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#2017-023

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UNU-MERIT Working Papers
ISSN 1871-9872

Maastricht Economic and social Research Institute on Innovation and Technology
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Maastricht Graduate School of Governance
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Regional Analysis of Sanitation Performance in India

By

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ABSTRACT

Introduction: India bears a disproportionate burden of open defecation in spite of investing more and more funds and ushering in several institutional efforts including *Swachh Bharat Mission* in the recent past. A large share of rural households still lack basic sanitation facilities in India and members practice open defecation.

Objective: The study endeavours to examine the existing anomaly between meagre sanitation productivity and enhanced resource allocation in rural sanitation in India. The study attempts to develop an instrument to monitor the differential regional performances across India.

Methodology: The paper applied data exploration to identify spatial inequality and economic inequity across the nation. The extent of inequality and inequity are measured through appropriate measure statistical indices. To quantify the level of efficiency of the districts in translating social spending in to sanitation coverage and usage, non-parametric data envelopment technique (DEA) has been applied to identify best-in-class performers. Finally, a regional sanitation performance index that premises on three dimensions of performance: efficiency, equity and equality is introduced.

Findings: Efficiency analysis reveals huge potential of India to attain a far higher sanitation access and usage with the given flow of social spending. The study unfolds that India is suffering from dual burden of spatial inequality and economic inequity. While the regional divergence in sanitation access escalates, households from lower income group increasingly construct toilets in comparison to their higher income counterpart even within the same region, originating a *paradox* in sanitation in India.

Conclusion: The performance index has the potential to be served as an instrument to monitor and evaluate regional performances on sanitation and to inform investment decisions for targeted improvement. This index is expected to serve as a useful tool for policy watch as it clearly identifies the best and the worst performers by allowing fair comparison among them.

Key Words: Performance Index, Efficiency, Equity, Equality, SBM (Swachh Bharat Mission), SDG (Sustainable Development Goal).

JEL classification: Q01, Q59, R10,O1

1. ***Introduction:***

The need for promotion of sanitation and pro-poor focus for achieving its universal access does not require any elaboration. Investment on sanitation has sound economic justification for enhancement the well-being of the ordinary people and healthy living with dignity for all. It is estimated that meeting the targets related to Millennium Development Goals on sanitation and drinking water by 2015 would have conferred an annual economic benefit of $38 billion to developing countries and 92% of the benefit accrues to meeting sanitation target. If universal coverage for sanitation and drinking water is achieved globally, the economic benefits would rise to $171 billion annually (Hutton, Haller, & Bartram, 2007, p. 22). The benefits of sanitation as a public health solution seem self-evident. *"It is already well known that improved sanitation could prevent 1.5 million deaths from diarrheal illnesses a year, enhances dignity, privacy, and safety, especially for women and girls, benefits the economy every dollar spent on sanitation generates economic benefits worth around nine more—and is better for the environment"* (Lancet Editorial, 2008, p. 1045). Yet, in many countries including India, failure to provide access to sanitation is quite high. Despite India's multi-decade battle against rural sanitation, 79% of rural population do not use improved sanitation (UNICEF, 2008), though toilets are absent for 69.3% of rural India (Census of India, 2011). According to (Spears, 2013) poor sanitation and high population density act as a double whammy on Indian children, half of whom grow up stunted. India's sanitation deficit leads to losses worth roughly 6.4% ($53.8 billion) of its GDP in 2006 (Tyagi & Hutton, 2011, pp. 53-59). Census (2011) also reveals that the share of households having access to television and telephones in rural India exceeds the share of households with access to toilet facilities (BBC, 2012). Moreover, the country marked as *"not on track"* for achieving MDG (WHO & UNICEF, 2014, p. 52) as she could improve the access only by 14% between 2000 and 2012. NSSO (2O12) reported that 61.2% of households in rural India lack sanitary toilet facility (NSS 69th Round, 2013). The report of (WHO & UNICEF, 2014, pp. 11; 44-64) reveals that globally India continues to be the country with the highest number of people practising open defection. India has become home to 597 million people defecating in the open; which is 65% of her rural population. In Bangladesh, and China, the corresponding figures are only 3% and 2% (WHO & UNICEF, 2014).

After MDG, Sustainable Development Goals (SDGs Goal 6) (September 2015) has set the target "*to secure water and sanitation for all for a sustainable world*" by 2030, giving more

emphasis on achieving access to adequate and equitable sanitation. In terms of the WASH performance index report developed by The Water Institute of University of North Carolina (Ryan Cronk, 2015), India emerges as one of the bottom performing country among 117 countries. This index is the sum of country performance values for the components of water access, water equity, sanitation access, and sanitation equity. The study conducted frontier analysis to identify *best-in-class performer* country. Country rates of change (progression or regression, percent per year) in access to water and sanitation were compared to the performance frontier (best-in-class performance) to generate a country value for performance in improving water and sanitation access.

Rural sanitation first came into focus of governance and policy making in India in the World Water Decade of 1980s. The Central Rural Sanitation Programme (CRSP) was started in 1986 to provide sanitation facilities in rural areas. It was a supply driven, infrastructure-oriented programme that relied heavily on high levels of subsidies for latrine construction. Due to the inherent problem of top-down approach and low financial allocations, the CRSP failed terribly and had little impact on the gargantuan problem (Fawcett, 2008). Later, the high subsidy approach was changed to a "*Demand Driven Approach*" under Total Sanitary Campaign (TSC), followed by incentive scheme titled *'Nirmal Gram Puraskar'* (NGP), which is given to "*open defecation free*" Gram Panchayats, Blocks, and Districts (World Bank 2015). The incentive is granted to Panchayati Raj Institutions (PRIs) as well as individuals and organizations that are the driving force for full sanitation coverage. Encouraged by the success of NGP, the TSC was revamped as "Nirmal Bharat Abhiyan" (NBA). To take the practice of sanitation to the next level by removing bottlenecks that were hindering progress, the program has been restructured with SBM (Swachh Bharat Mission). On 2nd October 2014, the Mission was launched throughout the length and breadth of the country as a national movement to give tribute to Great National leader Mahatma Gandhi on his 150th birthday in 2019.

After initiation of "*India's biggest ever cleanliness drive*" Swachh Bharat Abhiyan (The Times of India, 2014), 27.2% fund allocation was increased for rural sanitation as per the Indian budget from FY2014-15 to FY2015-16 (Centre for Policy Research, 2015, p. 2). Government sanctioned Rs.9,000 crores (1.5 billion dollar) for construction of toilets in rural households with the support from World Bank (Hindustan Times, 2016) and the entire cost of Rs.12,000 (raised from 10,000 under TSC) for constructing an individual toilet is given as

subsidy to Below Poverty Line (BPL) Households. The subsidy for Above Poverty Line (APL) households is restricted to SCs/STs, small and marginal farmers, landless laborers with homestead, physically handicapped and women headed households (Government of India (GOI), 2014, pp. 11-12). The subsidy would cover the cost of the superstructure, the bowl and two leech pits (The Hindu, 2015).

Though injected with substantial funds for rural sanitation, the program suffers from several issues like inadequate drive towards generating awareness and building enabling environment for demand creation and ensuring behavioral changes for using toilets involving intangible processes. In case of all centrally sponsored schemes in India, the implementation is left to the individual federal state governments with wide variation of the political set up, socio-economic and cultural context as well as of the implementation capacity and degree of involvement of the local governments. This has actually led to widely different outcomes in sanitation across the country, inter and intra state. Under similar set up of financing and administrative framework, the governance at grass-root level appear to be crucial in determining the final outcomes with respect to both coverage and usage of sanitation facilities. Given this aforesaid backdrop of multi-faced problems, the paper targets to assess the progress of SBM at sub-regional levels, recognizing efficiency of access creation (given the available funds), equity between different income classes and spatial equality across regions. The performance identifies two crucial indicators: coverage of sanitation and usage of toilets (using the proxy of open defecation free regions). Following this introduction, section 2 describes the data and methodology to create the indices of sanitation progress, while section 3 outlines the results. Section 4 contains the discussion of the results and finally the conclusions and policy prescriptions are mentioned in section 5.

