Smart Cities in India: Existing Facilities and Indicators of Development

ARUP MITRA
Professor, Institute of Economic Growth, University of Delhi, Delhi

JAY PRAKASH NAGAR
Research Associate, Centre for Advanced Financial Research and Learning, Reserve Bank of India, Mumbai

ABSTRACT

The paper examines the quality of life in smart cities versus all cities and towns in India. This is pursued based on a number of indicators including housing characteristics, access to basic amenities and assets, which when combined are termed as deprivation index. This is then examined in relation to certain indicators of development. Though within the group of the smart cities the deprivation index does not indicate wide variation compared to all urban centres, the objective of inclusive urbanisation does not seem to have been achieved significantly. However, the other programmes (e.g., AMRUT) available to larger number of cities are expected to mitigate inequity issues. On the positive side, the smart cities programme is one of the pioneering attempts of the government to recognise the economic efficiency of large cities. After all it is equally important to create and showcase space which is of international standard and can attract both domestic and foreign investment to enhance growth.

Keywords: Housing Characteristics, Urbanization, Smart Cities, Economic Efficiency, Deprivation Index

Introduction

Investment, particularly from foreign countries is, in fact, quite limited to the urban space in India. The relationship between urban and industry is rather weak except in a few regions. In what way India's urbanisation can be made the centres of economic growth and employment generation is one of the key questions that the country must address. Keeping in view the inclusiveness of growth, it is pertinent that urbanisation is able to contribute significantly to poverty reduction by creating livelihood opportunities, allowing rural migrants to move in and facilitating the transfer of workers from agriculture to non-agricultural activities. The Indian government has initiated certain programmes which aim at developing few new urban space so that new investment can flow in. In the backdrop of this initiative, the present paper aims at examining the smart cities (identified by the government of India) in terms of quality of life based on housing characteristics, access to basic amenities, the level of assets that the households have and other broad indicators of development.

Even with a low level of urbanisation (as mentioned in the next section), Indian cities still remain the major hub of production. Mitra and Mehta (2011) estimated that the cities contribute more than 76 percent of GDP, using various approaches. A large strand of urban economic literature has emphasized the role of cities as engine of growth, a detailed discussion of which can be found in studies by Becker and Morrison (1999), Montogomery M.R. Stren R, Cohen, B., & Reed, H.E. (2013) and Glaeser (2011).

Given this background, the present government reiterates on industry-led growth because compared to services-led growth this approach is expected to be more inclusive. However, the urban space must be developed adhering to international quality so that new investment can flow in, resulting in higher levels of employment. The smart city programme in this context offers a new policy vision though it requires a thorough evaluation, as the present study proposes to initiate.

India's Urbanisation

India's level of urbanisation measured as percentage of people living in urban areas is very low at 32 percent compared to the other developing countries. India's urbanisation level is lowest among BRICS nations (Table 1). China saw a dramatic rise in urbanization in last three decades. In China, the level of urbanisation was 2 percent and 3 percent lower than the level of urbanisation in India in 1971 and 1981 respectively. But in last few decades, massive investment in urban infrastructure followed by massive rural to urban migration flow has changed China's demographic distribution. In the last decade, India's urban population share increased from 28 percent in 2001 to 31 percent in 2011(Cencus of India, 2011) while China saw rapid rise of urban population from 37 percent to 50 percent in the same period.

Table 1: Urban population (% of total)

Country Name	India	China	South Africa	Brazil	Russian Federation	Bangladesh	Pakistan
1971	19.99	17.29	47.87	56.89	63.28	7.90	25.08
1981	23.42	20.12	48.59	66.37	70.19	15.80	28.38
1991	25.78	27.31	52.55	74.69	73.39	20.26	30.83
2001	27.92	37.09	57.37	81.55	73.35	24.10	33.45
2011	31.28	50.57	62.75	84.62	73.73	31.23	37.01

Source: United Nations Population Division. World Urbanization Prospects: 2014 Revision
Note: Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division.

The size of population living in big cities is also lowest in India compared to other developing countries. Presently population living in million plus urban agglomerations is almost half of that of China's level and the lowest among the BRICS nations (Table 2)

Table 2: Population in urban agglomerations of more than 1 million (% of total population)

Country Name	India	China	South Africa	Brazil	Russian Federation	Bangladesh	Pakistan
1971	8.26	7.82	26.53	28.09	16.40	3.98	14.47
1981	9.57	8.30	26.04	33.77	17.81	6.68	16.54
1991	10.91	10.33	26.94	35.48	18.05	9.36	16.81
2001	12.32	16.62	30.32	37.61	18.79	11.47	18.35
2011	13.83	22.12	35.23	39.06	20.53	13.34	20.88

Source: United Nations, World Urbanization Prospects
Note: Population in urban agglomerations of more than one million is the percentage of a country's population living in metropolitan areas that in 2000 had a population of more than one million people.

