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Investigating Study on "Used Water Management under SBM - U 2.0"- A Review

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Abstract: Used water management has emerged as a pivotal component in achieving sustainable and resilient urban infrastructure, particularly in the context of India's rapidly growing cities. With the launch of the Swachh Bharat Mission–Urban (SBM-U) 2.0, the Government of India has intensified efforts to promote effective wastewater management, emphasizing treatment, reuse, and resource recovery as central objectives. This review paper provides a comprehensive analysis of the current practices, technological advancements, and policy frameworks associated with used water management under SBM-U 2.0. The study explores various treatment methodologies including decentralized wastewater treatment systems, faecal sludge treatment plants, and the promotion of non-sewered sanitation solutions, assessing their implementation efficiency across diverse urban settlements. Key challenges such as infrastructure deficits, financial constraints, lack of public awareness, and institutional bottlenecks are critically examined to understand their impact on program success. The paper also evaluates government interventions, private sector participation, and community engagement in strengthening urban sanitation value chains. Furthermore, several case studies from different Indian states are reviewed to highlight best practices, scalable models, and lessons learned in used water recycling and reuse for non-potable applications like landscaping, agriculture, and industrial processes. The findings indicate that while SBM-U 2.0 has laid a strategic foundation for urban wastewater management, the translation of policy into action requires integrated planning, enhanced governance, and capacity-building at all levels. This review concludes by identifying potential areas for innovation and future research, emphasizing the need for a holistic, data-driven, and inclusive approach to achieve the mission's long-term goals.
Keywords: Used Water Management, SBM-U 2.0, Wastewater Treatment, Urban Sanitation, Sewage.

I. INTRODUCTION

Water scarcity and pollution have become major challenges in urban areas across India, driven by rapid urbanization, industrialization, and increasing population growth. The need for efficient management of used water is crucial to maintaining environmental sustainability and ensuring public health. Improper disposal of wastewater contributes to groundwater contamination, river pollution, and a decline in the quality of urban living standards. Recognizing the urgency of the situation, the Government of India launched the Swachh Bharat Mission-Urban (SBM-U) 2.0 in 2021, aiming to address wastewater treatment and promote the reuse of treated water. SBM-U 2.0 emphasizes scientific wastewater disposal, decentralized treatment approaches, and infrastructure improvements to tackle urban sanitation challenges effectively. This review paper explores the objectives and methodologies adopted under SBM-U 2.0, assesses their impact on urban wastewater management, and identifies areas that require further research and policy intervention to enhance the effectiveness of urban sanitation measures.

II. LITERATURE REVIEW

A thorough literature review is conducted to understand existing research on wastewater treatment and management under various government initiatives. Studies on decentralized wastewater treatment plants (DWTPs), public-private partnerships (PPP) in wastewater management, and innovative technologies such as constructed wetlands, phytoremediation, and membrane bioreactors are explored.

1) *Status of Wastewater Generation and Treatment in India*

India generates approximately 62,000 MLD (million liters per day) of sewage, of which only 37% is treated. The treatment infrastructure often operates below capacity due to maintenance and operational issues. Urbanization and industrial growth contribute significantly to untreated wastewater.

A study presented at the International Work Session on Water Statistics (IWG-Env) in Vienna, June 20-22, 2005, by R.M. Bhardwaj from the Central Pollution Control Board of India, highlighted the critical status of wastewater generation and treatment in India.

The study found that urban centers in India lack adequate sanitation infrastructure, leading to the deterioration of water quality in aquatic resources. The increasing population and resultant wastewater generation threaten to render water bodies unsuitable for their intended uses unless comprehensive wastewater treatment measures are adopted. According to the study, Class I cities (population >100,000) and Class II towns (population between 50,000 and 100,000) generate approximately 26,254 million liters per day (MLD) of wastewater, while the developed treatment capacity is only about 7,044 MLD—covering just 27% of the wastewater produced. These findings underscore the urgent need for improved wastewater treatment strategies and policies that balance water supply augmentation with the development of treatment facilities. Future urban water supply sustainability will largely depend on efficient wastewater treatment systems, as downstream cities increasingly rely on treated wastewater from upstream urban centers.

