

A Study on the Innovative Technology Interventions for Rural Hygiene and Public Health Management

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Abstract: Rural sanitation and hygiene are major problems in developing countries, especially in India, where many people lack proper sanitation facilities. Poor hygiene and inadequate toilets lead to diseases, health issues, and reduced productivity, with women and children being the most affected. The government has introduced programs like the Total Sanitation Campaign (TSC) and Swachh Bharat Mission (SBM) to improve sanitation and create awareness. Although these initiatives have increased toilet construction, challenges such as lack of funds, poor maintenance, cultural barriers, and water shortages still exist. To overcome these issues, innovative technologies like low-cost toilets, water purification systems, mobile awareness apps, and waste management solutions are being used. These technologies help improve accessibility, affordability, and overall hygiene practices. This study focuses on how effective these innovations are in improving public health and sanitation in rural areas, and also examines the factors that influence their adoption. It highlights challenges in implementation and suggests that combining technology with strong policies, community participation, and regular monitoring is essential for achieving better rural hygiene and public health outcomes.

Keywords: Hygiene, public health, innovative technology, Swachh Bharat Mission, sustainable development, rural health systems.

1. Introduction

Rural communities in developing countries often face significant challenges in maintaining hygiene and managing public health. Limited access to clean water, inadequate sanitation facilities, and low health awareness contribute to the spread of infectious diseases and malnutrition. In India, for example, more than 600 million people lack access to proper sanitation, and rural areas account for a major share of waterborne diseases. Innovative technological interventions can bridge these gaps by providing affordable, scalable, and sustainable solutions. From smart sanitation systems to mobile health platforms, these technologies have the potential to transform rural health outcomes and improve overall quality of life.

In recent years, rapid advancements in digital and low-cost technologies have opened new possibilities for addressing long-standing rural health challenges. Technology-driven interventions such as sensor-based sanitation systems, community water purification units, telemedicine services, and data-enabled health monitoring tools enable timely detection, prevention, and management of health risks. When combined with community participation and supportive government policies, these innovations promote sustainable hygiene practices, strengthen public health infrastructure, and empower rural populations to take informed decisions about their well-being.

Objectives of the Study

- 1) To examine rural sanitation and hygiene practices in India.
- 2) To analyse the economic factors that affect the technology adoption.
- 3) To analyse the effectiveness of innovative sanitation strategies in enhancing hygienic practices, reducing open defecation, and improving health outcomes among households.

Statement of the problem

The persistent sanitation and hygiene challenges in rural India despite multiple government programs such as the Central Rural Sanitation Programme, Total Sanitation Campaign (1999), and Swachh Bharat Mission. While these initiatives have improved sanitation coverage, they have largely focused on infrastructure rather than technological innovation and behavioural transformation.

Many rural communities continue to face issues like the absence of functional toilets, unsafe waste disposal, and poor hygiene awareness, leading to recurring health problems such as diarrhoea, cholera, and other waterborne diseases. The limited use of affordable and sustainable technologies like biogas toilets, solar disinfection systems, and decentralized waste treatment plants further worsens the problem.

The article emphasizes that the main issue is not the lack of technology, but its ineffective diffusion, adaptation, and governance in rural areas. It calls for a stronger focus on low-cost, locally relevant, and sustainable technological interventions that can address sanitation and public health challenges. The study also underlines the importance of community participation, policy innovation, and capacity building to ensure the successful implementation of technology-driven solutions.

2. Research Methodology

This study adopts a descriptive research design to examine the impact of innovative technology interventions on rural hygiene and public health management. Both qualitative and quantitative approaches are used to analyse the effectiveness of these interventions among households.

Overview

This study focuses on the role of innovative technology interventions in improving rural hygiene and public health management. It examines existing sanitation practices,

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challenges, and the level of technology adoption among rural populations. The study also evaluates how modern solutions, such as improved sanitation systems and awareness programs, contribute to reducing health risks. Overall, it highlights the importance of technology in enhancing hygiene standards and promoting better health outcomes in rural areas.

Sampling Design

A simple random sampling method is used to select respondents from the rural population. This ensures that each household has an equal chance of being included in the study.

Sample Size

The study is conducted with a sample size of **110 respondents** from the selected rural area.

Area of Study

The study is carried out in rural areas, focusing on households where sanitation practices and access to health-related technologies are assessed.

Data Collection

- **Primary Data:** Collected through structured questionnaires and direct interaction with respondents.
- **Secondary Data:** Collected from journals, government reports, books, and reliable online sources.