The definition used by India's population census office to define an urban area is the most stringent one in the world. An area is classified as urban if it satisfies all the three following criterion: i) a minimum population of 5,000; (ii) a maximum of 25 percent of the male working population employed in agriculture, the rest in non-agricultural activities; and (iii) population density of at least 400 per km^2. Sen (2017) argues that India is actually far more urbanized than the official measure. Most countries in the world follow only one criterion (size) or two criteria (size and density) whereas India's multiple criteria results in lower estimate. Sen (2017) argues, "when we drop one of the criterion of urban area definition, the urban proportion will increase to 40-70 percent versus the official estimate of about 32 percent and thus India is far more urbanised than official estimate suggests."

While India's urbanisation rate remains sluggish compared to other developing countries, the recent trends show some changes. Using the population census data from 1961 to 2011, Bhagat 2011 showed that "the declining trend in the urban population growth rate observed during the 1980s and 1990s was reversed at the national level, and the level of urbanization increased faster during 2001-2011." During 2001 to 2011 for the first time since independence the absolute increase in urban population has been greater than the increase in rural population.

As the McKinsey report (2010) argues, "it took India nearly 40 years (1971 to 2008) to increase the urban population by 230 million but Indian urban population will increase by 250 million in half of that time." India's rural to urban migration was low but it is expected to pick up given the low profitability and overdependence on agriculture. In a survey conducted by Lokniti and CSDS in 2013-14 in 18 states, around 59.8 percent of farmers reported that they wanted their children to settle down in cities. In the survey, 15.1 percent farmers listed employment, 22.3 percent listed education, and 16.6 percent listed better life as main reason for this. Only 19 percent farmers preferred village life than the city life.

Another major feature of India's urbanisation is the growing number of census towns (a settlement which conforms to urban definition but falls under rural governance). The number of such census towns increased from 1,362 in 2001 to 3,894 in 2011. This reclassification delays of government to recognise the census towns as urban settlements highlights the *rising hidden urbanisation in India*[1].

The government has fundamental policy challenges ahead to prepare Indian cities for future as growth and investment centres with international standards. India will need massive amount of infrastructure investment. McKinsey Global Institute report on Indian Urbanisation (2009) estimated that India will require around 1.2 trillion in capital expenditure in next 20 years. HPEC-2011 (High Powered expert committee) headed by Ahluwalia reported that the required investment for the eight sectors of core urban infrastructure for the 20-year period from 2012 to 2031 amounts to Rs 31 lakh crore at 2009-10 prices.

Following on the election campaign promise Prime Minister Modi announced smart city mission in 2015. Under this programme 100 smart cities were to be created with total investment of INR 48,000 crore ($7.2 billion), and 500 crore in each city during the period between 2014-2015 to 2019-2020. The present government discontinued JNNURM (Jawaharlal Nehru National Urban Renewal Mission)

[1] *Mukhopadhyay et all 2016 for detailed discussion*

arguably the first major urban development plan started by UPA-I in 2005. The present government started AMRUT (Atal Mission for Rejuvenation and Urban Transformation) and HRIDAY (Heritage City Development and Augmentation Yojana) which have similar overall purpose of boosting urban infrastructure. It also increased the coverage of scheme from 67 cities in JNNURM to 500 under AMRUT cities; and HRIDAY covers 12 heritage cities. "Smart City mission", a flagship scheme of Modi government can be a game changer for India's urbanisation story.

Smart Cities in India

Despite the growing interest of public policy makers, private sector, urban developer and other stakeholders in smart city project, there is no consensus on what makes a city smart. Different economic, demographic and geographical conditions make it difficult to arrive at a single definition but a central characteristic of smart city movement is pervasive use of ICTs (Information and Communications Technology) technology to improve the efficiency and quality of urban infrastructure.

US based Smart Cities Council defines a smart city as one that has digital technology embedded across all city functions. Burte (2014) defined smart city as a system which "leverage various computational, networking, self-regulational, and responsive capacities that ICTs can embed into administrative and infrastructural systems (like transport, power and water supply, for instance) and enable more effective, efficient, responsive and resilient management of city amenities". The core of smart city idea is the ICTs' enabled network infrastructure which involves the use of a wide range of infrastructures including transport, business services, governance, housing and a range of public and private services amenities (see Graham and Marvin, 2001; Komninos, 2002, Hollands 2008, 2013).

Söderström et al (2014) studied the evolution of the term "smart cities" in public discourse. They identified that cities are labelled as 'smart' "when they introduced functioning ICT infrastructure, e-governance, or attracted high-tech industries to foster economic growth". They also argue that smart cities discourse has been high-jacked by tech firms like IBM (Trademarks "Smarter cities" also belongs to IBM) and there is need to make the smart cities discourse more broad based and include "initiatives where technology is used to empower community networks, to monitor equal access to urban infrastructures or scale up new forms of sustainable living. However, contrary to corporate storytelling, no straightforward narrative about the smart city emerges from these initiatives as they can be driven by very different and politically variegated motives" (Söderström et al, 2014).