2) Policy Framework for Wastewater Management

India's wastewater management policies, such as the National Water Policy (2012) and Jal Shakti Abhiyan, emphasize decentralized treatment, reuse, and public participation. However, enforcement remains weak, and integration between state and local bodies is limited.

3) Decentralized Wastewater Treatment Systems (DEWATS)

Decentralized systems are gaining traction in peri-urban and rural areas for their low cost and adaptability. Case studies from Kerala and Maharashtra demonstrate the feasibility of DEWATS in reducing untreated discharge into local water bodies.

4) Role of Phytorid Technology in Wastewater Treatment

Phytorid systems utilize constructed wetlands with specific vegetation for natural treatment. Studies show removal efficiencies of over 85% for BOD and COD in domestic wastewater, with significant cost-effectiveness for small communities.

Domestic Wastewater Treatment using Phytorid Technology by R. Kaalipushpa, S. Karthika, S. Revathi (2018) In the developing technologies and growing environment, the usage of the water source plays a vital role and it’s been needed and used in large amount. Insufficient management of municipal and wastewater in immense environmental problems and increasing hygienic risks for the growing urban population thereby hampering poverty alleviation and a sustainable development of Indian society. But now days, the waste water is converted into a source for various purposes in different aspects by the use of phytorid technology. phytorid technology is a patented technology and being very effective in water pollution treatment it leads one step forward to sustainable treatment of wastewater in safe manner using Iris Pseudacorus (Yellow Iris) plants and natural source for the treatment without affecting the ecosystem. The Chrysopogonzizanioides is to increase the pH value and to reduce the nitrogen, phosphorous content. The coagulation and flocculation process is done by alum to have a turbidity and to remove the suspended solids. This method is more advantageous of cost effective, negligible operation and maintenance with minimum electricity, smaller footprint. The main focus of the project is to avoid the scarcity of the irrigation water and to avoid the odor in the treated water and to enhance the quality of the water to prevent ground water pollution by analyzing the nominal water parameters that need to be satisfied for reusing the treated water with the references of IS 3025 code books.

Phytorid System for Urban Wastewater Treatment by Suryapratap Galande, Gopi Kuwar, Satish Jadhal, Pankaj Akhade, Prof. Hameed Rafai, Prof.Keerthi BGurani (2022) The treatment of urban wastewater has become a significant challenge, especially in rural and urban areas where the demand for effective sewage treatment exceeds the capacity of existing infrastructure. As urban populations grow, so does the volume of wastewater generated, leading to untreated sewage being released into rivers, lakes, and other water bodies, causing severe environmental degradation. With increasing awareness of the harmful effects of untreated sewage, there is a growing need for alternative treatment solutions. Traditional methods like activated sludge systems, trickling filters, and lagoons, though effective, have limitations such as high operational costs and space requirements. This has led to the exploration of more sustainable, cost-effective methods, such as constructed wetlands and phytoremediation techniques. Phytoremediation, particularly the use of plant-based systems, has gained popularity as a natural method of treating wastewater. The Phytorid system is a form of constructed wetland that uses plants to filter and degrade pollutants in wastewater. By harnessing the power of plant roots and microorganisms, this system has proven to be highly effective in reducing organic matter, nutrients, and pathogens from urban wastewater. Studies, including the work by Galande et al. (2022), highlight the Phytorid system's potential to serve as an alternative or complementary treatment method in urban areas where centralized treatment plants are not feasible. The system is low-maintenance, energy-efficient, and can be scaled for various sizes of urban wastewater management. However, challenges such as plant growth variability, clogging in treatment beds, and the need for continuous maintenance remain.

Future research aims to optimize the system's efficiency, improve plant species selection, and explore ways to integrate Phytorid systems into large-scale urban infrastructure. Overall, the Phytorid system offers a sustainable, eco-friendly solution to urban wastewater treatment that could transform how cities manage their sewage.

