

Review Article

Modernizing Fundamental Sanitation in India through Technology

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ABSTRACT

Admittance to fundamental disinfection offices stays a significant test in India, where over portion of the populace needs admittance to legitimate latrines. This issue is especially serious in rural locales, where conventional pit restrooms and the act of open poop continue unmistakably. In this paper, we survey the innovation choices accessible for working on fundamental disinfection in India, with an emphasis on minimal expense and reasonable arrangements. We should begin by looking at the current circumstances of disinfection in India, taking into account both the snags and opportunities for improvement. We then, at that point, investigate a scope of innovation choices, including pour-flush latrines, environmental sterilisation frameworks, and biogas plants, as well as their expected advantages and impediments. We additionally look at the job of local area-driven approaches and government arrangements in advancing the reception and upkeep of these advancements.

Keywords: Sanitation, Technological, Alternatives, Challenges, Barrier

Introduction

India has witnessed notable advancements in enhancing sanitation accessibility over the past decade through the implementation of the Swachh Bharat Abhiyan (Clean India Campaign), resulting in the construction of millions of toilets. Nevertheless, despite these endeavours, a substantial portion of the population still grapples with inadequate toilet facilities, and open defecation persists as a prominent challenge, particularly in rural areas. The deficiency in fundamental sanitation infrastructure has profound repercussions on public health, particularly for women and children, elevating the matter to an urgent and pivotal concern. This document critically examines the technological alternatives available for enhancing basic sanitation in India, focusing on economically viable and sustainable solutions.¹

Current Sanitary Condition In India

The existing state of sanitation in India is marked by insufficient toilet facilities, a reliance on conventional pit latrines, and open defecation. Citing data from the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF), more than half of India's population lacks access to proper toilets.

Rural regions, in particular, grapple with a pronounced challenge, with traditional pit latrines and open defecation persisting, aggravating the issue. Moreover, the absence of adequate sanitation frequently leads to substandard hygiene practices and an increased susceptibility to waterborne diseases.

The insufficiency of proper sanitation disproportionately impacts vulnerable demographics, including women, children, and the elderly. The absence of private and secure toilets exposes women and girls to safety risks, compelling them to defecate in open areas during early morning or late evening hours. This compromises their dignity, privacy, and personal safety and constrains their educational and economic prospects.

Inadequate sanitation also has substantial economic implications. The World Bank estimates that India incurs an annual cost equivalent to 6.4% of its GDP due to expenses related to poor sanitation and its impact on health and productivity losses. Waterborne diseases and associated healthcare costs further perpetuate the poverty cycle, particularly among marginalised communities.

The absence of proper sanitation infrastructure also has environmental repercussions. Open defecation and inadequate waste management contribute to water source contamination, resulting in water pollution and ecosystem degradation. This poses risks to both human and environmental health, affecting biodiversity, agricultural productivity, and overall ecological sustainability.

Ongoing efforts to tackle sanitation challenges in India encompass various initiatives and campaigns at national and state levels. The Swachh Bharat Mission, launched in 2014, aimed to achieve universal sanitation coverage and eradicate open defecation by constructing millions of toilets nationwide. While progress has been achieved, considerable challenges persist, especially in altering deeply ingrained cultural and behavioural norms related to sanitation.

Data from the National Sample Survey Office (NSSO) reveals that only around 40% of rural households had access to toilets in 2012. Open defecation remains a significant issue, involving over half of the population, leading to water source contamination and an increased risk of waterborne illnesses such as diarrhoea and cholera.^{2,4}

Modern Technology Options for Improving Basic Sanitation In India

- **Water-Saving Toilets:** These toilets utilise water to flush waste into a pit or septic tank and can be easily constructed and maintained by Water-saving toilets are not only budget-friendly and eco-friendly but also offer a more sanitary and comfortable solution compared to traditional pit latrines or open defecation practices. With proper training and education, communities can independently build and maintain these toilets, fostering a sense of ownership and long-term sustainability. Additionally, the use of water in these toilets aids in waste removal, preventing the spread of

diseases, and contributing to enhanced public health outcomes in rural areas.