2. ***Data & Methodology:***

2.1. Data:

Data related to all the main variables required for the analysis are collected from the website of Ministry of Drinking Water and Sanitation (MoDWS) of Government of India, Swachh Bharat Mission-Gramin (SBM(G)). Data are freely downloadable from http://sbm.gov.in/. The website has archived all the preceding years (monthly progress reports are also available for the time period after launch of Nirmal Bharat Abhiyan) related to physical progress, expenditures and fund release, panchayat reports and others starting from

Total Sanitation Campaign (1999) up to Swachh Bharat Mission (2014). The data for each state are uploaded in the website through MIS (Management Information Service) reporting system by the respective state authority.

Due to unavailability of data at districts levels during the initial years of TSC, 2001-02 has been chosen as the starting point of the analysis and the same is extended up to the end of 2015-16. The website contains the information about all the 29 states and 7 UTs (Union Territory) of India. However, Goa and UTs are not considered in the main analysis due to irregularities in data upload in the concerned website. Therefore, the sample of the study consists of all districts of the rest 28 states in India. There are 630 districts at the time of baseline survey during the launch of NBA. For only one district (Kurnool of Andhra Pradesh) the APL coverage data at the baseline was not found. Therefore, the main area of study takes 629 districts of 28 states of India into consideration.

2.2. Methodology:

At first some descriptive statistics and exploration of data have been used to identify the trend of performance across the sub-regions in India. The idea of sanitation performance index is mainly developed following publication of WASH performance report (Ryan Cronk, 2015) which introduced WASH performance index that allows fair comparison among countries of the world on the basis of performances in WASH sector. Based on this report, sanitation performance index (SPI) at sub regional level is constructed in the paper. The sanitation performance index (SPI) is based on three key indicators:

- ***Efficiency Index***: This measures how far the districts/states are efficient in achieving current level of coverage & usage (sanitation outputs), given their level of social expenditure in sanitation program funded by central and state governments.
- ***Economic Equity Index:*** This component captures Intra district/state variation in access to sanitation among APL and BPL households.
- ***Geographic or Spatial Equality Index:*** This component identifies the inter-district variation in sanitation access.

It must be added here that these three indices would be combined for state level index, while the first two would be considered for district level index.

The first step towards building sanitation performance index is to measure the ***efficiency index*** of a region to utilise the available funds prudently to improve the access to sanitation. It has been identified that there lies strong deficiency in sanitation productivity in India, while on the other side, one can appreciate rise in real investment in rural sanitation sector. To answer such mismatch in social sector spending and sanitation productivity, the study has attempted to calculate technical efficiency of the districts as a major criterion to gauge sanitation performance. Several authors (Ray, 1991), (Miliotis, 1992), (Chakraborty & Lewis, 2001), (Tae Ho Eom, 2005), (Dutta, Bandhopadhya, & Ghose, 2014), (H-H Hu, 2012) have applied DEA method to measure efficiency in public sector units. The authors employed non-parametric measures to assess efficiency of government spending of health and education sectors. (Chakraborty & Lewis, 2001) had developed their paper for searching a valid answer behind the weak relationship between high increase of real expenditure per student and marginal increase in standardized test score in schools of Utah, United States. Following the same line of thought, the paper also attempts to measure the regional efficiency across districts of India in the field of sanitation by applying DEA methodology.

DEA is basically a linear programming approach for measuring the relative performance of a firm or decision making unit (DMU) in presence of multiple inputs and outputs following (Farell, 1957) and CCR Model (Charnes, Cooper, & Rhodes, 1978). Their measurement of efficiency allows separate DMU or firm to impose different weights on inputs and outputs, which shows the firm in the most in comparison to the other units. Thereafter, (Banker, Charnes, & Cooper, 1984) (BBC) extended the CCR model by incorporating the variable returns to the scale of technology proposition which is more realistic concept than the sole dependence on constant return to scale in CCR model.

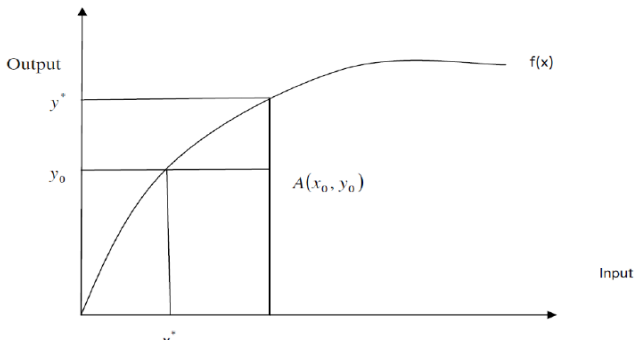
Measurement of technical efficiency can be sub divided into two components:

(a) Output oriented measure of TE

(b) Input oriented measure of TE

(Figure 1) shows that, the production function is y = f(x) where, x is the input and y is the output which are measured along the horizontal and vertical axis respectively. Let, y^* the maximum level of producible output from input x_0. Let, firm

Figure 1: Input and Output Oriented Technical Efficiency



Source: (Dutta, Bandhopadhya, & Ghose, 2014)

A is at production point A with x_0 input, y_0 output. Therefore, output oriented measure of technical efficiency of the firm A is = y_0/y^* or the ratio between actual and maximum output. Similarly, in case of input oriented measure for firm A can be defined as x^* / x_0 as the output y_0 could be reached by using only x^* amount of input. The score of technical efficiency lies between 0 and 1 where 1 stands for highest efficiency.

For performing this analysis, the input-output bundles, that are most appropriate to judge efficiency in utilization of social expenditure under sanitation, need to be identified. IEC Expenditure is that particular form of expenditure, which targeted towards behavioural change in the community through awareness generation campaign, advertisements, etc. Thus, IEC expenditure have been chosen as one of the critical input for the analysis. The other forms of expenditures like administrative, construction expenditure etc. are clubbed together to form another input and named as non-IEC expenditure.

Now, as the two prime outputs, sanitation coverage and usage have been selected for this analysis. Expansion in coverage is a necessary, but not sufficient to curb the rampant open defecation in the country. To evaluate how far the progress has been achieved in the process of reduction of open defecation, percentage share of Gram Panchayats (GPs) in a district that had been declared as ODF (Open defecation free) has been selected as another output for the efficiency analysis. In short, the analysis deals with district level outputs, one is related to sanitation access and the other is related with usage of toilet and two inputs i.e. average IEC and Non IEC expenditure per households in a district to judge the efficiency aspect in sanitation performance as shown in (Table 1).

Table 1: Input Output table for efficiency analysis

Inputs	Outputs
✓ **Average IEC Expenditure Per Households from 2001-02 to 2015-16**	✓ **Percentage of Households with Toilet at 2015-16**
✓ **Average Non-IEC Expenditure Per Households from 2001-02 to 2015-16**	✓ **Percentage of GPs declared ODF at 2015-16**

Source: Author's own presentation

To analyse the existing ***economic inequity*** in sanitation between APL and BPL groups within a district, a measure of equity index is needed. The paper utilizes coefficient of range as a measure of disparity or inequity between BPL and APL category within a particular region. Although coefficient of range (CR) has some demerits, but they are mainly arising out of the fact that CR considers only two extreme values in the distribution and

measures the extent of deviation among those extreme values only. But, such demerits cannot affect this particular case, as the analysis is dealing with two values only i.e. coverage of BPL and APL households within a region and trying to come up with a statistical measure that will provide us the extent of deviation in access among them. Hence, CR fits appropriately in this context. The formulation of CR has given below:

$$\boldsymbol{C.R=\frac{|Coverage\ of\ APL\ households - Coverage\ of\ BPL\ households|}{Coverage\ of\ APL\ households + Coverage\ \ of\ BPL\ households}}$$

The value of CR lies between 0 and 1. The lesser the value of CR, the higher is the equity among these two income groups. But, in case of efficiency index higher the value of technical efficiency score, the higher is the efficiency among the districts. So, to maintain a parity between value directions of each indexes, a linear transformation is applied on the values of CR as follows to construct the district wise **Equity Index**, given by,

Equity Index=1- C.R

To measure the ***extent of spatial inequality***, the paper has constructed three Gini coefficients corresponding to each variable written below:

- Coverage of districts within a state as whole (G_D)
- Coverage of APL households across districts within a state (G_{APL})
- Coverage of BPL households across the districts within a state (G_{BPL})

The first variable takes care of intra-state or inter-district inequality within the region. Moreover, other two variables are added to fetch out the inequality within each group of households i.e. APL and BPL. Reason being, in many cases overall measurement ignores the inequality that exists within different groups of the population, which might have separate impact on the inequality judgement. In our analysis as segregation between APL and BPL households carries special importance related to policy, it becomes necessary to evaluate inequality within each category along with the overall inequality measure.