Phytorid Technology by Tanmay Saka, Damini Ghule, Imran Patel, Safwan Sayyed, Assistant Prof. P.A. Manatkar (2021) The management and treatment of wastewater, particularly in rapidly growing urban and rural areas, is a critical concern in many countries, including India. Traditionally, wastewater was collected through primitive systems that relied on gravity to transport sewage to a disposal point. This method often involved open channels or direct disposal into water bodies, which contributed to environmental contamination. Over time, more sophisticated systems were developed, incorporating modern water carriage sewerage techniques, where sewage is mixed with water and transported through closed conduits under gravity flow. These modern systems ensure that sewage is safely carried and disposed of, often after undergoing treatment processes to remove harmful pollutants. In India, the situation is complex, with major metropolitan cities and larger towns typically equipped with modern sewage treatment facilities. However, smaller towns and villages continue to use outdated systems that struggle with efficient waste management. As urbanization intensifies, there is a pressing need for affordable, efficient, and sustainable wastewater treatment solutions, especially in areas that cannot accommodate expensive, large-scale infrastructure. One such promising solution is Phytorid Technology, a natural treatment process that utilizes plants to treat wastewater. Phytorid technology is a type of constructed wetland system where the root zone of plants and the surrounding soil matrix act as natural filters, removing contaminants from wastewater. This system is designed to handle various types of wastewaters, including domestic sewage, by using plants to filter out organic matter, nutrients, and pathogens. In addition to its low operational cost, Phytorid technology is environmentally friendly and can be integrated into areas with limited space, making it ideal for small to medium-sized towns and rural areas. Phytorid systems are a sustainable solution for wastewater management as they use minimal energy and chemicals. The plants in these systems, often selected for their ability to tolerate wet conditions and absorb contaminants, contribute to improving water quality by facilitating microbial processes that break down pollutants. These systems can be integrated into various urban and rural landscapes, providing an aesthetically pleasing green space while treating wastewater. Furthermore, treated effluents from these systems can be safely disposed of in water bodies or used for irrigation, helping to conserve water resources. However, the adoption of Phytorid technology faces challenges, including the need for regular maintenance and the sensitivity of plant growth to seasonal changes. Additionally, the technology's scalability for large urban centers has not been fully explored. Despite these challenges, the technology offers a promising alternative for wastewater treatment in communities where centralized treatment systems are not viable. In conclusion, Phytorid technology represents a sustainable, cost-effective solution to urban and rural wastewater treatment, offering significant environmental benefits. With further research and refinement, it has the potential to be widely implemented in regions with limited resources, providing an efficient and eco-friendly alternative to conventional treatment methods.

Implementation of Sewage Treatment Plant by using Phytorid Technology by Anuradha Manikrao Patil, Sagar Gawande (2016) With rapid population growth, urbanization, and industrial development, the pressure on water resources is mounting not just in terms of quantity but also in terms of quality. In many urban areas, domestic sewage, industrial effluents, and runoff from agricultural and mining activities are major contributors to water pollution. This pollution is a significant environmental and health concern, particularly in cities where water contamination is widespread. The competition for limited water resources, coupled with inadequate sanitation systems and insufficient wastewater treatment infrastructure, aggravates the problem. In India, approximately 95% of sewage treatment plants (STPs) in major cities are reported to be inefficient or not fully functional. Common issues include interrupted operations due to frequent power failures, hydraulic or organic overloading, inadequate oxygenation caused by mechanical breakdowns of aerators, uneven sewage distribution, difficulties in sludge handling, and financial constraints. These challenges make it increasingly difficult for traditional treatment plants to effectively manage urban wastewater and meet environmental standards. Phytorid technology offers a promising solution to address these issues. This system utilizes constructed wetlands with specific plant species to treat sewage through natural filtration processes. Plants play a crucial role in absorbing and filtering out pollutants, including organic matter, nutrients, and pathogens, while promoting microbial activity in the root zone. As a cost-effective, low-energy alternative to traditional STPs, Phytorid systems can be implemented in areas with limited infrastructure or resources. Furthermore, these systems can be integrated into urban landscapes, offering an aesthetically pleasing solution while improving water quality. The implementation of Phytorid technology in sewage treatment can significantly reduce the operational challenges faced by conventional treatment plants. Given that Phytorid systems require minimal power and maintenance, they are especially suitable for areas with frequent power shortages or financial limitations.

