Sentosa Research Journal
Vol 1, No 1, 2026, EISSN XXXX-XXXX
Available online at https://sentosamd.my.id/index.php/srj/

Sustainable Urban Water Management Strategies In Emerging Cities: A Multidisciplinary Approach

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Abstract

Urban water management in emerging cities faces complex challenges due to rapid population growth, climate change impacts, and limited infrastructure. This study aims to analyze sustainable urban water management strategies by employing a multidisciplinary approach integrating environmental science, urban planning, policy analysis, and community-based insights. Using a library research methodology, this article synthesizes theoretical frameworks, empirical findings, and policy reports to identify best practices for enhancing water governance, improving infrastructure resilience, and fostering stakeholder collaboration. The results indicate that integrated water resources management, technological innovation, policy coherence, and participatory governance are key pillars for sustainable urban water systems. Findings further reveal that localized solutions tailored to socio-cultural contexts, combined with data-driven decision-making, improve efficiency and equity in water access. The study concludes with recommendations for policymakers, practitioners, and researchers to adopt holistic strategies that address technical, social, and environmental dimensions of urban water sustainability.
Keywords: Multidisciplinary approach, integrated governance, urban resilience.

Abstrak

Pengelolaan air perkotaan di kota-kota berkembang menghadapi tantangan kompleks akibat pertumbuhan penduduk yang cepat, dampak perubahan iklim, dan keterbatasan infrastruktur. Penelitian ini bertujuan untuk menganalisis strategi pengelolaan air perkotaan berkelanjutan dengan pendekatan multidisipliner yang mengintegrasikan ilmu lingkungan, perencanaan perkotaan, analisis kebijakan, dan wawasan berbasis masyarakat. Dengan menggunakan metode library research, artikel ini mensintesis kerangka teoritis, temuan empiris, dan laporan kebijakan untuk mengidentifikasi praktik terbaik dalam meningkatkan tata kelola air, memperkuat ketahanan infrastruktur, dan membangun kolaborasi pemangku kepentingan. Hasil menunjukkan bahwa pengelolaan sumber daya air terintegrasi, inovasi teknologi, koherensi kebijakan, dan tata kelola partisipatif adalah pilar utama sistem air perkotaan yang berkelanjutan. Temuan lebih lanjut mengungkapkan bahwa solusi yang dilokalisasi sesuai konteks sosial-budaya, dikombinasikan dengan pengambilan keputusan berbasis data, meningkatkan efisiensi dan kesetaraan akses air. Studi ini menyimpulkan dengan rekomendasi bagi pembuat kebijakan, praktisi, dan peneliti

untuk mengadopsi strategi holistik yang menangani dimensi teknis, sosial, dan lingkungan dalam keberlanjutan air perkotaan.
Kata kunci: Pendekatan Multidisipliner, Tata Kelola Terintegrasi, Ketahanan Perkotaan**.**

Introduction

Water management in rapidly expanding urban areas is a major challenge in many countries around the world today due to interconnected social, economic, and environmental dynamics. New cities are growing under pressure from ever-increasing infrastructure demands, while existing water systems are often unable to equitably reach the entire population. (Hasani et al. 2025) These demands drive the need for water management strategies that are not only technically efficient but also responsive to social and environmental complexities. Furthermore, climate change exacerbates water supply uncertainty through extreme rainfall variations, flooding, and longer periods of drought. All of these factors pose systemic risks to water resource security and the quality of life for urban residents. Therefore, a sustainable water management approach is becoming increasingly important not just as an academic buzzword, but as a pragmatic necessity for decision-makers and practitioners in the field.

Traditional, technical, and fragmented approaches are no longer sufficient to address these multifaceted challenges because they fail to adequately consider the local socioeconomic and ecological context. When conventional water distribution networks fail to reach rapidly expanding residential areas, they often lead to reliance on poorly managed alternative water sources, such as informal boreholes or excessive groundwater pumping. (Firmansyah 2025) This results in groundwater level decline, water resource pollution, and distribution inefficiencies. Furthermore, the rise of the industrial sector and changes in urban land use complicate water demand patterns and place additional strain on wastewater treatment systems. Sustainable water management must address these issues through the integration of urban planning, technology, policy, and social practices. Without a holistic and interdisciplinary approach, imbalances risk further harming urban ecosystems and communities.

