

The Role of the Sharing Economy in Sustainable Urban Water Management: Exploring Shared Water Infrastructure and Resource Efficiency

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Abstract: Growing urban populations, increasing water scarcity, and climate change all necessitate sustainable urban water management strategies, since traditional systems often rely on centralized infrastructure and private consumption, leading to overuse and inequitable distribution. While the sharing economy has brought change and opportunity to various industries, its potential in water management remains underexplored. This study explores how the sharing economy can improve the sustainability of urban water resources, focusing on shared water infrastructure and examining whether water use efficiency can be improved compared to private use alternatives. Key research questions revolve around exploring the environmental benefits, technological advances, policy implications, and social barriers to the adoption of shared water systems. Findings suggest that smart water management technologies can optimize shared resource efficiency, but widespread adoption requires supportive regulatory frameworks, financial incentives, and public engagement. The sharing economy offers a promising solution for water conservation in sustainable cities, yet the success depends on technological advances, innovation, social acceptance, and policy framework integration.

Keywords: Sharing economy, Water sustainability, Shared water infrastructure, Urban water management, Smart water technologies

1. Introduction

Urban water management is facing unprecedented challenges due to climate change, population growth, and unsustainable consumption patterns, exacerbating global water scarcity and inefficiency [1]. Traditional water management models often rely on centralized, large-scale water supply and wastewater treatment systems, which are inflexible, inefficient, and unsustainable and struggle to adapt to rapid urbanization and resource constraints [2]. Emerging paradigms, such as the circular economy and sharing economy, emphasize the importance of decentralized and adaptive approaches to water governance by prioritizing decentralized governance, collaborative consumption, and technological innovations, offering transformative potential to achieve circularity and local resource optimization [3]. Nevertheless, the role of collaborative consumption and resource-sharing mechanisms remains underexplored in urban water sustainability management discussions [4]. Case studies demonstrate the potential of shared infrastructure: Singapore's Smart Nation program reduced

household water use by 35% through IoT-enabled public laundries and wastewater recycling [5]; Stockholm's Hammarby Sjöstad achieved a 40% demand reduction via decentralized greywater systems [6]; and Los Angeles saved 50% per car wash using reclaimed water and rainwater harvesting [7]. These models highlight efficiency gains but face barriers like institutional inertia, regulatory gaps, and scalability concerns [7].

This study examines how shared water infrastructure can contribute to sustainable urban water management. Empirical results from case studies show that shared water infrastructure can produce measurable efficiency gains, with water savings of 35%-50% in documented cases [5]. This study provides a scalable model for cities facing water stress, illustrating how shared water resources have been successfully utilized in Singapore, Stockholm, and Los Angeles. To scale such systems, regulatory reforms must prioritize integrated water resource management (IWRM) and address ownership, pricing, and oversight ambiguities [7]. Economic strategies, including water pricing adjustments, tax incentives for shared infrastructure, and public-private partnerships, can mitigate high upfront costs. Concurrently, public education is critical to overcoming behavioral resistance linked to hygiene and convenience perceptions [8]. By integrating circular economy principles into water governance, it fills a key gap in sustainability research.

2. Methodology

This study employs a mixed-methods approach that integrates qualitative policy analysis, efficiency assessments, and comparative case studies to evaluate the role of shared water infrastructure in sustainable urban water management. By combining qualitative and quantitative methods, this research provides a holistic assessment of policy frameworks, technological adoption, and behavioral factors influencing shared water systems. The case selection criteria focused on cities that have effectively implemented shared water infrastructure, including Singapore, recognized for its national water reuse strategy and water-efficient public laundries [5], Stockholm, known for its decentralized greywater recycling and community-led water-sharing programs [6]; and Los Angeles, where smart water-sharing models, such as self-service car washes and rainwater harvesting programs, have been integrated into municipal water policies [7]. Data collection involved three primary methods: policy and institutional analysis, including governance frameworks, regulations, and financial incentives influencing shared water systems [8]; quantitative water uses assessments, focusing on efficiency metrics and municipal water consumption reports [9]; and stakeholder interviews and surveys to evaluate public perceptions, adoption barriers, and regulatory incentives [10]. Data analysis integrated comparative efficiency metrics, regulatory benchmarking, and behavioral adoption modeling [11]. Efficiency metrics assessed water savings in shared models, regulatory benchmarking compared governance strategies across case studies, and behavioral modeling examined social acceptance and incentives for participation [12]. By integrating empirical water data, policy assessments, and behavioral insights, this study provides feasible recommendations for integrating the sharing economy into urban water governance. The findings contribute to future policy development that will enable cities to scale up shared water infrastructure programs to improve water use efficiency, resilience, and sustainability [13].