Additionally, the use of plant-based systems aligns with sustainable wastewater management practices, which is becoming increasingly important in developing countries like India. However, challenges remain, such as the need for suitable plant species, proper system maintenance, and the potential for clogging or seasonal variations in plant growth. Further research is required to optimize plant selection, system design, and treatment efficiency to ensure the widespread adoption and effectiveness of Phytorid technology in urban sewage treatment.

Performance Assessment of Domestic Wastewater Treatment Plants Operating on Different Technologies by Sudhir Kumar, Mahendra Pratap Choudhary (2020) The city of Delhi, with its rapidly growing population, faces significant challenges in managing wastewater, which contributes to the severe pollution of the Yamuna River. As one of the most polluted rivers in India, the Yamuna suffers from untreated wastewater being directly discharged into it, exacerbating environmental and public health risks. The sewerage system in Delhi has been affected by improper drainage management and insufficient sewer installations, particularly in undeveloped and slum areas. This results in poor water quality in surface water bodies, especially the Yamuna, which poses serious hygiene and health concerns for its increasing population. To address these concerns, the Delhi Jal Board has implemented sewage treatment plants (STPs) using various treatment technologies to efficiently treat wastewater before discharging it into rivers or using it for non-domestic purposes such as irrigation and cleaning. This study focuses on assessing the performance of three STPs located in Delhi: Najafgarh, Delhi Gate, and Shahdara, each employing different treatment technologies – Extended Aeration (EA), Biological Filtration and Oxygenated Reactor (BIOFOR), and Phytorid, respectively. The study found that the STPs using BIOFOR and Phytorid technologies were more efficient in treating municipal wastewater compared to the EA technology employed at the Najafgarh STP. Specifically, the effluent quality from the BIOFOR and Phytorid-based systems met the required standards for discharge into surface water bodies and could be safely utilized for irrigation, agricultural activities, and cleaning purposes. In contrast, the Najafgarh STP, which uses EA technology, showed less efficient removal of pollutants. This inefficiency highlights the need for more robust operation and maintenance protocols to ensure the treatment plant meets the prescribed effluent quality standards. Phytorid technology, developed by the National Environmental Engineering Research Institute (NEERI), stood out for its cost-effectiveness, low land area requirement, and easy maintenance. The technology proved highly effective in removing organic solids and nutrients, achieving removal efficiencies of up to 95%. This makes Phytorid technology a viable option for wastewater treatment in areas with limited space and financial resources. It also holds promise for use in agricultural applications, making it a sustainable solution for wastewater management in densely populated urban areas. In conclusion, the study underscores the effectiveness of Phytorid and BIOFOR technologies in improving wastewater treatment and surface water quality. The results suggest that these technologies should be prioritized for future STP implementations in urban areas, particularly in cities like Delhi, where wastewater management is crucial for both public health and environmental sustainability.