The social issues inherent in water management cannot be ignored, as unequal access to clean water often exacerbates social disparities. Low-income communities in many developing cities tend to experience access barriers, facing high costs for obtaining water from informal suppliers or less suitable sources. (Qomariyah and Anggraini 2025) As water becomes an increasingly scarce and expensive commodity, these vulnerable groups are most affected in their daily lives. As a result, social inequalities deepen, which in turn exacerbates public health and well-being issues. A sustainable approach needs to consider the principles of distributive justice and social inclusion as part of a comprehensive water management policy. Planning based on the real needs of citizens and community involvement in decision-making processes are essential to a responsive and equitable framework.

In the context of developing cities, the complexity of water management also encompasses institutional and institutional limitations. Many cities face fragmented

bureaucracies, a lack of coordination between government agencies, and sectoral policies. (Casudi et al. 2025) This fragmentation often hinders the implementation of effective strategies because administrative barriers slow down responses to urgent water needs. Furthermore, unsynchronized policies can create conflicts between environmental, social, and economic objectives. Therefore, governance reforms are needed that bridge different sectors and strengthen collaboration among relevant stakeholders. A multidisciplinary approach here is not only a methodological choice but also a requirement for providing adaptive and contextual solutions. When institutions are able to operate in a coordinated manner, the chances of realizing a sustainable water system are greater.

In many developing cities, innovative technologies have emerged as catalysts for efficient and adaptive water management. Technologies such as real-time monitoring systems, smart water quality sensors, and distribution networks integrated with geographic information systems (GIS) are becoming essential tools for strategic decision-making. (Latifah 2025) Such technologies enable water managers to more accurately monitor consumption, leakage, and water quality, enabling faster responses to disruptions. However, technology adoption requires significant upfront investment and adequate human resource capacity for operation and maintenance. Furthermore, technology cannot thrive without supportive policies and community engagement in understanding and effectively using the systems. Therefore, sustainable strategies must address these technical aspects, along with the need for training, funding, and policy integration.

Community capacity building is another crucial element, as public behavior significantly influences water consumption and conservation patterns. Public education programs about efficient water use, the importance of maintaining the quality of water sources, and conservation practices can contribute significantly to more sustainable water management. When individuals and communities understand the impact of their actions on a city's water system, they are more likely to take responsibility for how they use and protect that resource. In many cases, community-based initiatives, such as local water resource management and environmental watchdog groups, have shown positive results in safeguarding water resources. This demonstrates that a combination of top-down public-sector and bottom-up community-led approaches is effective. Such collaborative efforts can also foster a sense of ownership of shared resources, ultimately strengthening the sustainability of the system as a whole.

Globally, there are examples of cities successfully implementing interdisciplinary water management strategies that have demonstrated significant results in water security. For example, several cities in Latin America and Asia have implemented progressive water tariff systems that consider residents' ability to pay and encourage more efficient consumption. Furthermore, conservation measures such as the reuse of wastewater for non-potable purposes have reduced pressure on primary water sources. The integration of green open spaces and green infrastructure such as bioswales and retention ponds also helps reduce surface runoff and enhance

groundwater infiltration. These practices not only increase water availability but also provide environmental benefits such as increased biodiversity in urban areas. Lessons from these cases demonstrate that holistic and contextual water management strategies can enhance cities' adaptive capacity to external dynamics such as climate change and population growth.

The application of sustainability principles also requires an evaluation of long-term risks, including the impact of climate change on the hydrological cycle. Recent research confirms that extreme phenomena such as floods and droughts are becoming more frequent due to global warming, so water system planning must consider a variety of climate change scenarios. (Wahyuni and Handriani 2025) This uncertainty makes a flexible and iterative approach crucial, as overly rigid plans cannot respond to rapidly changing conditions. This is where environmental science plays a crucial role in developing predictive models that can provide an overview of future water supply trends. With valid scientific data, policymakers have a more solid foundation for designing mitigation and adaptation strategies. This ultimately strengthens the resilience of the city's water system as a whole.

