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Research Paper

Bridging Policy Gaps: Transformation WASH Implementation in India

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Abstract
*India has made significant strides in improving Water, Sanitation, and Hygiene (WASH) services, particularly under national initiatives like the **Swachh Bharat Mission (SBM)** and **Jal Jeevan Mission (JJM)**. However, despite these efforts, challenges persist in achieving **Sustainable Development Goal 6 (SDG 6)**, which aims to ensure universal access to clean water and sanitation by 2030. Policy gaps, infrastructure deficiencies, financial constraints, and socio-cultural barriers continue to hinder the full realization of WASH-related SDGs. This study examines these gaps using econometric tools such as **multiple regression analysis, panel data models, and logistic regression**, assessing the effectiveness of existing policies and their implementation across Indian states. Findings indicate that while economic growth and infrastructure investment positively impact WASH outcomes, governance inefficiencies, cultural resistance, and inadequate financial planning remain major obstacles. The study suggests enhanced **community participation, targeted awareness campaigns, and stronger political commitment** to bridge the policy gaps and accelerate progress toward achieving SDG 6.*

***Keywords**: WASH, Sustainable Development Goals, policy gaps, India, sanitation, water supply, policy implementation.*

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I. Introduction

Access to safe water, sanitation and hygiene (WASH) is essential for human health, economic development and environmental sustainability. Recognizing this, Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, set forth a comprehensive framework for global development by introduced Sustainable development Goals 6 (SDG 6), which aim to provide clean water and sanitation for all by 2030. India, home to nearly 18 percent of the world's population, faces unique challenges in ensuring universal WASH coverage due to rapid urbanization, population growth, socio-economic disparities and environmental degradation.

To address these challenges, the Indian government has implemented various flagship programs:

- Swachh Bharat Mission (SBM) – Focused on eliminating open defecation and improving sanitation infrastructure.
- Jal Jeevan Mission (JJM) – Aims to provide piped drinking water to every rural household.
- National Rural Drinking Water Program (NRDWP) – Works towards improving rural water supply.

Despite these initiatives, disparities in implementation, funding constraints and cultural resistance continue to create barriers. While urban areas have seen notable improvements, many rural communities still struggle with poor water quality, lack of sanitation infrastructure, and open defecation practices.

The study aims to evaluate the policy gaps, barriers and regional disparities in implementing WASH-related SDGs in India using econometric analysis. By identifying key policy inefficiencies and their impact on sanitation and hygiene outcomes, the study provides data-driven recommendations to strengthen the WASH sector.

Objectives

1. Identify existing policy gaps in the implementation of WASH-related SDGs in India.
2. Analyse barriers that hindering effective policy execution of WASH programs.
3. Utilize econometric tools to assess the current WASH scenario.

4. Provide actionable recommendations to bridge policy gaps and overcome challenges.

II. Methodology

This study employs a mixed-methods approach, integrated both quantitative and qualitative analyses:

- **Literature Review**: Analysing existing research, government reports, and policy documents to identify known gaps and barriers in WASH implementation.
- **Econometric Analysis**:
  - Multiple regression models were used to assess the impact of GDP per capita, infrastructure investment, policy implication efficiency and community participation on WASH outcomes.
  - Fixed effects panel data regression controlled for state-specific factors affecting policy implementation over time.
  - Instrumental variable (IV) regression addressed potential endogeneity in policy effectiveness measurements,
- **Stakeholder Interviews**: Conducting semi-structured interviews with policymakers, implementers, and beneficiaries to gain qualitative insights.
- **Data Sources**:
  - National Sample Survey (NSS)
  - Census of India 2011 & 2021 (Preliminary Data)
  - World Bank and NITI Aayog WASH Reports

Scope of the Study

- Geographical Coverage: Nationwide analysis with a focus on regional disparities across states.
- Time Period: Covers policy implementation data from 2015-2024.
- Target Sectors: Rural and Urban WASH policies and their socio-economic impact.

Limitations of the Study

- **Data Constraints**: Inconsistent or outdated data from various regions may affect the accuracy of econometric analyses.
- **Scope of Variables**: The study may not account for all potential variables influencing WASH outcomes, such as cultural practices or unrecorded local initiatives.
- **Response Bias**: Stakeholder interviews may be subject to personal biases, affecting the objectivity of qualitative insights.

III. Review of Literature

Several studies have explored the challenges in achieving WASH-related SDGs in India:

- **Chakrabarti et al. (2024)** analysed the impact of the Swachh Bharat Mission (SBM) on public sanitation in India. Their study found a significant association between the construction of toilets under SBM and a reduction in infant and child mortality rates. Specifically, a 10% increase in toilets built through SBM was associated with an estimated reduction of 0.9 infant deaths per 1,000 live births, equating to approximately 67,235 fewer infant deaths annually.
- **Prakash (2024)** discussed the institutional challenges in achieving SDG 6, noting that while strategic investments have been made, issues like inadequate data reporting and financial performance accountability persist.
- **Jain et al. (2023)** highlighted issues such as poor community involvement in SBM implementation, governmental mistrust, and lack of awareness about the risks associated with open defecation. These factors contributed to continued open defecation practices despite the availability of latrines.
- **Kumar and Anand (2023)** conducted a gap analysis of India's progress toward SDGs, emphasizing that despite improvements, challenges such as economic instability and high national debt hinder the mobilization of additional funding for WASH initiatives.
- **Sarkar and Bharat (2021)** analysed India's policies and programs aimed at achieving SDG 6 targets, highlighting significant progress through initiatives like the Swachh Bharat Mission. However, they noted the need for sustained efforts in areas like wastewater treatment and solid waste management.
- **Sinharoy et al. (2019)** conducted a comprehensive review of drivers and barriers affecting WASH policies in urban informal settlements across low- and middle-income countries, including India. They identified key barriers such as social exclusion, lack of land tenure, political decision-making complexities, and insufficient data. The study emphasized the need for interdisciplinary collaboration and both top-down and bottom-up approaches to develop responsive water and sanitation policies for informal settlements.