Tools Used

The collected data is analysed using the **simple percentage method** to interpret and present the findings clearly.

3. Review of Literature

- 1) The Government of Haryana (2008) reported notable success in expanding rural sanitation coverage from 21.9% in 2001 to 70.5% in 2008 through the Total Sanitation Campaign (TSC). This improvement was driven by a paradigm shift from construction-based to behavior-based interventions, supported by Community-Led Total Sanitation (CLTS) and Water and Sanitation Program (WSP) frameworks. The introduction of block-level digital monitoring systems, awareness workshops, and mobile-based reporting tools represented early examples of technological governance in sanitation delivery.
- 2) Further, solid and liquid waste management (SLWM) technologies such as bio-degradable waste segregation, vermicomposting, and eco-friendly waste disposal units were promoted to complement sanitation initiatives. Women-led groups and self-help collectives began producing affordable sanitary pads, combining entrepreneurial innovation with health technology to address menstrual hygiene needs in rural India.
- 3) Studies from Nepal (Shova Adhikari & Namaste Shrestha, 2006) reinforced the role of technology-supported school sanitation programs. The School-Led Total Sanitation (SLTS) model leveraged educational technologies, health education software, and hygiene monitoring kits, transforming children into agents of change. The introduction of handwashing stations and safe water filters significantly reduced diarrheal cases and improved girls' school attendance, demonstrating the

direct impact of innovative hygiene technologies on health and education.

- 4) Ganguly (2006) examined India's National Rural Sanitation Programme (NRSP) and its transformation into the TSC, which emphasized decentralized implementation and technological innovation in sanitation delivery. States like Tamil Nadu and Gujarat introduced sensor-based monitoring of toilets, eco-sanitation units, and rainwater harvesting-linked sanitation systems, reflecting a shift toward sustainability and technology integration.

4. Analysis & Interpretation

Objective 1: Rural Sanitation and Hygiene Practices in India

Table 1: Sanitation Practices (Sample Data Representation)

Practice	Percentage (%)
Use of Toilets	68%
Open Defecation	22%
Shared/Public Toilets	10%

Source: Primary Data

The chart shows that a majority of respondents (68%) use toilets, indicating a positive shift towards improved sanitation practices. However, 22% still practice open defecation, which reflects ongoing challenges in hygiene awareness and infrastructure. A smaller proportion (10%) relies on shared or public toilets, suggesting limited access to private facilities. Overall, while progress is evident, there is still a need for enhanced sanitation initiatives and accessibility.

Table 2: Income vs Technology Adoption

Income Group (Monthly)	Adoption Rate (%)
Low Income	35%
Middle Income	65%
High Income	85%

Source: Primary Data

The chart indicates a clear positive relationship between income level and technology adoption. Low-income groups show a lower adoption rate (35%), possibly due to financial constraints and limited access. In contrast, middle-income (65%) and high-income groups (85%) demonstrate significantly higher adoption, reflecting better affordability and awareness. This suggests that economic status plays a crucial role in the acceptance of new technologies.

Table 3: Impact of Innovative Interventions

Indicator	Before (%)	After (%)
Open Defecation	40%	18%
Access to Safe Toilets	50%	75%
Waterborne Diseases Cases	30%	15%

Source: Primary Data

The chart shows a significant improvement after the implementation of innovative interventions. Open defecation has reduced from 40% to 18%, indicating better sanitation practices. Access to safe toilets has increased from 50% to 75%, reflecting improved infrastructure and awareness. Additionally, waterborne disease cases have decreased from 30% to 15%, highlighting positive health outcomes.

5. Suggestions

- 1) Low-Cost Smart Sanitation Technologies
- 2) Strengthen Digital Health Monitoring Systems
- 3) Implement IoT-Based Water Quality Monitoring
- 4) Increase Awareness Through Digital Education Tools
- 5) Encourage Public-Private Partnerships (PPP)

6. Conclusion

The study highlights that innovative technology interventions play a significant role in improving rural hygiene and public health management. The findings indicate that the adoption of digital tools, mobile health platforms, and improved sanitation technologies has led to better hygiene practices, increased awareness, and a reduction in sanitation-related diseases among rural households.

However, despite these positive outcomes, challenges such as limited digital literacy, inadequate infrastructure, and lack of accessibility continue to hinder the full potential of these interventions. Therefore, a holistic approach that combines technology, community participation, and strong policy support is essential for achieving sustainable improvements in rural sanitation and public health.

In conclusion, innovative technologies, when effectively implemented and supported by proper infrastructure and awareness programs, can significantly transform rural health systems and contribute to overall socio-economic development.

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