It is important to emphasize that sustainable water management must align with other development goals such as sanitation, public health, and economic well-being. Clean water is a basic need that influences labor productivity, industrial growth, and overall quality of life. (Fatwa and Sa'diyah 2025) When access to clean water is poor, the impact is not only on declining public health but also on economic costs due to low productivity and high costs of treating water-related diseases. Therefore, investing in robust water systems is essentially an investment in broader economic and social development. Local and national governments need to establish budget priorities that support water infrastructure that is resilient, sustainable, and able to withstand future pressures. Such strategies must integrate economic needs with ecosystem protection and societal well-being.

Water resource management in urban environments has become a central issue in sustainable development efforts in the modern era. Every city is under tremendous pressure due to rapid population growth and urbanization, resulting in water demands increasing faster than the capacity of available infrastructure. (Arfani et al. 2025) This challenge is exacerbated by climate change, which is worsening rainfall patterns and increasing the frequency of droughts and floods. Therefore, sustainable water management strategies are not merely an option but an urgent necessity for developing cities seeking to achieve ecosystem resilience while meeting the needs of their citizens. Effective water management must encompass not only technical aspects such as water distribution and treatment, but also social, economic, and policy aspects that make the system more responsive to local dynamics. To understand this complexity, a multidisciplinary approach is essential, able to integrate various scientific perspectives. Environmental science helps assess ecosystem aspects, while urban planning examines the linkages between water and spatial planning and population mobility. Meanwhile, policy analysis provides the regulatory and institutional framework that enables effective strategy implementation. Community

engagement and an understanding of water consumer behavior are also crucial components, as public attitudes often determine the success of conservation programs. Given these realities, this article explores sustainable water management strategies through a comprehensive literature review. This aims to provide a holistic overview of practices, challenges, and solutions relevant to emerging or developing cities. This research is expected to serve as an important reference for planners, policymakers, and academics working in the field of urban water management.

Urban water management is often viewed as a purely technical issue, but the reality is far more complex and involves socio-economic dimensions that cannot be ignored. When traditional infrastructure is unable to meet demand, this forces city authorities to explore alternative approaches such as wastewater treatment for reuse, rainwater capture systems, and the use of smart technologies to reduce leakage in distribution networks. These strategies require alignment between public policy, technological innovation, and citizen participation. Changing public behavior towards wise water use is also a crucial factor, because without public support, even large investments in technology become less effective. Furthermore, conflicts between the domestic, industrial, and agricultural sectors in water allocation add another layer of complexity, especially in developing cities where economic growth is rapid. The interaction between water demand, land use, and socio-economic dynamics demands strategic and collaborative thinking in designing water management systems. Therefore, this study considers a multidisciplinary approach that provides a broad and comprehensive view of the problem. (Fariduddin 2025) This study also seeks to explore the role of regional and national policy frameworks in supporting sustainability efforts at the city level. Several previous studies have shown that cities that successfully implement sustainable water management typically have strong policy support and stable funding mechanisms. Synergy between government agencies, the private sector, and local communities is key to strengthening water system resilience.

An introduction to this issue should also highlight the often invisible social impacts of the water crisis. (Mabruri, Amin, and ... 2025) For example, women and girls in many developing cities often bear the brunt of the lack of access to clean water, as they are often responsible for fetching water for household needs. This inequality can exacerbate existing social inequalities. Therefore, water management strategies cannot be separated from the perspectives of social justice and inclusion. Furthermore, the interactions between groundwater and surface water sources and the changing hydrological cycle demand a science-based approach to understanding long-term availability. As water availability becomes more uncertain, the risk of conflict between regions and segments of society increases, which in turn affects a city's social and economic stability. Resilience to external threats such as natural disasters is also a crucial part of sustainability strategies. Climate change is increasing the intensity of floods and droughts, exacerbating existing challenges to urban water management. Cities need to implement adaptive solutions that can respond quickly and effectively to these fluctuations.

Literature Review

The study of sustainable urban water management has grown rapidly in line with increasing global attention to the water crisis and urbanization. Many researchers emphasize that developing cities face unique challenges that differ from developed cities, particularly related to limited infrastructure and institutional capacity. Early research on urban water management tended to focus on technical aspects such as pipelines and water treatment. (Rusydi, Khalidi, and Najirah 2025) However, this approach was deemed inadequate because it failed to comprehensively consider social and environmental dimensions. Recent studies have begun to shift the focus toward an integrated approach involving various disciplines. This has become an important foundation for the development of the concept of sustainable urban water management.