The Gini measures are derived by using DASP package of STATA software. In general, the Gini Co-efficient is determined by following the formula given below:

$$G = |1 - \sum_{k=1}^{k=n} (X_k - X_{k-1})(Y_k + Y_{k-1})|$$

where, G: Gini coefficient

In our topic of discussion X and Y variables are defined as:

X: cumulated percentage of households within a state

Y: cumulated percentage of households with toilet

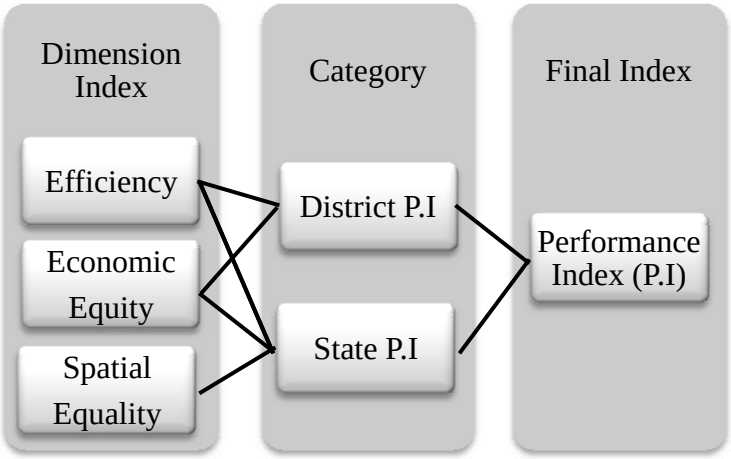
After estimating three Gini coefficients, to have the combine effect of these variables, a Composite Gini index (CGI) is formed by taking geometric mean of three Gini indices as follows:

$$C.G.I = (G_D^{1/3} * G_{APL}^{1/3} * G_{BPL}^{1/3}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The values of Gini index lie between 0 and 1. The lesser the value of CGI, lower the inequity within a state. Again, to maintain the similarity in the value judgement, high performing states should be associated with higher value of equality index. Therefore, we have done similar type of linear transformation as done in the case of Equity index.

The skeleton of the performance index has been described in (Figure 2) below:

Figure 2: Final Sanitation Performance Index construction



Source: Author's own presentation

The District Sanitation Performance Index is based on two dimensions: Efficiency Index and Intra-district Economic Equity Index. For calculation of the final index, geometric mean (G.M) of two aforesaid indices has been used. The choice of G.M has motivated by its property of partial substitutability among components, unlike the prefect substitution as in the case of arithmetic mean (A.M). Therefore, Formulation of District Sanitation Performance index (D.P.I) is given as:

D.P.I=$\sqrt[2]{Efficiency\ Index * Equity\ Index}$**…… *(2)***

Thematic maps are also developed using GIS software to visually explain the geographical concentration of poor and better performing districts.

The state performance index is consisting of three indices as shown in the (Figure 2). They are Efficiency Index, Intra district Economic Equity Index, Inter district or Intra state Spatial Equality Index. Efficiency Index for a state ***j*** (***Eff$_j$***) having n number of districts and ***i*****(*i= 1(1) n*)** being the representative district is calculated as,

$$\boldsymbol{Eff}_j = \sqrt[n]{\prod_{i=1}^{n}(Efficiency\ score\ of\ district\ i)} \quad \text{…….. (3)}$$

Following the same procedure, state equity index for each states of India is also estimated by taking G.M of all the district equity scores within a particular state. The geographical equality index is calculated at state level only. Therefore, the inter-district equality index or state equality index is applied directly as the 3rd dimension index for the State Sanitation Performance Index (SPI).Finally, to construct the final performance index at the state level, geometric mean over three dimension indices are taken after following normalization for each of three indices as per HDI (Human Development Index) rule. i.e.

$$Dimension\ Index = \frac{\text{actual index value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

After applying the above rule for each of the three indices, then a G.M of resulting dimension index is created and termed as State Sanitation Performance Index (SPI).

Hence, SPI is finally computed as:

S.P.I= $\sqrt[3]{Efficiency\ Index * Equity\ Index * Equality\ Index}$**……*(4)***

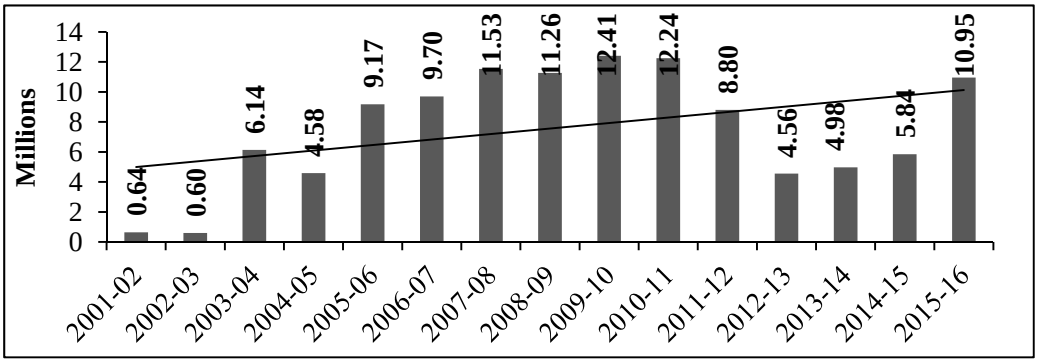
3. Results:

3.1.Overview of National trend:

Following the state policy in improving sanitation coverage, state-sponsored construction of Individual Household Latrine (IHHL) started since the initiation of Total Sanitary Campaign in 1999. Data suggest that since the new millennium, there is an overall positive trend in the IHHL construction as expected, with a sudden fall during 2010-11 to

2014-15 as shown in (Figure 3). Again, after launch of SBM, there was resurgence of high construction of IHHL. In the year 2015-16, the construction was 87.5% higher than that of in previous year.

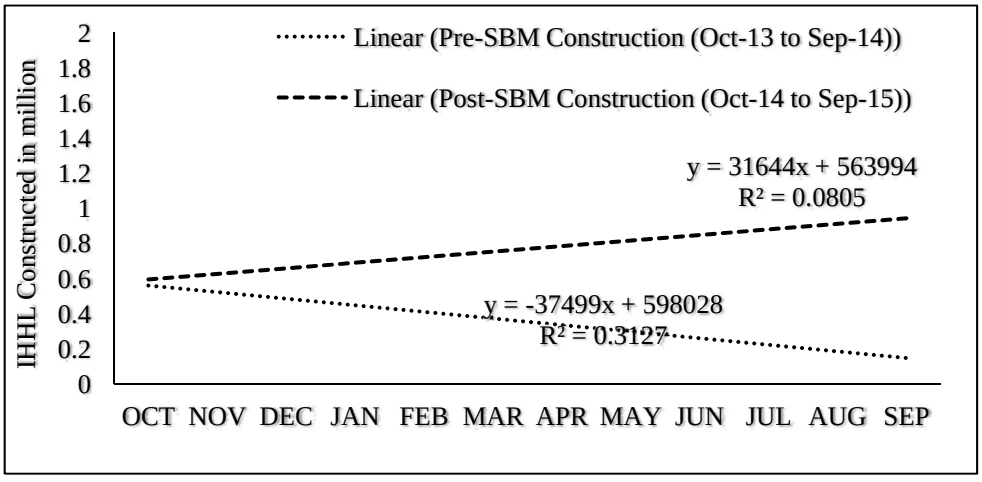
Figure 3: IHHL Construction trend over the years (2001-02 to 2015-16)



Source: Authors' presentation using data from http://sbm.gov.in/

For more detailed analysis, monthly construction trend has been compared between one year before and after SBM in (Figure 4). Here, monthly construction values are plotted after exponential smoothening to leave out the seasonality effect. Monthly construction trend lines for pre-SBM period (i.e. just 12 months before launch of SBM) appear to have a negative slope with a reasonable goodness of fit indicating that before the launch of SBM, the construction is falling gradually in a steady manner and with lesser fluctuation as measured through high value of R^2. Whereas, the post-SBM trend line exhibits a positive slope but a low value of R^2, implying that on an average construction figures are increasing with time in this phase, but with greater fluctuations compared to that of in pre-SBM period.