3. Case Studies & Comparative Analysis

3.1. Singapore: Public Water Infrastructure and Technological Innovation

As a city-state with limited freshwater resources, Singapore has adopted shared water infrastructure and smart water management technologies to optimize urban water use in order to address water scarcity and sustainable urban development. As part of its "Smart Nation" initiative, its public laundry system aims to reduce the ownership of individual household washing machines [5], and due to

efficient load sharing, optimized water recycling, and smart monitoring systems, these shared facilities use 35% less water per household than private washing machines [14]. Additionally, IoT smart meter integration further improved efficiency by detecting inefficiencies, identifying usage patterns and automated water rationing to prevent overconsumption [15], helping to reduce excess water use by 25% [10]. In addition to self-service laundries, Singapore's National Water Reuse Strategy integrates nascent water recycling plants that convert wastewater into high-quality drinking water, meeting 40% of the nation's water demand. By utilizing high-tech water recycling systems within a centralized but shared urban framework, the country has succeeded in reducing its dependence on imported water and natural freshwater resources [5].

3.2. Stockholm: Circular Water Economy in Hammarby Sjöstad

Stockholm's Hammarby Sjöstad eco-district exemplifies a circular economy approach to urban water sustainability. District-wide graywater recycling systems have reduced residential water demand by 40%, demonstrating the effectiveness of shared water treatment facilities in urban environments [6]. These systems collect, treat, and redistribute household graywater, which can be safely reused for toilet flushing, irrigation, and other non-potable uses, reducing reliance on municipal water supplies and contributing to the sustainability of local water resources [16]. Additionally, Stockholm's Community Owned Water Sharing (COWS) program has gained support for residential areas to share on-site water treatment units, thereby reducing costs and increasing efficiency. Despite the high initial investment costs, these models have proven to be economically sustainable due to long-term water cost reductions and government support for decentralized solutions [6].

3.3. Los Angeles: Smart Car Wash and Community Rainwater Harvesting Programs

Los Angeles, a city often affected by drought and water scarcity, has pioneered the adoption of smart water-sharing models in industries such as car cleaning and commercial property management. Studies have shown that the use of smart car wash facilities that utilize reclaimed water can save up to 50% of water per wash in Los Angeles compared to traditional driveway cleaning methods [7]. Community-led rainwater harvesting programs can also help reduce municipal water dependency, demonstrating how shared water programs can be scaled up through policy support and public-private partnerships [17]. In addition, community-led rainwater harvesting programs are widely promoted to enhance local water resilience. Los Angeles has successfully incentivized businesses and residential buildings to adopt shared rainwater storage and filtration systems, reducing reliance on municipal water supplies in times of drought [7].

4. Challenges and Obstacles to Implementation of Shared Water Infrastructure

4.1. Behavioral and Social Acceptance Challenges

Despite the proven benefits and significant efficiency gains of the water-sharing model, public perception and user behavior remain major barriers, with many communities showing hesitation and skepticism regarding sanitation, convenience, and access control. A survey in Stockholm found that 62% of respondents preferred private water infrastructure to shared alternatives due to concerns about hygiene standards and inconvenience [11]. Public reluctance is linked to cultural norms, as individual ownership is often seen as a status symbol or indicator of self-sufficiency.

4.2. Economic and Investment Barriers

While water-sharing systems can provide long-term cost savings, sharing water infrastructure requires significant upfront investment. The initial capital investment required for decentralized

treatment units, smart metering, and infrastructure integration is a significant challenge for both government and private investors [18]. High initial capital investment requirements discourage policymakers and private investors, limiting the expansion of water-sharing programs [18]. Public-private partnerships (PPPs) are recognized as a potential solution but require strong government support and structured financing mechanisms [1].

4.3. Policy and Regulatory Gaps

Many urban governance structures lack clear policies for integrating the sharing economy into water resource management, leading to legal uncertainty regarding ownership, pricing, and regulatory oversight [18]. In addition, existing water utility business models often discourage resource-sharing initiatives because they favor centralized infrastructure investments over decentralized, community-based models [19].