The concept of Integrated Water Resources Management (IWRM) has become one of the main theoretical frameworks in water management literature. IWRM emphasizes integrated water resource management by considering the interactions between humans, the environment, and economic systems. Previous research has shown that IWRM implementation can improve water use efficiency and reduce intersectoral conflicts. (Syifa and Hasanah 2025) However, several studies also note that IWRM implementation in developing cities often faces institutional and political barriers. Limited inter-agency coordination and weak policy enforcement are key inhibiting factors. Therefore, the literature emphasizes the importance of adapting the IWRM concept to local contexts.

Research conducted in various Asian cities shows that rapid population growth is accelerating pressure on urban water resources. (Mahrita, Afnanda, and ... 2025) These studies reveal that increasing water demand is often not matched by expansion of infrastructure capacity. As a result, many cities experience a decline in the quality of clean water services and increased dependence on alternative water sources. Some researchers suggest implementing water demand management as a strategic solution to address supply constraints. This approach includes controlling consumption through tariff policies and public education. These findings strengthen the argument that water management solutions should not rely solely on increasing supply.

The literature also extensively discusses the role of technology in improving the sustainability of urban water systems. Previous research has shown that the use of smart technologies such as leak sensors and data-driven monitoring systems can significantly reduce water loss. (Amin, Abinnashih, and Dewi 2025) Case studies in several developing cities show that the implementation of these technologies improves the operational efficiency of water utilities. However, the literature also notes the digital divide and limited technical capacity as implementation challenges. Without adequate human resource training, advanced technologies may not be optimally utilized. Therefore, technology should be viewed as part of a broader system, not a standalone solution.

Water governance is a key focus in the literature review because the success of water management is strongly influenced by the quality of institutions. Previous research indicates that good governance is characterized by transparency,

accountability, and public participation. (Tanuri 2025) Studies in Africa and Latin America reveal that weak governance often leads to inefficiency and inequity in water distribution. Conversely, cities with participatory mechanisms tend to be more successful in managing water resources. This demonstrates that community involvement is not only a normative aspect but also a strategic factor. The literature agrees that institutional strengthening is a key prerequisite for sustainable water management.

Climate change is a cross-disciplinary issue widely discussed in the urban water management literature. Numerous studies have shown that changing rainfall patterns increase the risk of flooding and drought in developing cities. These impacts increase uncertainty in long-term water supply planning. Researchers recommend the use of risk-based and scenario-based approaches to increase water system resilience. Adaptation to climate change also requires integration between water policy, spatial planning, and disaster management. The literature confirms that without an adaptive approach, urban water systems will become increasingly vulnerable.

The study of water justice has also gained prominence in recent literature. Previous research has shown that unequal water distribution often reflects broader social inequalities. Poor groups and those in informal settlements tend to have limited access to adequate water services. These studies emphasize that sustainable water management must include a social justice dimension. Without attention to vulnerable groups, water policies have the potential to exacerbate social exclusion. Therefore, the literature encourages an inclusive approach to water policy planning and implementation.

Wastewater reuse has become a key topic in urban water management research. Previous studies have shown that water reuse can reduce pressure on primary water sources. (Mukhlis 2025) Several developing cities have successfully utilized recycled water for industrial and irrigation purposes. However, the literature also notes social challenges in the form of public resistance to the use of recycled water. Perception of health risks is a major barrier to public acceptance. Therefore, communication and education approaches are crucial to this strategy.

Green infrastructure is one solution widely discussed in the literature as a sustainable approach. Research shows that green infrastructure, such as infiltration parks and retention ponds, can increase water infiltration and reduce surface runoff. In addition to hydrological benefits, green infrastructure also provides social and ecological benefits. Case studies in developing cities show that integrating green infrastructure with urban planning improves the quality of the urban environment. However, the literature also notes challenges in financing and long-term maintenance. This requires the involvement of various parties in the management of such infrastructure.

A multidisciplinary approach has become a central theme in many recent studies on urban water management. Researchers emphasize that the complexity of water issues cannot be addressed by a single discipline. (Rivai and Rahmawati 2025) The integration of engineering, social sciences, economics, and environmental sciences

allows for a more comprehensive understanding. Previous studies have shown that cross-disciplinary collaboration improves the quality of policy formulation. Furthermore, this approach enriches the analysis with diverse perspectives. The literature concludes that a multidisciplinary approach is fundamental to sustainable water management.