Figure 4: Construction trend during one year before and after launch of SBM

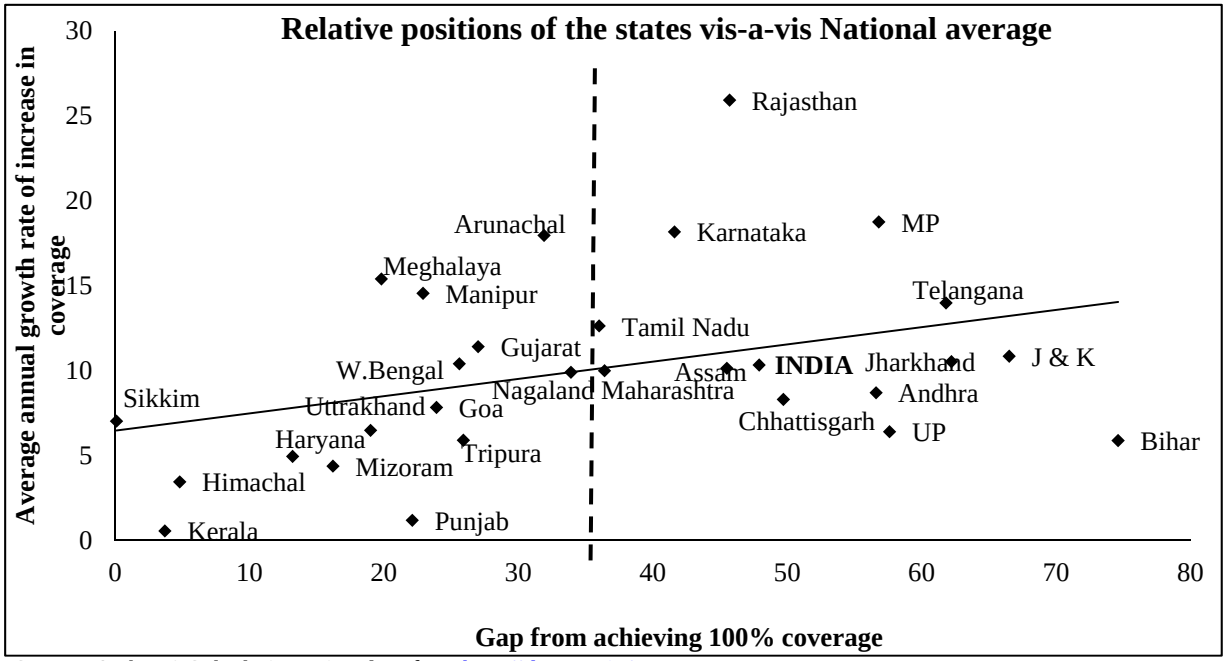


Source: Authors' Calculation using data from http://sbm.gov.in/

The discussions so far are based only on the all India national scenario. However, the actual status of sanitation coverage and progress will be clearer with a more disaggregated analysis, by scrutinizing every tiers of hierarchy from nation to states and from states to districts. District is actually the base unit of all sanitation programmes as described in the guideline of both NBA and SBM.

3.2.Interstate comparison reflecting Spatial inequality:

Figure 5: Sanitation coverage and progress across states of India at the end of 2014-15



Source: Authors' Calculation using data from http://sbm.gov.in/

This analysis attempts to explore the relationship between level of coverage and rate of progress in expanding coverage across the states of India. All the states have the target to reach 100% coverage i.e. to provide access to toilets to *all* households in that particular state. Therefore, the state with higher gap from 100% coverage was expected to move faster. This inverse relationship between level and trend is well acknowledged in terms of almost all MDGs across the globe. To check whether such usual relationship holds true or not in Indian context, gap from reaching 100% coverage as found in the year 2015-16, has been plotted in the horizontal axis and average rate of increase in coverage (starting from NBA 2012-13 to 2015-16) is plotted in the vertical axis of (Figure 5). Odisha has been excluded from this analysis being an outlier. The scatter diagram depicts that there is a positive relationship between gap from target (reaching 100%) and rate of progress i.e. states with lower sanitation coverage are progressing at a higher rate and vice versa. Hence, the figure is indicating

towards a positive sign of convergence among the states of India. The nation as whole has 52.13% coverage having a gap of 47.87% from attaining 100% coverage at an aggregated level. However, (Figure 5) shows that the states are highly scattered and the fitted line is quite flatter implying that the relationship between level of coverage and progress is not strong enough. To validate whether such relationship exists for all categories of states or not, states are subdivided into two categories viz. states with higher coverage than average coverage of all the states i.e. 64.96% (i.e. 35.05% gap from reaching 100% or universal coverage) and states with lower coverage than that of the mean coverage. The dotted line represents the segregation of the states into two groups.

Figure 6A: States with more than mean national coverage

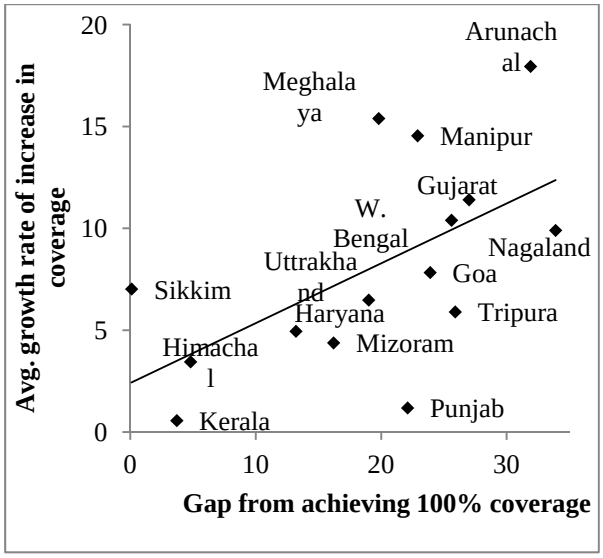
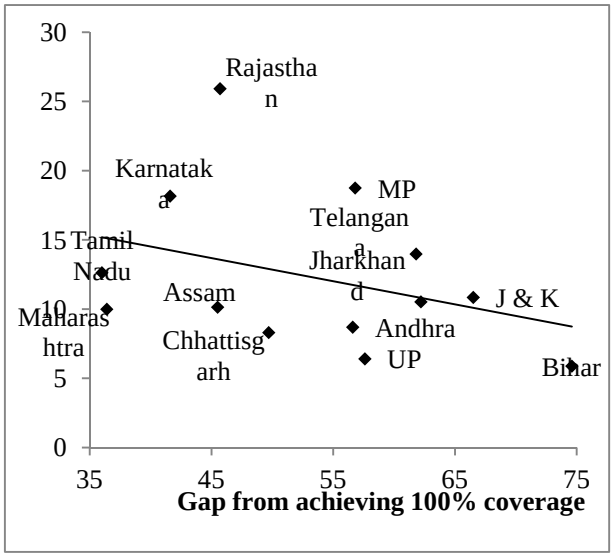