However, only ICT based solution will not be able to meet the desired improvement in urban life. Other institutional changes like investment in human capital will also be required to make cities and citizens smart (Neirottiet al2014)[2]. The importance of other factors is highlighted in Caragliu, A., Del Bo, C., & Nijkamp P (2011), they used European data to show that the presence of a *"creative class, the quality of and dedicated attention to the urban environment, the level of education, multimodal accessibility, and the use of ICTs for public administration are all positively correlated with urban wealth".*

[2]*Neirotti et al (2014) which provides an excellent literature review of various aspects of smart city notions using the elaboration of a taxonomy of pertinent application domains such as natural resources and energy, transport and mobility, buildings, living, government, and economy and people. See Caragliu et al (2009) for discussion of smart city definition.*

The Smart Cities initiative of the present government aims at creating cities with basic infrastructure built on a sustainable model. With assured water and electricity supply, sanitation and solid waste management, urban mobility and efficient public transport, IT connectivity, e-governance and citizen participation and the safety and security of citizens investment is expected to go up resulting in productivity induced higher rates of economic growth. One hundred cities and towns[3] have been selected by the Ministry of Urban Development with at least one city from each state. The Smart Cities Council India has been formed which is a part of the US-based Smart Cities Council, operating in 140 countries.

Some common features to identify smart city and those which appear in the smart city document (of the urban ministry) are the state of art infrastructure, parks, playgrounds, and recreational spaces, inclusive and housing for all, smart public transport and last mile transport connectivity, walk able localities, using new technological innovation to make governance citizen friendly and cost effective, using IT to bring transparency and accountability, using machine learning and AI to make city transportation, security and other services more efficient.

Under the smart city initiative the government is investing in pan city infrastructure to improve the quality of urban life and also to develop city amenities through one of the following strategies: A) Retrofitting: Implementing the ICT based smart infrastructure solution to already built-in area of city; B) Redevelopment: replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure in city; C) Greenfield: Building smart infrastructure in previously vacant area of city.

In the present paper, we propose to construct the deprivation index corresponding to each of the 100 smart cities and then examine its relationship with respect to other demographic and economic variables. The proposed index is multi-dimensional in nature, which includes a wide range of characteristics (see Mitra and Nagar, 2018). . This enables us to assess the quality of infrastructure existing within the cities. By reflecting on the housing characteristics, access to basic amenities of the households and the asset base of the residents we are able to develop a broad idea of the quality of urban space both from demand and supply point of view. To what extent the local government is able to provide for and what is the quality of life that the existing residents are able to create for themselves can unfold a broad overview of the urban space which has been selected for further improvement and attract both domestic and foreign investment (Mitra and Nagar, 2018). The database is drawn primarily from population census, 2011.

As we consider a number of heterogeneous characteristics to form the deprivation index, it becomes a major problem to combine them logically. From this point of view, factor analysis is considered to be relatively better because it does not assume assignment of subjective weights to different variables used for constructing deprivation index. The factor loadings are picked up as weights.

[3] *In our analysis New Town Kolkata and Bidhannagar are taken as part of Kolkata UA; Navi Mumbai, Thane, Greater Mumbai and Kalyan, Dombivali are part of Mumbai UA; and Gandhi Nagar and Ahmadabad are part of Ahmadabad UA. In total, we have 95 smart cities (urban agglomeration).*

In the next step, we try to assess the relationship between the index and other demographic, social and economic variables, representing the overall development dynamics of the selected cities under the smart city project. In what way such relationships are different in smart cities from the remaining urban agglomerations is a key question. This exercise again takes recourse to factor analysis because regression exercise assumes a cause-effect association whereas this multivariate technique includes a number of variables and multi-directional association among them.

4. Construction of Deprivation Index

The deprivation index for each of the smart cities is constructed based on the variables, which cover, dwelling conditions, access to basic amenities and certain assets, which are important for wellbeing, awareness and mobility in the labour market (see Mitra and Nagar, 2018). The methodological details relating to the construction of the index and the justification for using the variables to reflect on well-being (or deprivation) are given by Mitra and Nagar (2018). Whether these special units selected by the government are already developed or are at the initial stages of development or are at the mid-way is a critical question. If they are already developed, the cost of investment to make them attractive enough for investment to flow in may be far less compared to a situation when the selected lot are just transiting at the initial stages of urban transformation.