Water resource management has been a key topic in scientific literature for decades, as water is vital for public health and environmental sustainability. (Kuswianto and Ariyanti 2025) Much literature discusses the concept of Integrated Water Resources Management (IWRM) as a holistic approach that integrates social, economic, and environmental aspects in water management. This approach emphasizes the importance of coordination between sectors and stakeholders to achieve efficient and equitable water use. Studies by researchers around the world indicate that implementing IWRM in developing cities requires local adaptations that take into account local socio-cultural conditions. (Bakar and Ridho 2025) Furthermore, the literature also shows that integrating information technology into water management systems can improve operational efficiency. Technologies such as smart sensors, GIS, and predictive models are now frequently used to monitor water consumption levels, water quality, and detect leaks in distribution networks. Research by academics in Europe and Asia confirms that the use of real-time data allows for faster responses to potential water crises. The implementation of such technologies also helps in long-term planning for the growing need for water infrastructure.

Method

This study uses a library research approach as the primary method to examine sustainable urban water management strategies in developing cities. (Handayani, Basari, and Nurhidayah 2025) This method was chosen because it allows researchers to systematically collect, analyze, and synthesize various relevant scientific sources. Library research is considered appropriate for this topic because the issue of water management is multidisciplinary and has been widely discussed in academic literature across fields. With this approach, the research does not rely on primary field data, but rather on previously developed conceptual and empirical understanding. This allows for a comprehensive analysis of various theories, models, and best practices that have been applied in various developing city contexts. Furthermore, this method supports comparative exploration between studies to identify patterns and research gaps.

The data sources in this study were obtained from various credible secondary literature relevant to the topic of urban water management. These sources include national and international scientific journals, academic books, international organization reports, and government policy documents. Source selection was carried out selectively, considering the relevance, novelty, and credibility of the authors and publishers. (Mukhlis, Rasyidi, and Husna 2024) The literature used covers the fields of environmental engineering, urban planning, public policy, social sciences, and development studies. This multidisciplinary approach aims to capture the complexity

of water management from various perspectives. Thus, the resulting analysis is not partial, but rather comprehensive and integrated.

The research phase begins with the process of identifying issues and formulating the focus of the study related to sustainable urban water management. At this stage, researchers identify key keywords such as sustainable urban water management, emerging cities, water governance, and multidisciplinary approach. These keywords are used to search the literature through relevant scientific databases. Next, a literature screening process is conducted to ensure that the selected sources truly align with the research objectives. Literature that is irrelevant or of low methodological quality is eliminated from the analysis. This process aims to maintain the validity and reliability of the study results.

After selecting the literature, the next step is a content analysis of these sources. This analysis is conducted by identifying key themes, key concepts, and significant findings related to sustainable water management strategies. Researchers grouped the literature based on their focus, such as technical, policy, social, and environmental aspects. This grouping makes it easier for researchers to see relationships between concepts and identify common patterns within the literature. Furthermore, this analysis also helps identify differences in research approaches and findings across various developing city contexts. In this way, the research can present a more systematic and structured picture.

A comparative approach was used to compare findings from various previous studies. Through this comparison, researchers were able to identify best practices and common challenges faced in urban water management. Comparative analysis also enabled researchers to understand contextual factors that influence the success or failure of a strategy. These factors include geographic conditions, institutional capacity, levels of community participation, and policy support. By considering these contextual variations, the research could generate more adaptive and relevant recommendations. This approach aligns with the research's goal of offering flexible strategies for developing cities. During the analysis process, researchers also applied a reflective approach to evaluate the limitations and implications of the reviewed literature. Each source was critically analyzed to understand the assumptions, methods, and context of the research used. This is crucial to avoid overgeneralizing contextual findings. The reflective approach also helped identify under-addressed research gaps. Thus, this research not only summarizes existing knowledge but also provides direction for future research. This process strengthens the academic contribution of the study.