Figure 6B: States with less than mean national coverage



Source: Authors' Calculation using data from http://sbm.gov.in/

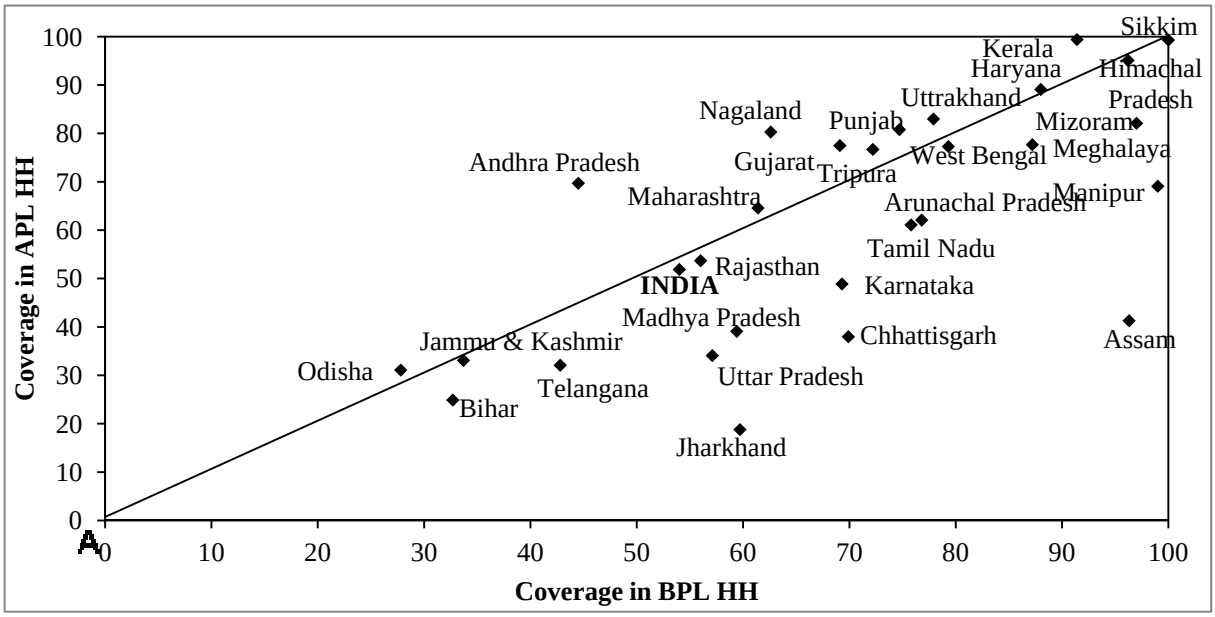
Here, both of the figures provide us sharply different findings unlike the general understanding at the national level. The states with higher coverage i.e. having lower gap from 100%, are progressing at a higher pace as visible in (Figure 6A), which indicates that these states are likely to reach saturation much faster, while the states having lower coverage, are moving at a slower pace as shown in (Figure 6B). The latter states thus exhibit a negatively sloped trend line within their set, implying that the states with lower levels of coverage are further delaying their year of saturation. This result highlights the stark divergence in performance among the states, hinting a substantial rise in spatial inequality across the states in terms of sanitation coverage. The issue of unbalanced growth models with spatial and geographical inequality has been explored well in terms of usual development

parameters, but less so in terms of sanitation coverage. This aspect is considered in analysis of regional indices of sanitation performance in the next section.

3.3.Assessment of Economic inequity:

So far, the analysis has addressed the problem of spatial inequality across India. But households within a particular region have different characteristics. Mainly, the households of a specific region can be classified into two broad categories, based on their economic standard. Such characteristic plays a very crucial role when we consider construction of IHHL under sanitation programme run by government. All the households of a specific region have been segregated into two mutually exclusive and exhaustive income classes during the national survey for NBA. The purpose of such segregation is that BPL households are entitled to get subsidy for constructing toilets in post-construction period. However, there is no such provision of incentives for APL households except for a few weaker sections among them. Thus, construction of IHHL in APL households heavily depends on their self-motivation and willingness to pay. Now, the important question that emerges is whether such motivation or demand generation among APL households are actually taking place or not. To visualize this (Figure 7) has been presented. In this scatter diagram coverage of BPL households of the states has been measured along the horizontal axis and the same has been plotted for APL households along the vertical axis. AB is the 45° line which is basically the line of equality.

Figure 7: Sanitation Coverage among APL vs. BPL Households across states



Source: Authors' Calculation using data from http://sbm.gov.in/

Interestingly the (Figure 7) reveals that the states with higher coverage (Kerala, Sikkim, Himachal Pradesh, Haryana etc.) exhibit greater parity between coverage of APL and BPL households i.e. these states are placed around the 45° line. Paradoxical results are found in case of states with relatively lower coverage such as Jharkhand, Assam, Chhattisgarh, Uttar Pradesh, Madhya Pradesh, Karnataka, Telangana and Bihar. In majority of these states, coverage among BPL households is far higher than their APL counterpart. Even, the country as a whole is a bit tilted towards BPL section i.e. 54.0% of BPL households in rural India has their own latrine in comparison with 51.9% for the APL households.

Sustainable Development Goal (SDG) for the sanitation sector (Goal 6) has targeted towards ensuring basic sanitation for all for a sustainable world by giving more importance on achieving access to adequate and equitable sanitation. However, present scenario of the country raises doubt about two stylized words mentioned in the goal statement. *First*, "*equitable*" sanitation could only be achieved through vigorous behavioural change and not just by constructing toilet with the help of subsidy. The present condition reveals poor performance in such direction by most of states along with country. *Secondly*, existing inequity in sanitation access cannot lead to a "*sustainable*" world. From this section, it becomes transparent that while measuring sanitation performance of any region, equity in access should be treated as one of the most important parameters (as remarked in SDG also). Therefore, the subsequent analysis has included "equity" as an indicator in Sanitation Performance Index. The construction and illustration of the performance index is demonstrated in section 3.4.

3.4.Construction of Sanitation Performance Index across states and districts:

3.4.1 Efficiency Index:

The first index considered as per the methodology outlined in earlier section (section 2.2) attempts to identify the extent of efficacy of a particular district/state in making use of public expenditures, spent in the field of sanitation to maximize their respective sanitation outputs. It is well recognized that resources are scarce in the economy and to obtain maximum output, optimum utilization of resources are necessary. Whether such optimum uses of resources (i.e. expenditures in sanitation sector) are actually taking place or not leads towards the concept of technical efficiency analysis. Here it must be added that efficiency here represents technical efficiency (TE) in using the inputs to produce the outputs, and not the allocative efficiency. Thus, a technically efficient region is able to use its resources

relatively better among other regions, though it might suffer from allocative inefficiency. After following the required steps to determine the relative efficiency score of DMUs (districts), the DEAP software provides us the following results are shown in (Table 2) discussed below:

Table 2: Summary of DEA results

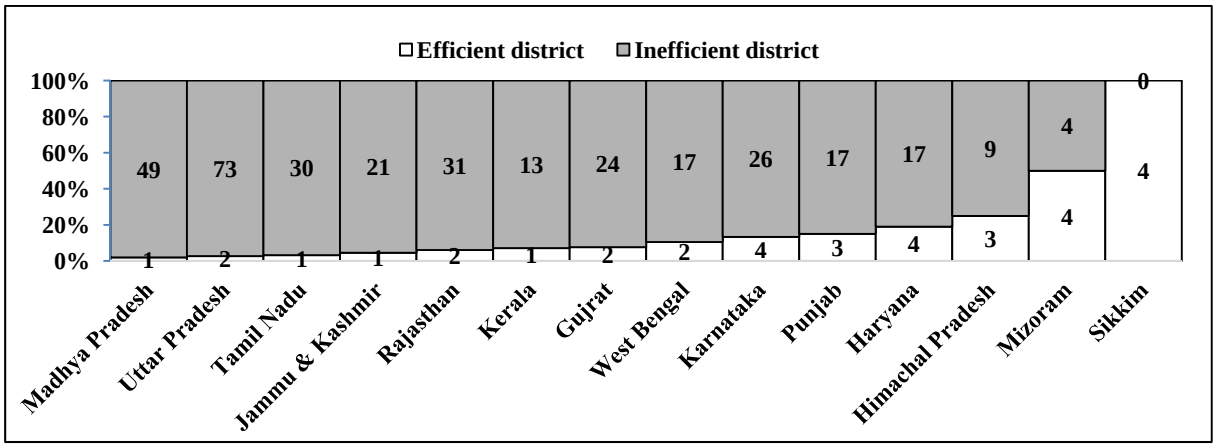
Total number of districts	**630**
Number of Efficient districts	34 (5.4%)
Number of Inefficient districts	596 (94.6%)
Mean score of efficient districts	1
Mean score of all districts	0.568
Mean score of inefficient districts	0.543
Median score of all districts	0.549
Standard Deviation	0.246
Skewness	0.199
Kurtosis	1.96
Minimum Score	0.118

Source: Calculations from DEA result

It is quite shocking to note that only 34 districts (5.4%) emerged as efficient out of total 630 districts. This result carries serious implications that the country as a whole required a big push to accelerate the pace of increase in sanitation outputs. There is indeed a great scope to raise the output as around 94.6% of districts in India given the set of inputs for which are revealing inefficiency in sanitation performance. That means, 94.6% districts of India are failed to achieve the maximum output, which would be achievable by efficient utilization of given inputs had they followed similar methods of utilization as in 34 districts lying on the frontier. Minimum score of 0.118 belongs to Kalahandi district of Odisha. Mean efficiency score of the districts is 0.568 implying that 43% higher output would be achievable with the given amount of social spending. Literatures have pointed out the crunch in the fund and expenditure devoted to social sector. The requirement of additional investment in social sector cannot be debated in the country like India. But, the table above posits a very different story i.e. the nation actually *has the potential* to attain a far high sanitation progress than that had been achieved so far, even without spending an additional rupee in the rural sanitation sector. Running the input-oriented DEA, the input slacks appear to be quite high in both types of expenditures: IEC expenditures (66.6% of mean use) and non-IEC expenditures (49.5% of mean use). This indicates that the funds available are utilized only partially. Therefore, instead of considering just the rise in investment, authority should give more stress on stricter monitoring at grassroot-level construction activity in the present scenario to attain the desired

maximum level of output. (Figure 8) represents the percentage share of efficient districts out of total districts within 14 states of India having at least one efficient district within the state. On the other hand, rest 14 states have no district that reaches up to efficient level.

