Chapter

Does Smart City Development Promote Urbanization in India?

Sabyasachi Tripathi

Abstract

The recent explosion of urbanization is mainly driven by the developing countries in the world. Therefore, urban planners in less developed countries face huge pressure to create planned urbanization which includes the higher provision of infrastructure and basic public services. The part of this planned urbanization 'smart city' development is one of the important initiatives taken by many countries and India is one of them. In terms of the size of the urban population through India ranked the second position in the world but in terms of the percentage of the urban population, it ranks very low. Therefore, to promote the urbanization Government of India (GoI) has taken 'Smart Cities Mission' initiatives for 100 cities in 2015. In this context, the present chapter quantitatively assesses the impact of smart city development on the urbanization in India. Urbanization is measured by the size, density, and growth rate of the population of the smart cities. On the other hand, we use factor analysis to create infrastructure index by considering city level total road length, number of latrines, water supply capacities, number of electricity connections, hospitals, schools, colleges, universities, banks, and credit societies. OLS regression analysis suggests that infrastructure has a strong positive effect on urbanization. Therefore, the smart city mission is very much essential for the promotion of urbanization in India. Finally, we suggest that we need to have more smart cities in the future so that a higher rate of urbanization promotes higher and sustainable economic growth.

Keywords: urbanization, infrastructure, smart city mission, India

1. Introduction

The United Nations World Urbanization Prospects shows that in 2017, 4.1 billion people were living in urban areas. This indicates that more than half the world population (55%) lived in urban areas. In this context, India's urbanization is much slower than many developing countries and even its peers such as China, Brazil, and Russia. The latest Census data shows that the percentage of India's urbanization was 31.15% in 2011. On the other hand, China (or Brazil or Russia) has experienced about 49.2% (or 84.3% or 73.7%) urbanization rate in 2010. The reluctant urbanization in India can be because of a lack of governmental supportive policies or challenges in managing the urban dynamics [1]. On the other hand, China's urban policies are focused on integrated urban and rural development, the creation of city clusters to spread the benefits of urbanization, and the promotion of sustainable urban development. Though China's urbanization is more policy-induced, India's urbanization is more market-determined. Therefore, appropriate urban policies in India are required for proper design and implementation.

No country has ever reached middle-income status without a significant increase in urbanization [2]. Urbanization has contributed not only to higher income but also it has improved people's lives [3, 4]. Therefore, the promotion of urbanization is very important for many developing countries such as India. Currently, India is facing numerous challenges as a result of enormous urban dwellers. India has now two challenges; first, it has to speed up the urbanization rate, and secondly, it has to make proper or planned urbanization so that the maximum benefits of urbanization are achievable. Urbanization use resources such as excess labor and land more productively and becomes the engine of economic growth.

To achieve planned urbanization for higher and sustainable economic growth Government of India (GoI) has taken Smart Cities Mission initiatives. In June 2015, the Ministry of Urban Development (MoUD) released a mission statement and guidelines for the Smart Cities Mission. This program replaced the previous major central government's flagship program Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and wanted to move India's cities forward under Prime Minister Narendra Modi's leadership. Under the guidelines, several strategies are sketched by which an applicant entity can apply to achieve smart city designation [5].

Though there is no universally accepted definition of 'smart city', India's smart city development mission is meant to invest more on the core infrastructure elements such as water, electricity, sanitation, solid waste management, public transport, e-governance, etc. GoI also has proposed eight features of comprehensive development for smart cities. This includes promotion of mixed land use, housing and inclusiveness, creation of walkable localities, preservation and development of open spaces, promotion a variety of transport options, making governance citizen-friendly and cost effective, giving an identity to the city, applying Smart Solutions to infrastructure and services in area-based development to make them better.

In this context, the present chapter assesses the impact of higher infrastructure availability on the population size of the smart cities in India. For the analysis, we consider only 85 smart cities in India that have populations more than 1 lakh (class I cities). The relevance for consideration of these cities that the class I cities accommodate about 70.2% of the total urban population in 2011. This indicates that India's urbanization is concentrated in and around the class I cities. Therefore, it is important to investigate whether a further increase in the infrastructure of class I cities escalate population or not. It is very important to increase urbanization in India as it is having a slower rate of urbanization.