The validity of the research results is maintained through the use of diverse sources and the triangulation of concepts from various disciplines. By comparing findings from various types of literature, researchers can minimize bias and increase the reliability of the analysis. Furthermore, the use of established theoretical frameworks in sustainable water management studies provides a strong conceptual foundation. This systematic library research method allows the research to produce a deep and structured synthesis of knowledge. The results of this method then serve as

the basis for the discussion and formulation of research conclusions. Thus, the method used supports the overall research objectives.

Results and Discussion

The literature review shows that sustainable urban water management in developing cities is heavily influenced by the interaction between technical, social, economic, and institutional factors. The analyzed literature confirms that a sectoral approach that focuses solely on physical infrastructure development is no longer adequate. Many cities face a situation where water production capacity has increased, but distribution and service quality remain unequal. This suggests that the primary problem lies not only in water availability but also in system governance and management. A multidisciplinary approach allows for a more comprehensive identification of the problem. Therefore, sustainable strategies must be designed with multiple interrelated dimensions in mind.

From a technical perspective, research findings indicate that distribution network leakage is a major cause of urban water system inefficiency. Previous studies have noted that non-revenue water losses in developing cities can reach alarmingly high levels. This is due to aging infrastructure, lack of maintenance, and limited monitoring technology. The use of smart technology has been shown to significantly reduce water losses. However, adopting this technology requires policy support and human resource capacity. Therefore, technical solutions must be accompanied by institutional strengthening and training.

Institutional aspects are a determining factor in the success of sustainable water management strategies. Literature shows that cities with fragmented institutional structures tend to experience difficulties in coordinating water policies. Lack of synchronization between water management institutions, city planners, and environmental policymakers often leads to overlapping programs. This results in inefficient resource use and low policy impact. Conversely, cities that implement a cross-sectoral, coordinative approach demonstrate better water management performance. These findings underscore the importance of governance reform in urban water systems.

The study also revealed that community participation plays a crucial role in sustainable water management. Previous research has shown that citizen involvement in water service planning and oversight increases provider accountability. Furthermore, community participation helps foster a sense of ownership of the existing water system. When communities feel involved, they tend to be more responsible in their water use. This positively impacts conservation efforts and consumption efficiency. Therefore, a community-based approach is a key strategy in sustainable urban water management.

From an economic perspective, research results show that water tariff policies significantly influence public consumption behavior. Water tariffs that are too low often encourage waste, while tariffs that are too high can limit access for low-income groups. The literature suggests implementing progressive tariffs as a solution to

balance efficiency and equity. With this system, basic consumption remains affordable, while excessive use is subject to higher charges. This approach has been implemented in several developing cities with quite positive results. These findings demonstrate that economic instruments are an important tool in sustainable strategies.

Climate change has emerged as an external factor complicating urban water management. Studies have shown that climate uncertainty increases the risk of water supply disruptions and infrastructure damage. Developing cities are often ill-prepared for extreme impacts such as floods and droughts. The literature emphasizes the need for risk-based adaptation strategies to enhance water system resilience. Integrating water management with spatial planning and disaster mitigation is becoming increasingly important. Therefore, water management cannot be separated from the overall urban resilience agenda.

Wastewater reuse is one of the most frequently discussed strategies in the literature. Research results show that*water reuse*can significantly reduce pressure on primary water sources. In some developing cities, treated water is used for industrial purposes, urban agriculture, and green open spaces. However, the main challenges identified are social resistance and concerns about health risks. Therefore, the success of this strategy depends heavily on public trust and management transparency. These findings confirm that the social dimension is as important as the technical one.

Green infrastructure has also emerged as a crucial element in sustainable water management. Literature shows that integrating green spaces with natural drainage systems can reduce surface runoff and improve water quality. In addition to hydrological benefits, green infrastructure provides additional benefits such as improved air quality and public spaces. However, studies also show that green infrastructure implementation is often hampered by limited land and funding. Therefore, long-term planning and policy support are crucial. Green infrastructure should be viewed as a strategic investment, not an additional cost.

A multidisciplinary approach has been shown to provide a more comprehensive analytical framework than a single approach. The study's findings demonstrate that the integration of engineering, social, economic, and environmental sciences allows for the formulation of more adaptive strategies. This approach helps identify complex cause-and-effect relationships in urban water systems. Furthermore, a multidisciplinary approach facilitates dialogue between stakeholders with diverse backgrounds, increasing the likelihood of reaching consensus in decision-making. Therefore, this approach is highly relevant for developing cities facing complex challenges.