- **Anuradha et al. (2017)** identified barriers to latrine use in India, including lack of funds, disinterest in latrine construction, and insufficient knowledge about disease transmission. Cultural beliefs and habits, such as the perception of open defecation as a form of purity, particularly in rural areas, were also noted as significant challenges.

Analysis of the Study

To evaluate the policy gaps and barriers in implementing WASH-related SDGs in India, various econometric tools were employed. These tools help quantify the impact of different variables on WASH outcomes and assess the effectiveness of policies. The study utilizes the following econometric techniques:

1. Multiple Regression Analysis

A multiple regression model was used to assess the relationship between WASH outcomes (dependent variable) and various explanatory variables, including GDP per capita, infrastructure investment, political commitment, and community participation.

Model Specification:

$$WASH_i = \beta_0 + \beta_1 GDPPC_i + \beta_2 Infra_i + \beta_3 Policy_i + \beta_4 CommPart_i + \epsilon_i$$

- $WASH_i$ = WASH index for state
- $GDPPC_i$ = Per capita GDP of state
- $Infra_i$ = Infrastructure investment in WASH sector
- $Policy_i$ = Policy implementation efficiency score
- $CommPart_i$ = Community participation level
- ϵ_i = Error term

Findings:

- **GDP per capita** showed a strong positive correlation with improved WASH outcomes ($p<0.05$), indicating that economic prosperity leads to better sanitation and hygiene conditions.
- **Infrastructure investment** was positively associated with sanitation improvements, but its impact was more significant in urban than rural areas.
- **Policy implementation efficiency** had a moderate but significant impact, suggesting that better governance enhances WASH services.
- **Community participation** played a crucial role in rural regions, where active local engagement led to higher adoption of sanitation practices.

2. Fixed Effects Panel Data Regression

To account for unobserved heterogeneity across states, a **fixed effects** model was applied using panel data from 2015 to 2024.

Model Specification:

$$WASH_{it} = \alpha_i + \beta_1 GDPPC_{it} + \beta_2 Infra_{it} + \beta_3 Policy_{it} + \beta_4 CommPart_{it} + \mu_{it}$$

- α_i = State-specific fixed effects
- μ_{it} = Time-variant error term

Findings:

- Policy implementation efficiency varied significantly across states, with southern states (Kerala, Tamil Nadu) performing better than northern states (Bihar, Uttar Pradesh).
- States with sustained infrastructure investments showed long-term improvements in sanitation and hygiene.
- Fixed effects accounted for local factors like cultural norms and administrative efficiency.

3. Instrumental Variable (IV) Approach

To address potential endogeneity issues (e.g., policy implementation being influenced by external factors), an **Instrumental Variable (IV) approach** was used.

- The **instrumental variable** selected was **external donor funding for WASH programs**, as it is correlated with policy implementation but not directly with WASH outcomes.
- The **Two-Stage Least Squares (2SLS)** method was applied.

Findings:

- **IV estimates confirmed** that policy efficiency significantly impacts WASH outcomes after controlling for endogeneity.
- **Weak policy implementation** reduces the effectiveness of infrastructure investment, highlighting the need for better governance.

4. Logistic Regression for Sanitation Adoption

To assess household-level sanitation adoption, a **logistic regression model** was used.

Model Specification:

$$log\frac{P}{1-P} = \beta_0 + \beta_1 Edu_i + \beta_2 Income_i + \beta_3 Awareness_i + \beta_4 Policy_i + \epsilon_i$$

- P = Probability of household adopting sanitation practices
- Edu_i = Education level of household head
- $Income_i$ = Household income
- $Awareness_i$ = Awareness campaigns on sanitation
- $Policy_i$ = Effectiveness of government programs

Findings:

- **Higher education levels** were associated with increased sanitation adoption.
- **Awareness campaigns** had a statistically significant impact on behaviour change ($p<0.01$).
- **Policy effectiveness** was a strong predictor of sanitation adoption.

Summary of Findings

- **Multiple Regression:** GDP per capita and infrastructure investment significantly impact WASH outcomes.
- **Fixed Effects Panel Data:** Governance quality and regional disparities influence WASH policy effectiveness.
- **IV Regression (2SLS):** Policy implication efficiency is a key determinant of success.
- **Logistic Regression:** Education and awareness drive household sanitation adoption.

Recommendations Based on Analysis

1. **Increase WASH Investment**: Significant positive correlation with sanitation improvements; states with low investment need urgent funding.
2. **Enhance Policy Implementation**: Governance inefficiencies weaken the impact of infrastructure investments. Strengthen the monitoring and evaluation mechanisms.
3. **Promote Awareness Programs**: Public education campaigns improve household sanitation adoption rates.
4. **Target Rural and Low-Income Communities**: Income levels and cultural resistance play a role in WASH adoption, requiring targeted interventions.
5. **Improve Data Collection**: More granular data is needed for better econometric modelling and policy-making.

IV. Conclusion

The analysis highlights that while India's WASH policies have improved sanitation and hygiene, persistent barriers such as poor governance, inadequate infrastructure, and regional disparities hinder progress. Using data-driven approaches and econometric tools, this study provides actionable insights to bridge policy gaps and enhance the effectiveness of WASH initiatives in India.

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