Constructed Wetlands - Natural Treatment of Wastewater by Mrs. Snehal Bhaskar Thamke, Dr. Arif Khan (2021) Constructed wetlands are engineered and managed wetland systems that are increasingly receiving worldwide attention for wastewater treatment and reclamation. Compared to conventional treatment plants, constructed wetlands are cost-effective and easily operated and maintained, and they have a strong potential for application in a small community. Constructed wetlands for wastewater treatment have substantially developed in the last decades. As an eco-friendly treatment process, constructed wetlands may enable the effective, economical, and ecological treatment of agricultural, industrial, and municipal wastewater. Constructed wetlands are very effective in removing organics and suspended solids, whereas the removal of nitrogen is relatively low, but could be improved by using a combination of various types of constructed wetlands meeting the irrigation reuse standards. The removal of phosphorus is usually low, unless special media with high sorption capacity are used. Pathogen removal from wetland effluent to meet irrigation reuse standards is a challenge unless supplementary lagoons or hybrid wetland systems are used. In this paper studies various case study related to Wetlands in Indian Cities and also described include systems involving both constructed and natural wetlands, habitat creation and restoration. Constructed wetlands (CWs) are increasingly being recognized as a sustainable and cost-effective method for treating wastewater. These engineered systems, designed to mimic the filtration and treatment capabilities of natural wetlands, are gaining global attention due to their ability to treat agricultural, industrial, and municipal wastewater efficiently. Unlike conventional treatment plants, CWs require less investment, are easier to operate and maintain, and have the potential for widespread application in small communities or areas with limited infrastructure.

Effectiveness of Constructed Wetlands in Wastewater Treatment: CWs have proven highly effective in removing organic pollutants and suspended solids from wastewater. The system works by utilizing the natural filtration and absorption processes of plants and soil, which helps break down contaminants. However, the removal of nitrogen and phosphorus can be a challenge in CW systems. Nitrogen removal efficiency is relatively low, but improvements can be made by combining different types of CWs to enhance treatment, potentially achieving irrigation reuse standards.

Phosphorus removal is similarly low unless special media with high sorption capacity are used in the system. Moreover, pathogen removal remains a challenge, and meeting irrigation reuse standards often requires additional steps such as supplementary lagoons or hybrid systems.

Types of Constructed Wetlands: The most common type of constructed wetland is the Horizontal Subsurface Flow (HF CW) system, where wastewater flows horizontally beneath the surface of a planted medium. This system offers good treatment for organic pollutants and suspended solids. In recent years, Vertical Flow (VF CW) systems have become more popular due to their ability to enhance aeration and improve the removal of certain contaminants.

Emergent plant species, such as common reed, cattail, and bulrush, are typically used in CW systems because they are robust and well-suited for growing in wetland environments. These plants play a vital role in oxygenating the water and supporting the microbial processes that degrade contaminants.

Advantages of Constructed Wetlands:

- Cost-Effective: Constructed wetlands are less expensive to build and operate compared to conventional treatment plants, making them an attractive option for small-scale or rural applications.
- Sustainability: CWs utilize natural processes, reducing the reliance on mechanical systems and energy-intensive processes. They have low environmental impacts and are energy-efficient.
- Simple Construction and Maintenance: These systems can be constructed with local materials, which reduces costs. Their operation and maintenance are straightforward, and the systems are relatively stable.
- Eco-Friendly: As an eco-friendly treatment option, CWs contribute to habitat creation and restoration, making them a valuable tool in environmental conservation.

Limitations of Constructed Wetlands:

- Space Requirements: One of the main challenges of CWs is the large area required for their implementation. In densely populated urban areas, this may be a limiting factor.
- Limited Efficiency for Some Contaminants: While CWs excel in removing organics and suspended solids, their efficiency in removing certain pollutants, such as nitrogen and phosphorus, may be insufficient without additional treatment steps.

In conclusion, constructed wetlands present a promising alternative for wastewater treatment, especially in regions where space and cost are limiting factors. Their ability to remove key contaminants, including suspended solids and organic matter, while being environmentally sustainable, makes them an attractive solution for wastewater treatment. However, addressing their limitations in removing nutrients and pathogens will be critical to enhancing their effectiveness for more diverse wastewater applications.

5) Industrial Wastewater Management Challenges

Industries in India contribute over 12% of total wastewater. Stringent norms under the Environment Protection Act (1986) are often evaded due to insufficient monitoring and lack of compliance by small-scale industries.

6) Wastewater Reuse and Recycling in Agriculture

Reuse of treated wastewater for irrigation has been successfully implemented in Gujarat and Tamil Nadu, reducing dependency on freshwater. Studies highlight the economic benefits and the need for stricter quality monitoring.