2. Review of literature

There are very few following studies which explore the impact, structure, and implementation strategies of smart cities program in India. Russell et al. [6] argued that the Smart Cities Mission marks a continued shift for urban development policy in India away from direct government intervention. They argued that the cities nominated for the Smart Cities Mission have adequate levels of public services, a lower percentage of slums, and are bigger. Therefore, providing basic infrastructure to these cities is against the smart city ideas and concepts.

Praharaj et al. [7] indicated that Indian cities need synergy across urban policies for better results. They also stated that smart city plans lack integration and have a conflict with statutory master plans. Praharaj et al. [8] explored the relationship between active civic engagement and the availability of basic digital infrastructure and socio-economic standards in Indian cities. They provide important lessons for building future smart and connected cities as well as promoting healthy urban relationships and welfare, in the emerging economies of the world. Aijaz and Hoelscher [9] argued that to make the 'smart city mission' more equitable and sustainable the fair engagement of citizens and all stakeholders need to involve. Praharaj and Han [10] stated that the Indian smarty city discourse predominantly corporate-driven and technology-focused. Therefore, smart cities should engage with sustainability and community issues. Randhawa and Kumar [11] argued that smart city development policies lack concerns towards the natural environment which is an important dimension of sustainable development of a city.

Rana et al. [1] found that that 'Governance' is the most significant category of barriers for smart city development followed by 'Economic; 'Technology'; 'Social'; 'Environmental' and 'Legal and Ethical' in India. Hoelscher [12] stated that the smart cities agenda in India appears to be characterized by a failure to conceptualize and develop an integrated set of policies, and while a clearer (yet contested) concept is emerging, the prospects for success are uncertain. Praharaj and Han [13] found that the vast disparities remain across India's urban centers, located in different geographical regions, in terms of access to social capital and physical infrastructure. Their analysis suggests that education, health, and social services are important drivers in the urban typology building process. The small to medium sized cities in India are missing basic community infrastructure. This implies that smart city development strategy which considers one-size-fits-all by assuming importance of foundational infrastructure has the shortcomings. Tripathi [14] argued that smart cities in India should ensure smart distribution of benefits of urban economic growth to the poorer section of urban dwellers for future development of urban India.

Adapa [15] presents a comprehensive review of the existing smart city frameworks and cleaner production initiatives in the Indian context. Aijaz [16] argued that the negative effect of India's urbanization includes informal-growth of peri-urban areas, escalating water crises, social exclusions, an extension of slums, and mismanagement of solid waste. The author argued that the success of smart city development only possible if civic institutions correctly understand the city's social, economic, and physical requirements and its diversity. At the same time, citizens should show a greater sense of civic responsibility.

The brief review of the literature mainly suggests that how smart city development initiatives can be more effective if properly implemented. In other words, what are the important dimensions of India's urbanization that have to be considered for the successful implementation of smart city development strategies which will lead to successful urban development in India? However, these studies have missed important dimensions of India's urban development policy which is how to increase the urbanization rate which is essential for economic development. Therefore, the present study attempts to fulfill this gape for better urban development in the future.

3. Empirical analysis

To estimate the impact of infrastructure on smart cities we consider the following econometric model:

$$Urbanization = \alpha_0 + \sum_{i=1}^{10} \beta_i \boldsymbol{Infrastructure}_i + e_i \tag{1}$$

where e_i represents well-behaved error term and α_0 stands as constant. Ordinary least squares (OLS) method is used to analyze the impact of infrastructure on urbanization in India. Based on Tripathi [17, 18] city population size, city population density, and city population growth rate are considered to measure the urbanization in this paper. On the other hand, city-level availability of infrastructure is measured by considering city level total road length, number of latrines, water supply capacities, number of electricity connections, hospitals, schools, colleges, universities, banks, and credit societies.

In the context of the positive impact of infrastructure on urbanization, Tiebout [19] indicated that accessibility and superiority of public facilities such as parking facilities, police protection, roads, parks, and municipal golf courses are very important for choosing a municipality. Therefore, consumer voters would migrate to a city that satisfied their demand for infrastructure. Harris and Todaro's [20] model explained that rural to urban migration depends on expected rural–urban income differential rather than rural–urban wages. This indicates that urban condition is better with higher infrastructure facilities which attract more rural people [18].