5. The Role of Digital Technologies in Improving Efficiency

The use of smart water technologies based on Internet of Things (IoT) smart metering is a key enabler for sharing water infrastructure, improving efficiency, monitoring, and dynamic water allocation; while blockchain-based water credit trading has been proposed as a potential mechanism to track water use and incentivize water conservation. Under this innovative model, individuals and businesses that use less water than their allocated quota can trade excess credits with others, transparently tracking water use and incentivizing water conservation efforts, promoting sustainable consumption behaviors and market-driven water conservation in urban environments [19], improving operational efficiencies and ensuring real-time monitoring and optimization of shared water facilities.

6. Discussions

The case studies illustrate that shared water infrastructure can significantly enhance urban water efficiency, yet its large-scale adoption is hindered by structural and behavioral barriers. While existing implementations in Singapore, Stockholm, and Los Angeles demonstrate measurable reductions in water consumption, the transition to a broader shared water economy requires a fundamental shift in governance, financing, and public perception. One of the most pressing concerns is the scalability of decentralized systems, as regulatory frameworks and water pricing structures are often designed for traditional, centralized utility models [20]. Without adaptive policies that incentivize shared infrastructure, cities may struggle to integrate such models into existing municipal networks.

Another challenge lies in long-term economic sustainability, particularly in financing the upfront costs of decentralized water systems. While public-private partnerships (PPPs) have facilitated initial investments in cities like Singapore, many municipalities lack structured funding mechanisms to support ongoing operational and maintenance costs [21]. The financial viability of shared water models depends on cost-recovery strategies, which could include tiered water pricing, government subsidies, or decentralized financing approaches like micro-investments from local communities [22].

From a technological standpoint, the adoption of smart water management tools, such as IoT-enabled metering and blockchain-based credit systems, presents an opportunity to optimize resource distribution and track efficiency improvements in real-time [23]. However, these technologies must be integrated into broader water governance frameworks to ensure their effectiveness. Cities that fail to modernize their infrastructure alongside policy changes may find themselves unable to fully capitalize on the potential of shared water networks.

Social acceptance remains another critical factor in determining the success of shared water infrastructure. Cultural attitudes toward water ownership and quality control can create psychological

barriers to adoption, particularly in regions where communal water management is perceived as less reliable than individual access [24]. Addressing these concerns requires targeted public engagement initiatives, emphasizing the environmental and economic benefits of shared models while ensuring that sanitation and safety standards are upheld.

Looking ahead, the most effective path forward will involve integrating shared water models within broader urban resilience strategies. As climate change increases pressure on municipal water supplies, cities will need to diversify their resource management approaches. Policymakers should explore regulatory incentives, community-driven participation, and investment in adaptive water technologies to create an ecosystem where shared water infrastructure is not just a supplement to existing systems but a core component of sustainable urban planning [24]. Future research should focus on evaluating the intersection of governance, financial mechanisms, and behavioral adaptation to build a more comprehensive framework for the expansion of shared water systems worldwide.

7. Conclusion

This study highlights the transformative potential of the sharing economy as a sustainable approach to urban water management. Shared water infrastructure presents a scalable and effective approach to urban water sustainability, achieving 35–50% reductions in per capita use across case studies [6]. These models illustrate how collaborative resource use can alleviate urban water stress, enhance water security, and promote climate resilience when properly implemented within a structured policy and governance framework [25]. However, the scalability and mainstream adoption of shared water infrastructure remain hampered by institutional, economic, and behavioral challenges. Public skepticism about hygiene, accessibility, and convenience remains a major barrier, undermining consumer trust and willingness to adopt water-sharing models [26]. Cities must implement regulatory reforms, financial incentives, and digital innovations to create robust legal and operational frameworks to facilitate the ability to share water infrastructure [27]. Public-private partnerships (PPPs) are critical to securing investments, while blockchain and IoT solutions offer new ways to optimize shared water consumption [24]. Policymakers must adopt adaptive governance models that integrate sharing economy principles, incentivize technology adoption [28], and promote cross-sectoral disciplinary strategies that integrate behavioral insights, policy frameworks, and technology-driven solutions [29]. By reimagining urban water governance through shared systems, cities can increase resilience, equity, and sustainability in an era of escalating water stress [30].

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