- **Sustainable Sanitation Methods (Sani Sustain):** These methods utilise natural processes to treat and recycle human waste, providing a valuable resource for agriculture to fertilise crops and enhance soil fertility. Sani Sustain methods are particularly well-suited for rural areas, where they can be integrated with agriculture and livestock production.
- **Bioenergy Facilities:** Bioenergy facilities employ anaerobic digestion to convert organic waste, including human waste, into biogas, a valuable energy source for cooking and lighting. These facilities offer a dual benefit by efficiently converting organic waste into biogas for household use and simultaneously producing nutrient-rich fertiliser to support agricultural productivity.
- **Intelligent Sanitation Systems:** Intelligent sanitation systems utilise IoT and other technologies to manage and monitor sanitation facilities, such as toilets and waste treatment plants. Implementing such systems can enhance the efficiency and efficacy of sanitation services, leading to cost reductions and improved public health outcomes.
- **Water Purification Systems:** India faces significant water contamination and scarcity issues, often due to inadequate sanitation. Various water purification systems can be installed to purify water and make it safe for consumption, addressing the challenges of water contamination and scarcity.
- **Promoting Awareness and Education:** Educational initiatives and awareness campaigns play a pivotal role in fostering behavioural transformation and cultivating a sense of accountability towards sanitation. Emphasising the importance of hygiene, proper toilet usage, and waste management empowers communities to reduce open defecation and adopt improved sanitation behaviours.
- **Portable Sanitation Units:** Portable sanitation units, such as mobile toilets, can be used to provide sanitation services in areas where traditional infrastructure is not feasible. These units can serve temporary settlements, construction sites, or events, ensuring access to clean and hygienic sanitation.
- **Technologically Advanced City Sanitation:** Smart city sanitation systems leverage IoT and other advanced technologies to optimise sanitation services in urban areas, enhancing efficiency, reducing costs, and improving public health outcomes through data-driven decision-making and real-time monitoring capabilities.

Additionally, community-led approaches, effective government policies, subsidies, financial incentives, and collaborative efforts are crucial for the long-term success and widespread acceptance of sanitation technologies in India.^{5,6}

Challenges and Barriers

Lack of consciousness: Numerous individuals in India, especially in rural regions, lack awareness regarding the significance of proper hygiene practices and the risks associated with open defecation. This creates obstacles to convincing people to embrace innovative sanitation technologies and practices.

Resource and funding constraints: Many rural communities in India face limitations in accessing the necessary resources and funding for the construction and upkeep of sanitation. This hinders the implementation of new technologies and approaches.

Inadequate infrastructure and technical expertise: Several rural areas lack basic infrastructure such as roads, electricity, and plumbing, posing challenges in establishing and maintaining sanitation. Additionally, there is a shortage of technical know-how in planning, constructing, and maintaining sanitation facilities.

Political reluctance and insufficient coordination among government levels: Limited political commitment and coordination among various government levels make the execution of large-scale sanitation projects and policies challenging.

Reluctance to embrace change: Individuals may resist change, particularly when it involves adopting new technologies and practices related to

Involvement of the community: Engaging communities in the design and implementation of sanitation projects is crucial for success, but it is not always straightforward.

Challenges in maintenance and sustainability: Maintaining and sustaining sanitation facilities pose significant challenges in rural areas due to a lack of resources and technical expertise.

Ineffective Monitoring and Evaluation: The monitoring and evaluation of sanitation projects are often not carried out effectively, making it hard to gauge their impact and identify areas for

Difficulty in scaling up: Scaling up successful sanitation projects and technologies from small-scale pilot projects can be a formidable task.

In conclusion, enhancing basic sanitation in India requires a comprehensive strategy addressing not only technical hurdles but also cultural, social, and economic barriers. Community-led initiatives and effective government policies are crucial for the successful adoption and maintenance of these technologies.⁷

Conclusion

In brief, tackling the complex issue of advancing fundamental sanitation in India demands a thorough and di-

verse strategy. Despite recent advancements, additional endeavours are required to guarantee universal access to fundamental sanitation facilities for all individuals in India. The absence of proper sanitation access significantly impacts public health, especially for women and children, leading to subpar hygiene, water pollution, and an elevated risk of waterborne illnesses like diarrhoea and cholera.

Various technological alternatives exist to enhance basic sanitation in India, encompassing budget-friendly and sustainable choices like pour-flush toilets, ecological sanitation systems, and biogas plants. Nevertheless, the pivotal roles of community-driven initiatives and governmental policies cannot be overstated in encouraging the acceptance and sustainability of these technologies. Community-driven approaches, such as involving local communities in the design and construction of sanitation facilities, prove effective in boosting the acceptance and upkeep of these technologies. Governmental policies, including subsidies and technical support, also play a crucial role in fostering the adoption and sustainability of these technologies.

Obstacles and hindrances to the enhancement of basic sanitation in India encompass lack of awareness, restricted access to resources and funding, insufficient infrastructure and technical know-how, limited political resolve, inadequate coordination among different government levels, and reluctance to change. Yet, with collective endeavours and policies aimed at addressing these challenges, the prospective scenario for basic sanitation in India appears optimistic.

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