In the context of India, several studies (e.g., [21–24]) argued that India's urban areas lack adequate infrastructure which requires urgent attention. Pradhan [25] investigated the impact of infrastructure on urbanization in India, using a composite infrastructure development index based on three sub-indexes: physical infrastructure, social infrastructure, and financial infrastructure. Using multivariate principal component analysis, the study confirmed that infrastructure has a significant positive impact on urbanization in India. On the contrast, Tripathi [18] argued that the improvement of infrastructure in large cities may not increase population concentration, but it will improve the living conditions and business activities that increase economic growth potential. Based on these studies we expect a positive or negative effect of infrastructure on urbanization driven by smart city development.

Details about the variable measurement and data sources are provided in Appendix A. **Table 1** presents the summary statistics of each variable used in the analysis. The coefficient of variation (CV) measures the dispersions of data points in a data series. Log of the city population, city population density, and city-wise total number of colleges have lower values of a coefficient of variation (CV) which indicates that there are little differences in their means, implying a more symmetrical distribution. However, it is not the case for the city-wise total number of credit societies, city-wise total water supply capacity, the city-wise total number of banks, and the city-wise total number of latrines.

Table 2 shows the raw correlation of the variables. The results show that the log of the city population is positively associated with all the infrastructure variables. Most importantly, the log of city population highly correlated with city-wise road length, the city-wise total number of latrines, city-wise total number of electricity connection, and city wise total number of schools. On the other hand, the correlation between city population densities and infrastructure variables is not strong. Similar results are obtained for the correlation between city population growth rate and infrastructure variables.

We now investigate the impact of infrastructure on the urbanization. Based on Tripathi [17, 18], we consider the city population, density, and growth rate for the measurement of urbanization. We consider a total of 10 variables to measure the infrastructure and stand as interdependent variables. **Table 1** shows that there are considerable variations between the minimum and maximum values of the variables. The correlation coefficients show that data are more correlated as the values increase. Hence, factor analysis is considered to reduce the number of independent variables to obtain appropriate estimation.

Variable	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation
Log of city population (v1)	13.52	0.91	11.59	15.96	6.75
City population growth rate (v2)	19.02	22.54	−60.00	111.00	118.46
City population density (v3)	9084.07	5974.53	679	32622.00	65.77
City-wise total road length (v4)	1160.34	1536.60	9.00	11812.00	132.43
City-wise total number of latrines (v5)	198560.00	300578.80	1114	2063946.00	151.38
City wise total water supply capacity (kilo liter) (v6)	115657.90	231942.40	0.00	1200000.00	200.54
City wise total number of electricity connection (v7)	330136.00	449066.80	25500.00	2700000.00	136.02
City-wise total number of hospital (v8)	198.67	310.98	5.00	1706.00	156.53
City-wise total number of schools (v9)	859.68	1174.64	9.00	8397.00	136.64
City-wise total number of colleges (v10)	67.98	75.29	1.00	532.00	110.76
City-wise total number of universities (v11)	2.18	3.10	0.00	18.00	142.35
City-wise total number of banks (v12)	185.51	366.68	2.00	2247.00	197.66
City-wise total number of credit societies (v13)	272.95	806.75	0.00	5193.00	295.56

Note: calculations are based on 85 observations. Source: Author.

Table 1.
Description of data used for the analysis.

To ensure the validity of data, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity are used. The KMO test is performed by using STATA version 14.1. The estimated results in **Table 3** show that factor analysis is highly recommended as the KMO value is 0.851. The probability of Bartlett's test of Sphericity is very significant ($0.000 < 0.01$). Thus, factor analysis is desirable.

The initial eigenvalues (i.e., a variance of the factor) are presented in **Table 4**. The most variance is presented by the first factor, the next maximum amount of variance is considered by the second factor, and so on. The negative eigenvalues indicate that the matrix is not full rank suggesting six factors for the analysis can be considered at most. On the other hand, the KMO criterion recommends that factors with Eigenvalues ≥ 1 should be considered for the analyses. Therefore, the only first factor is relevant for the study that accounts for about 86% of the variance in the solution.