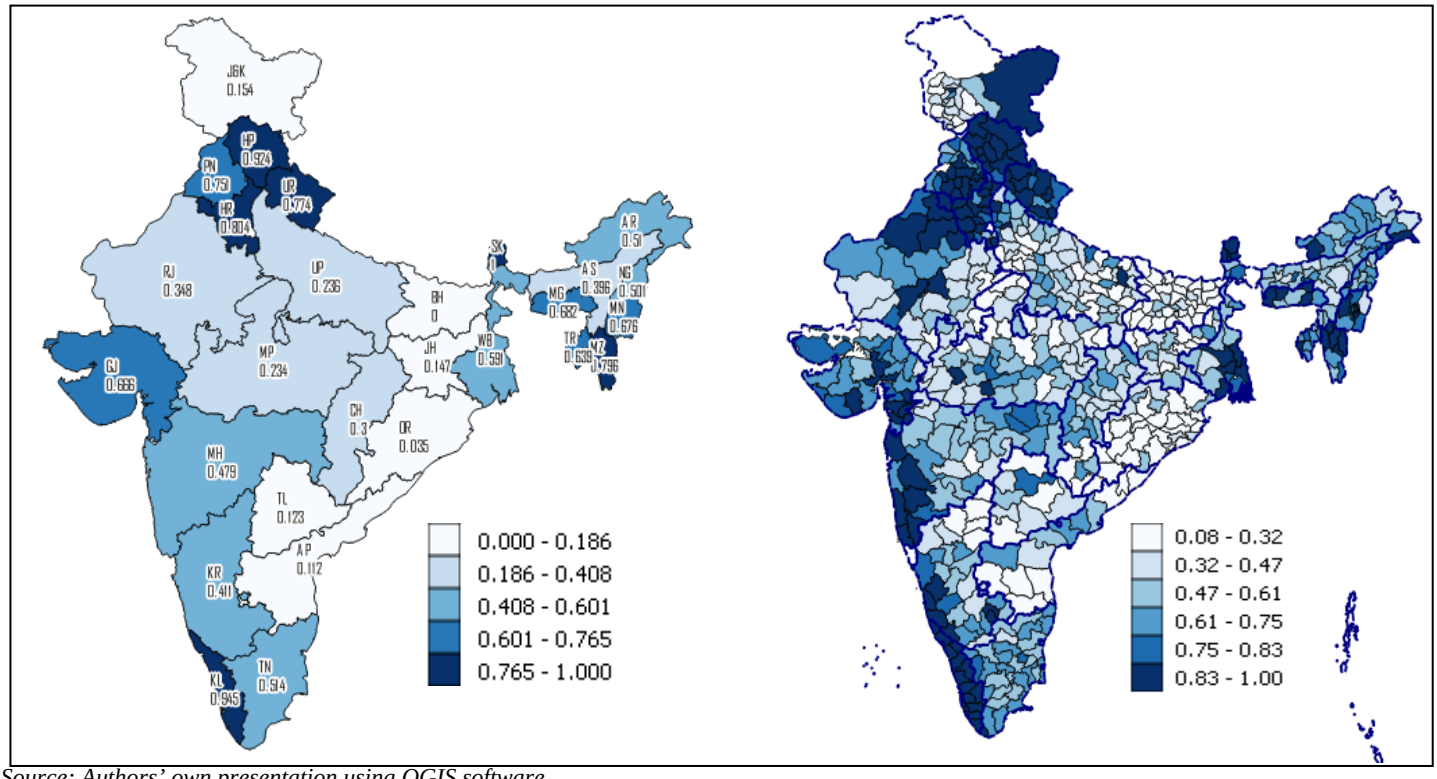
Figure 8: Share of efficient districts across the states



Source: Calculations from DEA result

It is clear from the above figure that all the four districts of Sikkim are technically efficient. Half of districts of Mizoram and one fourth districts of Himachal Pradesh have attained TE score equals to 1. The efficiency index for the states has been constructed by applying equation (3) discussed in section 2. The efficiency performance index of states and districts are represented by the thematic map as shown in (Figure 9).

Figure 9: Efficiency Dimension Index



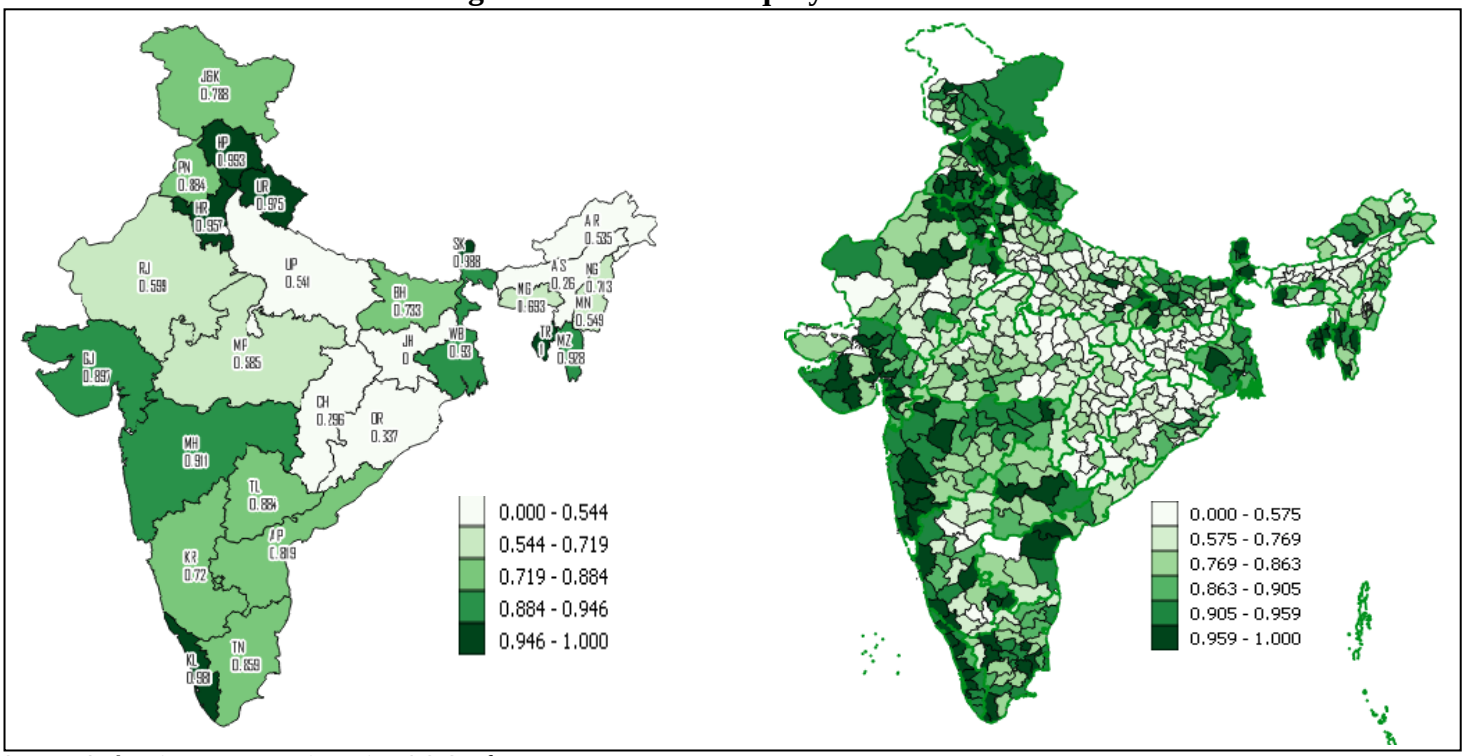
Source: Authors' own presentation using QGIS software

It could be seen from the map that some particular regions within a state are having relatively higher (lower) efficiency even within the states of India. For example, districts situated in northern part of Rajasthan state are doing better in comparison with rest of the districts belonging to the same state. Similar case happens in case of western edge of Maharashtra; the districts concentrated in this zone have relatively higher technical efficiency scores than remaining part of the state.