7) Technological Innovations in STPs

Emerging technologies like Moving Bed Biofilm Reactor (MBBR) and Sequential Batch Reactor (SBR) are widely adopted in urban STPs, offering compact designs and high efficiency. However, energy consumption remains a concern.

The research paper titled "Design of MBBR Based Sewage Treatment Plant" was published in the year 2022 by authors Priyanka R. Kamble, Nalini Thakre, and Hiradas Lihare. The study explores the effectiveness of Moving Bed Biofilm Reactor (MBBR) technology in treating sewage, particularly within educational institutions where water demand is high. MBBR technology is an advanced and efficient method for biological wastewater treatment. It combines the advantages of activated sludge and biofilm processes, making it an ideal solution for sewage treatment plants (STPs). The system utilizes suspended plastic carriers with a high surface area to support biofilm growth, enhancing microbial activity and wastewater treatment efficiency. Numerous studies have highlighted the effectiveness of MBBR technology in municipal and industrial wastewater treatment. Research indicates that MBBR systems achieve high removal efficiencies for organic matter, nitrogen, and phosphorus. Unlike conventional treatment methods, MBBR is resistant to shock loads and variations in influent characteristics. Studies also show that MBBR requires a smaller footprint compared to conventional activated sludge systems, making it suitable for space-constrained areas such as educational campuses. A critical aspect of wastewater treatment is its cost-effectiveness. Literature suggests that MBBR technology has moderate operational costs due to reduced sludge production and minimal maintenance. The estimated treatment cost of 1 KLD of sewage in India ranges between INR 18 to 20, with treated water valued at INR 40-60 per KLD. This economic advantage supports the adoption of MBBR for sustainable wastewater management. Research emphasizes the need for wastewater recycling in educational premises where water demand is high. Key reuse applications include toilet flushing, landscaping and gardening, and cooling system replenishment. By implementing MBBR-based STPs, institutions can significantly reduce freshwater consumption and promote environmental sustainability. The design of an MBBR-based sewage treatment plant for a 530 KLD capacity requires proper selection of biofilm carriers for optimal microbial growth, efficient aeration systems to enhance biological oxidation, and robust sludge handling to minimize operational challenges. MBBR technology presents an efficient, cost-effective, and sustainable solution for wastewater treatment. Existing research supports its application in diverse settings, including educational campuses. Future studies should focus on optimizing energy consumption and integrating renewable energy sources to further enhance the sustainability of MBBR-based STPs.

8) Urban Wastewater and River Pollution

Untreated urban sewage is a major contributor to river pollution in India. The Ganga River Basin study reveals that over 60% of pollutants are due to insufficient treatment capacity in cities along the river.

9) Community-Based Approaches in Wastewater Management

Community-led initiatives in Rajasthan and Himachal Pradesh demonstrate effective wastewater treatment through participatory planning and localized solutions, including the use of greywater for gardening.

Brenda Lizeth Monzón-Reyes, Humberto Raymundo González-Moreno, Alex Elías Álvarez Month, Alexi Jose Peralta Vega, Gaston Ballut-Dajud, and Luis Carlos Sandoval Herazo (2025) explore the critical role of community participation in wastewater management strategies for rural communities using constructed wetlands. The authors highlight that rural areas often lack access to centralized wastewater technologies and sufficient financial resources, making decentralized, nature-based systems like constructed wetlands a viable and sustainable alternative. Monzón-Reyes and colleagues argue that the long-term success of such systems does not depend solely on their ecological or engineering design but heavily on the involvement of local communities throughout the project lifecycle—from planning to operation and maintenance. Drawing from a literature review of peer-reviewed studies published in English and Spanish over the past 20 years, they identify best practices and recurring challenges in fostering community involvement in sanitation projects. To address these challenges, the authors propose a “triple helix” model that integrates efforts from academia, government, and civil society, thereby creating a structured approach for mobilizing community action. This framework is applied in a case study involving the Salvador Díaz Mirón community in Veracruz, Mexico, demonstrating how local engagement leads to improved management outcomes and long-term system sustainability. The study provides crucial insights for policymakers, engineers, and development planners aiming to embed community-based approaches in decentralized water management.