The factor loadings (pattern matrix) according to the uniqueness i.e., a variance is exclusive to the variable and not contributed by other variables is presented in **Table 5**. The bigger values of uniqueness indicate that variables are not properly explained by the factors. For instance, 93.3% of the variance in 'total credit society'

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1	1.00												
V2	0.13	1.00											
V3	0.23	−0.11	1.00										
V4	0.68	−0.09	0.16	1.00									
V5	0.70	0.04	0.22	0.80	1.00								
V6	0.42	0.04	−0.04	0.44	0.51	1.00							
V7	0.75	0.05	0.27	0.81	0.91	0.41	1.00						
V8	0.38	−0.12	0.08	0.35	0.24	0.37	0.30	1.00					
V9	0.68	−0.04	0.17	0.87	0.81	0.43	0.82	0.25	1.00				
V10	0.64	0.01	−0.05	0.78	0.67	0.53	0.63	0.34	0.82	1.00			
V11	0.56	0.04	0.10	0.55	0.69	0.35	0.68	0.37	0.68	0.56	1.00		
V12	0.59	−0.04	0.27	0.69	0.79	0.32	0.81	0.13	0.71	0.53	0.52	1.00	
V13	0.32	0.04	0.05	0.23	0.20	−0.02	0.23	0.04	0.25	0.31	0.18	0.25	1.00

*Note: see **Table 1** for variable definitions. The calculation is based on 85 observations. Source: Author.*

Table 2.
Correlation coefficient of the variables used for the analysis.

KMO measure of sampling adequacy		0.851
Bartlett's test of sphericity	Approximate chi-square	707.040
	Df	45
	Sig.	0.000

KMO, Kaiser-Meyer-Olkin. Source: Author's calculation.

Table 3.
KMO and Bartlett's test.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	5.61362	5.01985	0.8569	0.8569
Factor2	0.59377	0.23801	0.0906	0.9475
Factor3	0.35576	0.14509	0.0543	1.0019
Factor4	0.21067	0.11021	0.0322	1.034
Factor5	0.10046	0.03567	0.0153	1.0493
Factor6	0.0648	0.09602	0.0099	1.0592
Factor7	−0.03122	0.03265	−0.0048	1.0545
Factor8	−0.06387	0.06123	−0.0097	1.0447
Factor9	−0.1251	0.04279	−0.0191	1.0256
Factor10	−0.16789	.	−0.0256	1

Source: Author's calculation.

Table 4.
Explanation of total variance.

Variable	Factor1	Uniqueness
Total road length	0.8937	0.2013
Total number of latrines	0.9241	0.146
Total water supply	0.5232	0.7263
Total number of electricity connections	0.9179	0.1575
Total number of schools	0.923	0.1481
Total number of hospital	0.3619	0.869
Total number of colleges	0.8166	0.3332
Total number of universities	0.721	0.4802
Total number of banks	0.7801	0.3914
Total number of credit societies	0.2583	0.9333

Source: Author's calculation.

Table 5.
Factor loadings (pattern matrix) and unique variances for one factor model.

is not contributed by the other variables in the overall factor model. On the contrary, the 'total number of latrines' that has very low variance (14.6%) is not shared by other variables. As the values of factor loading for approximately all variables are higher (>0.3), we can conclude that factor 1 is defined by all six variables that are considered to produce an infrastructure index. Quite importantly, factor1 is mostly related to the city-wise number of electricity connections and city-wise number of latrines. It is also important to note that as we are using one factor only, factor rotation which helps to see the underlying dimensions (scales) more clearly is not suitable as there's nothing to rotate.

The linear regression analysis is used to investigate the impact of infrastructure on urbanization in India. **Table 6** presents the results of the regression analysis. The factor score values for the one selected factor is considered as the independent variable. Regression models 1–5 present the estimated results for three dependents variables i.e., size, growth, and density of city populations. To control the heteroscedasticity problem we estimate the robust standard errors.

Regression 1 shows that the infrastructure index has a positive and statistically significant effect on the smart city population in 2011. A 10% increase in infrastructure index increases the smart city population by 7.1%. This indicates that higher infrastructure investment increases the population of smart cities. On the other hand, a higher level of infrastructure also increases the population density of the smart cities in regression 4. The coefficient 0.123 indicates that a 10% increase in infrastructure index increases smart city density by 1.2%. However, infrastructure may not increase the growth rate of the city population as it has a statistically insignificant effect on it in regression 5. This is quite evident as most of the large cities considered for smart city development experienced a negative growth rate. For example, Thiruvananthapuram experienced a 14% negative population growth rate from the period of 2001 to 2011. Therefore, smart city development does not increase the population growth rate of smart cities.