3.4.2. Economic Equity:

Although the two words i.e. "Equality" and "Equity" are often used interchangeably but there exists a fine line of distinction. Equality means equal access or opportunity for all; it treats all the units identically. However, equity is about treating every unit according to their requirement so that they can achieve same level of access i.e. equity is associated with fairness of treatment among different groups. APL and BPL households are classified as distinct income groups which are potentially different from each other and face different kind of treatment in the context of sanitation programme. Therefore, assessment of achievements or sanitation access by these two groups is a question of equity not equality. Whether they are getting the fair treatment for achieving making progress in an equal manner is more relevant question that needed to be asked. The economic equity index results are shown in (Table 4) along with other two indices following equation (3) in Section 2.2. The economic equity index of states and districts are represented by thematic map in (Figure 10).

Figure 10: Economic Equity Dimension Index



Source: Authors' own presentation using QGIS software

3.4.3. Spatial Equality:

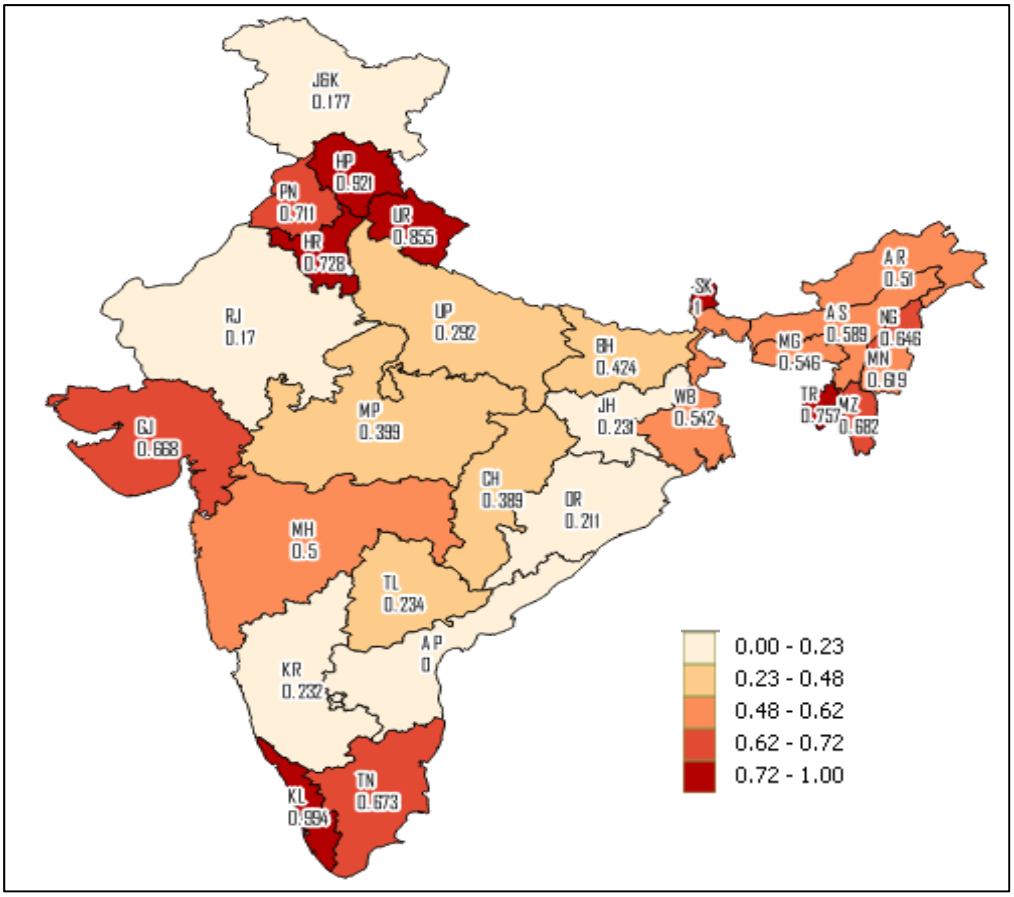
The districts within a particular state share same geographic boundary, governed and monitored under same state authority and fund for sanitation programme are also supplied by the same state body. Thereafter, the differences in the level of sanitation achievements across spatially similar districts within a state should be termed as spatial or geographic inequality. (Table 3) shows formulation (applying equation 1) and results related to Equality index. Sikkim ranked highest in the equality index while Rajasthan and Jammu Kashmir are least performers. (Figure 11) depicts the state-wise variation in spatial equality index through thematic map presentation.

Table 3: Construction of Equality index from the Gini co-efficient

State	G_D	G_{APL}	G_{BPL}	*C.G. I*	*Spatial Equality Index*
Andhra Pradesh	0.31	0.36	0.31	0.33	0.67
Arunachal Pradesh	0.12	0.23	0.16	0.17	0.83
Assam	0.10	0.23	0.12	0.14	0.86
Bihar	0.16	0.21	0.20	0.19	0.81
Chhattisgarh	0.17	0.31	0.16	0.20	0.80
Gujarat	0.09	0.12	0.14	0.12	0.88
Haryana	0.08	0.09	0.12	0.10	0.90
Himachal Pradesh	0.03	0.05	0.03	0.04	0.96
Jammu & Kashmir	0.25	0.30	0.26	0.27	0.73
Jharkhand	0.22	0.34	0.22	0.25	0.75
Karnataka	0.23	0.31	0.23	0.25	0.75
Kerala	0.02	0.00	0.04	0.01	0.99
Madhya Pradesh	0.19	0.27	0.15	0.20	0.80
Maharashtra	0.16	0.20	0.15	0.17	0.83
Manipur	0.09	0.24	0.11	0.13	0.87
Meghalaya	0.12	0.25	0.12	0.15	0.85
Mizoram	0.10	0.11	0.13	0.11	0.89
Nagaland	0.11	0.11	0.15	0.12	0.88
Odisha	0.21	0.33	0.26	0.26	0.74
Punjab	0.08	0.07	0.18	0.10	0.90
Rajasthan	0.23	0.34	0.25	0.27	0.73
Sikkim	0.01	0.00	0.06	0.01	0.99
Tamil Nadu	0.10	0.12	0.13	0.11	0.89
Telangana	0.26	0.24	0.26	0.25	0.75
Tripura	0.08	0.09	0.09	0.09	0.91
Uttar Pradesh	0.21	0.29	0.21	0.23	0.77
Uttrakhand	0.05	0.06	0.07	0.06	0.94
West Bengal	0.15	0.16	0.16	0.16	0.84

Source: Authors' own calculations

Figure 11: Geographical Equality Dimension Index



Source: Authors' own presentation using QGIS software

3.4.4. Final Sanitation Performance Index:

(Table 4) shows the final scores of dimension indices. The ranking according to the index values has been presented in the next (Table 5). Results find that Sikkim is the top performing state in India in terms of SPI, followed by Kerala and Himachal Pradesh while bottom three performers are Bihar, Jharkhand and Andhra Pradesh. The thematic map corresponding to each dimension index value as well as combined final sanitation performance index has been presented for better understanding of state wise performance in case of each indicator along with the overall performance.