In their 2020 study published in the IOP Conference Series: Earth and Environmental Science, D. Werdhani and M. Karuniasa evaluate the effectiveness and sustainability of a community-based sanitation communal wastewater treatment plant (WWTP) in Metro City, Lampung, Indonesia. The research focuses on the operational challenges and treatment efficiency of the WWTP managed by the Community-Based Organization (CBO) Mandiri. Utilizing a mixed-methods approach—quantitative laboratory testing during the dry season and qualitative interviews with CBO board members and local facilitators—the authors found that critical wastewater parameters, particularly BOD (Biochemical Oxygen Demand) and ammonia, failed to meet the domestic wastewater quality standards outlined by Indonesia’s Ministry of Environment and Forestry Regulation No. 68 of 2016. Werdhani and Karuniasa emphasize that inadequate community participation and insufficient financial and technical support have hindered the plant's performance and maintenance. The study suggests integrating improved biofilter systems with zeolite media and reinforcing government involvement for sustained funding and technical capacity-building. Additionally, the authors call for stronger socialization and educational programs to enhance local community participation, as effective engagement is crucial for the success of decentralized, community-driven sanitation systems. This work highlights the gaps in community-based wastewater governance and provides practical recommendations for improving similar initiatives in urban and peri-urban settings.

10) Financing Wastewater Management in India

Public-Private Partnership (PPP) models are increasingly employed for financing wastewater projects. Case studies of PPP in Chennai highlight the importance of shared risks and transparent operations for success.

In the comprehensive study by Breitenmoser et al. (2022) delve into the complexities surrounding the governance of wastewater treatment and reuse in India. Through a two-round Delphi study involving 75 expert panelists and supported by literature reviews and case studies, the research identifies both drivers and barriers perceived to influence the adoption and effectiveness of wastewater governance. The study reveals that persistent water scarcity is regarded as the primary driver that compels the adoption of alternative water resources, including treated wastewater. However, significant barriers such as weak enforcement of pollution monitoring, lack of a unified policy framework for integrated water resources management, and fragmented responsibilities among central and state authorities continue to hinder progress. The study underscores that states like Maharashtra, Gujarat, and Punjab have taken pioneering steps by establishing well-defined reuse standards and governance models, which have shown positive outcomes. Nonetheless, the absence of central guidelines, insufficient regulatory enforcement, and lack of financial mechanisms for long-term sustainability pose critical challenges. The authors highlight the potential of recent regulatory developments, such as the effluent discharge standards by the National Green Tribunal and various governmental support initiatives, to catalyze improvements in wastewater treatment and reuse. Importantly, the study calls for the development of fit-for-purpose technology frameworks and the strengthening of institutional capacities to enhance public trust in reclaimed water, create demand, and ultimately protect public health and the environment. This research contributes valuable insights into the policymaking and implementation strategies required to improve wastewater governance in India.

III. PROPOSED METHODOLOGY

The methodology involves:

1) Data Collection: Gathering information from government reports (MoHUA, CPCB, State Urban Departments), research articles, and urban wastewater management case studies.
2) Comparative Analysis: Evaluating different wastewater treatment technologies implemented under SBM-U 2.0.
3) Impact Assessment: Identifying the effectiveness of SBM-U 2.0 interventions on urban water sustainability.
4) Challenges & Recommendations: Highlighting key obstacles in implementation and proposing solutions for better wastewater management.

IV. CONCLUSION

Used water management is a crucial component of urban sanitation, and SBM-U 2.0 has introduced various measures to address wastewater treatment and reuse. While significant progress has been made, challenges such as inadequate infrastructure, financial constraints, and lack of public awareness persist. Future efforts should focus on enhancing technological adoption, policy integration, and community participation to ensure effective and sustainable wastewater management in urban India.

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