To estimate the robustness of the results we consider smart city population data for 2020 and 2025 from World Urbanization Prospects (WUP): The 2018 Revision [26]. The WUP provides a data population of urban agglomerations with 300,000 inhabitants or more in 2018. On the other hand, though 11% of the total proposed work under the smart city mission completed in 2019, still we have to wait for 2021 (i.e., next Census data) for the evaluation of the impact of infrastructure on the population of smart cities. As some of the smart cities that are considered for our survey have a population less than 3 lakh we could collect data only 77 smart cities. The regression results 2 and 3 show that available

	Dependent variable				
	Log of city population 2011	**Log of city population 2020**	**Log of city population 2025**	**Log of city population density 2011**	**Log of city population growth rate 2011**
	(1)	(2)	(3)	(4)	(5)
Infrastructure index	0.711*** (0.165)	0.628*** (0.147)	0.632*** (0.145)	0.123* (0.074)	0.218 (0.183)
Constant	13.516*** (0.064)	7.142*** (0.079)	7.256*** (0.079)	8.961*** (0.065)	2.987*** (0.096)
F Statistics	18.44***	18.33***	18.95***	2.80*	1.42
R^2	0.5886	0.4656	0.4648	0.0415	0.0343
Observations	85	77	77	83	67

Robust standard errors in parentheses. Source: Estimated using Eq. (1).
$^{*}p < 0.1$.
$^{***}p < 0.01$.

Table 6.
Results of regression analysis.

infrastructure in 2011 has a positive and statistically significant effect on the log of the smart city population in 2020 and 2025. This indicates that infrastructure has a big role in the promotion of urbanization in India and smart city mission is very important for that.

4. Conclusions

The present chapter assesses the impact of infrastructure on the urbanization by smart cities in India. Smart city urbanization is measured by population, density, and growth rate of the population of the 85 smart cities in India. On the other hand, smart city-wise availability of infrastructure is measured by the considering city level total road length, number of latrines, water supply capacities, number of electricity connections, hospitals, schools, colleges, universities, banks, and credit societies.

The factor analysis is used to create an infrastructure index by considering all the infrastructure variables. The OLS regression analysis is used to measure the impact of infrastructure on urbanization. The OLS regression results suggest that the availability of infrastructure has a positive and statistically significant effect on the urbanization measured by the smart city population and densities of the smart city population. This indicates that the smart city mission promotes India's urbanization.

India's cities and towns are having a serious lack of adequate infrastructure facilities. The Report on Indian Urban Infrastructure and Services [21] urged that urban India severely faces deficiency in the provision of urban public services such as street lights, solid waste management, roads, sewerage, and drinking water. The report estimated that Rs 39.2 lakh crores at 2009–10 prices are required over a 20-year period to achieve this growth. The outlay on urban roads accounts for Rs 17.3 lakh crore (or 44%) of this amount. In this perspective, the smart cities mission is appropriate for the promotion of urbanization in India by huge investment in infrastructure. It is very much important to indicate that India had a total of 7935 cities and towns in 2011. Therefore, smart cities initiatives only for 100 cities may not fulfill the urbanization dream for India. In the coming years, India should have more smart cities to explore the benefits of urbanization for higher economic growth.

Appendix A: Measurement of variables and data sources

City population, density and growth: City population data is collected from Census of India, 2011. Website: https://www.census2011.co.in/urbanagglomeration.php

Total road length: Both Kachcha road length and Pucca road length are considered for the measurement of total road length of a city. Source: Town amenities, District Census Hand Book, Census of India 2011. Website: http://censusindia.gov.in/2011census/dchb/DCHB.

Number of Latrines: Total number of pit, flush/pour, services, and other latrines. Source: Town amenities, District Census Hand Book, Census of India 2011.

Total water supply: Total protected water supply in city. Source: Town amenities, District Census Hand Book, Census of India 2011.

Electricity connection: Total number of electricity connections in domestic, industrial, commercial, road lighting, electricity, and other connections. Source: Town amenities, District Census Hand Book, Census of India 2011.

Total hospitals: It includes allopathic hospitals, alternative medicine hospitals, dispensary/health Centers, family welfare centers, maternity and child welfare centers, maternity homes, TB hospitals/ clinic, and nursing homes Source: Town amenities, District Census Hand Book, Census of India 2011.

Total number of schools, colleges, and universities: It includes all the private and governments' school, colleges and universities of a city. Source: Town amenities, District Census Hand Book, Census of India 2011.

Total number of banks: It includes nationalized banks, private commercial banks, and cooperative banks.

Total number of credit societies: Total number agricultural and non-agricultural credit societies.

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