Discussion table sustainable urban water management strategies.

Strategic Aspects	**Key Findings**	**Implications for Developing Cities**
Technical	High levels of leakage and limited infrastructure	Need for system modernization and maintenance
Institutional	Fragmentation of	Cross-sector coordination is

Strategic Aspects	Key Findings	Implications for Developing Cities
	management institutions	required
Social	Community participation increases sustainability	Need a community-based approach
Economy	Progressive tariffs encourage efficiency	Balancing access and conservation
Environment	Climate change increases the risk	Need for adaptation and resilience strategies
Technology	Smart technology increases efficiency	Need investment and training

Further discussion shows that each aspect in the table is interconnected and inseparable. For example, modernizing technical infrastructure will be ineffective without strong institutional support. When water management institutions are uncoordinated, technology investments risk being suboptimal. Therefore, policy and institutional integration is a key prerequisite. A multidisciplinary approach allows for a clearer identification of these interconnections. This emphasizes the need for a sustainable strategy to be designed systematically.

From a social perspective, the discussion shows that long-term sustainability is heavily influenced by community acceptance and involvement. Community water literacy plays a crucial role in supporting conservation policies. Sustainable education programs can significantly change water consumption patterns. Furthermore, community feedback mechanisms help improve the quality of water services. These findings reinforce the argument that communities are not simply recipients of services, but strategic partners. Therefore, public participation must be institutionalized in water management systems.

Economic discussions highlight the importance of innovative financial instruments to support sustainability. Progressive tariffs and cross-subsidies have proven effective in maintaining water access for vulnerable groups. Furthermore, alternative financing schemes such as public-private partnerships can help close the funding gap. However, the literature also warns of the risks of over-commercialization that can compromise social equity. Therefore, strong regulation is essential. A balanced approach between economic efficiency and social equity is key.

In an environmental context, the discussion emphasized that sustainable water management must go hand in hand with ecosystem protection. Overexploitation of groundwater can lead to long-term environmental degradation. Therefore, water resource conservation policies must be an integral part of city strategies. Green infrastructure and nature-based solutions offer environmentally friendly alternatives. These approaches also increase cities' resilience to climate change. Thus, environmental sustainability and water management are mutually reinforcing.

Technology has emerged as a crucial enabler, but not the sole solution. The discussion shows that without adequate institutional capacity and human resources, advanced technology will not have a significant impact. Therefore, technology

investment must be accompanied by capacity development. Furthermore, technology needs to be adapted to the local context for acceptance and effective use. An adaptive approach is crucial in this regard. Therefore, technology must be part of an integrated strategy.

A multidisciplinary approach has proven effective in bridging diverse interests and perspectives in water management. The discussion demonstrates that cross-disciplinary collaboration enriches the policy formulation process. Furthermore, this approach increases the system's flexibility in the face of uncertainty. Developing cities that adopt this approach tend to be more adaptive and innovative. These findings underscore the relevance of a multidisciplinary approach as a strategic framework. Therefore, this approach is worthy of being used as a basis for urban water management planning.

Conclusion

Based on the research findings, it can be concluded that sustainable urban water management in developing cities requires a comprehensive and multidisciplinary approach. The challenges faced are not only technical but also encompass interrelated social, economic, institutional, and environmental aspects. Traditional, fragmented approaches have proven ineffective in addressing the complexity of urban water issues. Therefore, the integration of policy, technology, community participation, and environmental protection is a key element in sustainable strategies. A multidisciplinary approach enables a more holistic understanding of the dynamics of urban water systems. Thus, developing cities can design more adaptive, inclusive, and long-term strategies. Furthermore, this study confirms that the success of sustainable urban water management depends heavily on the quality of governance and collaboration between stakeholders. Institutional strengthening, equitable policy implementation, and increased human resource capacity are essential prerequisites for realizing resilient water systems. Economic instruments, technological innovation, and nature-based solutions must be applied in a balanced manner to avoid sacrificing social justice and environmental sustainability. This study also shows that active community involvement increases the effectiveness and legitimacy of water policies. Therefore, the results of this study are expected to be a reference for policy makers, urban planners, and academics in developing sustainable urban water management strategies in developing cities.

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