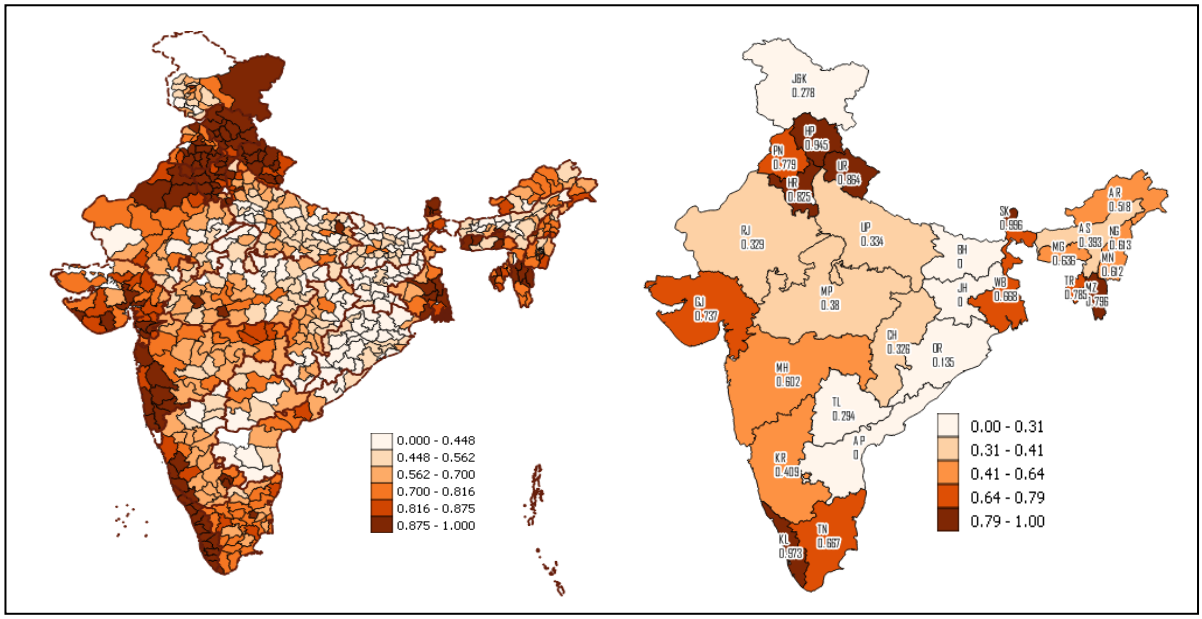
Table 4: Dimension Index value across the states of India

State	*Efficiency Index*	*Equity Index*	*Equity Index*
Andhra Pradesh	0.11	0.82	0.00
Arunachal Pradesh	0.51	0.53	0.51
Assam	0.40	0.26	0.59
Bihar	0.00	0.73	0.42
Chhattisgarh	0.30	0.30	0.39
Gujarat	0.67	0.90	0.67
Haryana	0.80	0.96	0.73
Himachal Pradesh	0.92	0.99	0.92
Jammu & Kashmir	0.15	0.79	0.18
Jharkhand	0.15	0.00	0.23
Karnataka	0.41	0.72	0.23
Kerala	0.95	0.98	0.99
Madhya Pradesh	0.23	0.59	0.40
Maharashtra	0.48	0.91	0.50
Manipur	0.68	0.55	0.62
Meghalaya	0.68	0.69	0.55
Mizoram	0.80	0.93	0.68
Nagaland	0.50	0.71	0.65
Odisha	0.03	0.34	0.21
Punjab	0.75	0.88	0.71
Rajasthan	0.35	0.60	0.17
Sikkim	1.00	0.99	1.00
Tamil Nadu	0.51	0.86	0.67
Telangana	0.12	0.88	0.23
Tripura	0.64	1.00	0.76
Uttar Pradesh	0.24	0.54	0.29
Uttrakhand	0.77	0.97	0.86
West Bengal	0.59	0.93	0.54

Source: Authors' own calculations

(Figure 12) reveals the comparative scenario of sanitation performance across the districts and states in India for identification of better or worse performers. S.P.I provides the macro view of the state-wise performances while D.P.I serves as an instrument to detect the poor performing districts within a state as well as the country, which improves the process of monitoring and evaluation at micro level for faster attainment of desired goal. Thematic distribution of D.P.I as presented in (Figure 12) fetches out the concentration of the worse performance districts making it easier for the policy makers to initiate appropriate actions. It is quite interesting to note that some districts of good performing states are performing as bad as a district within a poor performing states and vice versa. Therefore, up gradation of one state's performance does not address the root of the crisis; to diminish the root cause of the crisis every poor performing pockets within a state should be identified and improvement in sanitation scenario should occur in a decentralised manner. For that, there is high need of more disaggregated analysis like the one presented in this paper.

Figure 12: Final District Performance Index (D.P.I) and State Performance Index (S.P.I)



Source: Authors' own presentation using QGIS software

Table 5: Ranking of states for each Dimension and Final Performance Index

State	*Geographical Equality Rank*	*Economic Equity Rank*	*Efficiency Rank*	*Rank Final*
Sikkim	**1**	3	1	1
Kerala	2	4	2	2
Himachal Pradesh	**3**	2	3	3
Uttrakhand	4	5	6	4
Haryana	6	6	4	5
Mizoram	8	8	5	6
Tripura	5	1	11	7
Punjab	7	11	7	8
Gujarat	10	10	10	9
West Bengal	15	7	12	10
Tamil Nadu	9	13	13	11
Meghalaya	14	19	8	12
Nagaland	11	18	15	13
Manipur	12	22	9	14
Maharashtra	17	9	16	15
Arunachal Pradesh	16	24	14	16
Karnataka	23	17	17	17
Assam	13	27	18	18
Madhya Pradesh	19	21	22	19
Uttar Pradesh	21	23	21	20
Rajasthan	27	20	19	21
Chhattisgarh	20	26	20	22
Telengana	22	12	25	23
Jammu & Kashmir	26	15	23	24
Odisha	25	25	27	25
Andhra Pradesh	28	14	26	26
Jharkhand	24	28	24	27
Bihar	18	16	28	28

Source: Authors' own calculations

4. Discussion:

The report of UNC (2015) (Ryan Cronk, 2015) for the first time attempted to look at the WASH performance index across the countries holistically going beyond just access to sanitation and improved drinking water facilities. It considers both the dimensions of access and equity performances of each country in terms of the above mentioned dimensions. This report found gradual decline in India's relative position, though the country witnessed a big push in finance of sanitation coverage following SBM in 2014. Given this contrary results, it was crucial to locate the sub-regional characteristics of the performance, given the sheer size and diversity of the country. The construction of similar index for only sanitation considers access, economic equity and spatial equality among federal states and districts is thus crucial to identify the divergence in performance, following the difference of governance capabilities. This paper identifies this need across the regions in this vast country.

Initial exploration of data suggests that though there seems to be pumping in substantial funds in sanitation sector in recent years, the states with the poorest infrastructure facilities actually could not catch up in construction of toilets to converge. Rather, there seems to be a diverging trend as states with already existing better infrastructure could bridge the gap from full coverage far more efficiently. This result actually brings forth serious governance issues for the central government. The lagging states should have received more funds and attention, as per the logic of vertical equity, which remained a far cry.

In terms of sanitation performance index, the top performer is Sikkim, followed by Kerala. The ranking actually shows that the smaller states perform better not only in spatial equality index, but also in efficiency index. Among the larger states, better performance is recorded in Gujarat and West Bengal. Spatial equality among larger states is better in Tamil Nadu. Though Sikkim tops the performance in both efficiency and spatial performance, the economic inequality is higher in the state compared to Tripura and Himachal Pradesh. The worst performing states are Bihar, Jharkhand, Andhra Pradesh and Odisha. Bihar posits better economic equity and spatial equality, while worst in efficiency; thus indicating a homogenously bad performance across districts of the state. Opposite is the case for Andhra Pradesh.

The issue of optimum use of funds, especially the IEC expenditures, needs to be analysed at further details. Focus Group Discussions with the PRIs and local bodies identify that at GP level, people hardly know about the strategies to use IEC rightly. These

expenditures are targeted towards demand generations and hence need prudence use. The manpower under cadres for GP based '*nirmal doot*' or village motivators are hardly available. Block level members design the IEC materials, often lacking basic skills.

This actually gets carried on in rural areas of almost all low-sanitation coverage states, as BPL households tend to construct toilet or IHHL far higher in share than compared to APL households, which actually contradicts the general notion that non-poor people demand toilets (presumably a non-inferior good) more than the poor. The existing difference in subsidy policies for APL and BPL category under sanitation programme is actually favouring one group i.e. BPL via scheme of incentive while the other group is not able to cope up with the performance due to underutilization of IEC funds. Thus, as India escalates along the ladder of development, sanitation performance suffers from a reversed economic inequity.

5. ***Conclusion:***

Wrapping up the conclusions related to main findings of the study, the paper hopes to contribute to the existing list of literature by creating a new concept of sanitation performance index, which can invoke new thoughts and insights in the field of sanitation policy in India. The most important contribution that the paper attempts to make in the existing literature is measuring regional efficiency analysis in response to social spending in sanitation programme. This clearly identifies the best-in-class performers. The study also makes an attempt to investigate on existing inequity and inequality issues in sanitation access within and across regions of the country. All the way through, the study has followed a top down approach and applied the strategy of micro-foundation of macro analysis. However, further analysis to identify the environmental factors lying outside the control of district authorities which determine the sanitation performance must be attempted in future research.

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