernization, capacity building, and supportive policy frameworks. Public-private partnerships and government incentives can further accelerate the adoption of smart technologies, making them more accessible to utilities of varying scales. As global water demands continue to rise, these technologies are indispensable in ensuring equitable and sustainable distribution while safeguarding water resources for future generations. This study underscores the critical role of smart technologies in transforming water management systems, highlighting their ability to mitigate pressing global challenges. With continued innovation and strategic implementation, smart technologies are poised to become a cornerstone of resilient and sustainable water management in the 21st century.



## References

1. Gupta, A. D., Pandey, P., Feijóo, A., Yaseen, Z. M., & Bokde, N. D. (2020). Smart water technology for efficient water resource management: A review. *Energies*, 13(23), 6268.
2. Palermo, S. A., Maiolo, M., Brusco, A. C., Turco, M., Pirouz, B., Greco, E., ... & Piro, P. (2022). Smart technologies for water resource management: An overview. *Sensors*, 22(16), 6225.
3. Aivazidou, E., Baniyas, G., Lampridi, M., Vasileiadis, G., Anagnostis, A., Papageorgiou, E., & Bochtis, D. (2021). Smart technologies for sustainable water management: An urban analysis. *Sustainability*, 13(24), 13940.
4. Sammaneh, H., & Al-Jabi, M. (2019, October). IoT-enabled adaptive smart water distribution management system. In *2019 International Conference on Promising Electronic Technologies (ICPET)* (pp. 40-44). IEEE.
5. Lee, S. W., Sarp, S., Jeon, D. J., & Kim, J. H. (2015). Smart water grid: the future water management platform. *Desalination and Water Treatment*, 55(2), 339-346.
6. Alshattnawi, S. K. (2017, October). Smart water distribution management system architecture based on internet of things and cloud computing. In *2017 International conference on new trends in computing sciences (ICTCS)* (pp. 289-294). IEEE.
7. Ramos, H. M., McNabola, A., López-Jiménez, P. A., & Pérez-Sánchez, M. (2019). Smart water management towards future water sustainable networks. *Water*, 12(1), 58.
8. Rath, S., & Gola, V. K. (2021, June). Innovative components of Smart Cities with a special focus of Water Distribution Systems Challenges and Opportunities: A Review. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1326, No. 1, p. 012146). IOP Publishing.
9. Public Utilities Board Singapore Pan\_Ju\_Khuan@ pub. gov. sg. (2016). Managing the water distribution network with a Smart Water Grid. *Smart Water*, 1(1), 4.
10. Jenny, H., Alonso, E. G., Wang, Y., & Minguez, R. (2020). Using artificial intelligence for smart water management systems.
11. Jenny, H., Alonso, E. G., Wang, Y., & Minguez, R. (2020). Using artificial intelligence for smart water management systems.
12. Owen, D. A. L. (2018). *Smart water technologies and techniques: Data capture and analysis for sustainable water management*. John Wiley & Sons.
13. Velayudhan, N. K., Pradeep, P., Rao, S. N., Devidas, A. R., & Ramesh, M. V. (2022). IoT-enabled water distribution systems—A comparative technological review. *IEEE Access*, 10, 101042-101070.
14. Giudicianni, C., Herrera, M., Nardo, A. D., Adeyeye, K., & Ramos, H. M. (2020). Overview of energy management and leakage control systems for smart water grids and digital water. *Modelling*, 1(2), 134-155.
15. Helmbrecht, J., Pastor, J., & Moya, C. (2017). Smart solution to improve water-energy nexus for water supply systems. *Procedia Engineering*, 186, 101-109.
16. Hamdy, A. (2015). Information and communication technologies in smart water management.
17. Byeon, S., Choi, G., Maeng, S., & Gourbesville, P. (2015). Sustainable water distribution strategy with smart water grid. *Sustainability*, 7(4), 4240-4259.
18. Sarkar, A. (2019). The role of new 'smart technology' to provide water to the urban poor: A case study of water ATMs in Delhi, India. *Energy, Ecology and Environment*, 4(4), 166-174.
19. Olatunde, T. M., Adelani, F. A., & Sikhakhane, Z. Q. (2021). A review of smart water management systems from Africa and the United States. *Engineering Science & Technology Journal*, 5(4), 1231-1242.
20. Soares Ascensão, É., Melo Marinangelo, F., Meschini Almeida, C. F., Kagan, N., & Dias, E. M. (2021). Applications of smart water management systems: a literature review. *Water*, 15(19), 3492.