As mentioned above, using the factor loadings the index has been formed at the city/town level. Since there are two factors which are statistically significant two sets of indices have been generated and both have been combined using the Eigen value of each of the significant factors as weight. Factors 1 and 2 are said to be statistically significant because each of the two has an Eigen value greater than 1. Given below is the analysis of the deprivation index for the smart cities only. Higher is the index value higher is the deprivation. Since the factor loadings do not add up to unity, the index value does not necessarily range between zero and unity.

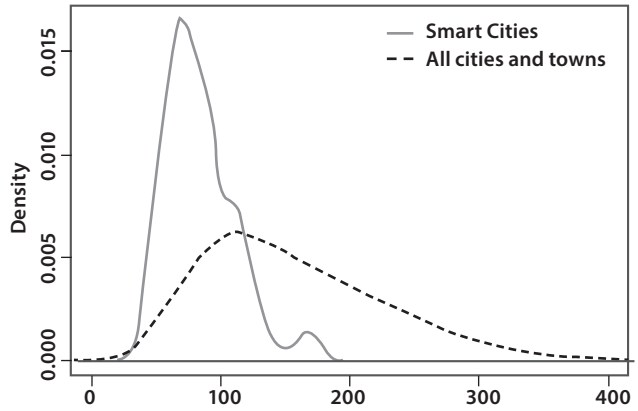
First of all more than half of the proposed smart cities are very large: either million plus or each with a population of 500,000 and above but less than one million (Table 3). Another group of 28 cities are in the size class of one to five hundred thousand population. Besides, around five are in the close proximity of some of the large cities, forming part of the urban agglomerations. Pertaining to the deprivation index value of the smart cities the following results can be discerned: the smart cities to begin with are mostly large in size; hence, their index values are low in magnitude, which conforms to the inverse pattern between size and index as observed in the context of all urban centres (Mitra and Nagar, 2018). However, what is interesting to note is that even the small towns which belong to this group of proposed smart cities do not have a high index value (see figure 1). Usually the large cities are seen to have benefitted from the past investment and hence, the agglomeration economies are said to have made them large. The small towns in the list of proposed smart cities may have been chosen in such a manner that they have already benefitted from the past investment to some extent. But the worry is why more such urban centres were not selected instead of a few.

Table 3: Number of Smart Cities by Deprivation Index and Population Size

Index Range	Population Size of Smart Cities					
	Million Plus	5-10 lakh	5-1 lakh	50,000-1lakh	50000-10000	<10000
0-100	34	16	16	2	4	0
100-125	3	7	6	–	0	–
125-150	0	–	3	–	1	–
150-200	0	–	3	–	–	–
200-250	0	–	–	–	–	–
250-300	0	–	–	–	–	–
>300	0	–	–	–	–	–
Total Number of Cities (Col. Total)	37	23	28	2	5	0

The probability density plot of the index in Figure 1 indicates that the range of variation for smart cities is much narrower compared to all cities and towns. Secondly the average value is much higher than the corresponding figure for all cities and towns. Thirdly, the smart cities by and large follow a normal distribution with short tails on both sides while all cities and towns correspond to log normal kind of a distribution with a very long right hand tail. This implies that among smart cities almost equal number have very high and low index values though the difference between these values is not much as mentioned above. Besides, a very large percentage of smart cities concentrate around the average value, unfolding lower level of inequality across smart cities in terms of deprivation index. Also, the percentage of smart cities corresponding to their average value is much higher than the percentage of all urban centres concentrating around a modal value. The average value of the index for the smart cities is slightly lower than the modal value of all the urban centres, indicating relatively less deprivation in the smart cities. Besides, among all the urban centres the inequality as seen in terms of index value and the number of cities and towns, is highly evident. While a cluster of urban centres can be seen around a lower value of the deprivation index there are other cities and towns with much higher values of the index and the extreme values tend to vary widely in relation to the modal value.

Figure1: Smart Cities vs allCities and Towns: Probability Density Plot of City Deprivation Index



In the next step we have tried to assess the relationship of the deprivation index with other socio-economic and demographic variables. This is done for three sets of cities: all class 1 cities (each with a population of 100,000 and above), million plus cities and the smart cities. From the factor analysis results carried out for the smart cities we note a number of counter-intuitive results (Table 4: last three columns). First of all, in factor 1 city size and deprivation index are positively associated, not so strongly though. Literacy tends to decline while fertility increases with city size. Female to male ratio among the workers and the female work participation rate correspond to the highest factor loading and both the variables, as per expectation, are positively associated with each other but they are again inversely related to the city size. Further, the male work participation rate which is taken to indicate the dynamism in the job market does not take a significant value in terms of factor loading though in the case of class 1 cities it is somewhat evident.

In the second factor, however, the city size and deprivation index move in the opposite direction. But the percentage of scheduled caste and scheduled tribe population tend to decline with city size. This result is also discernible in the case of class I cities and million plus cities but it is distinct only in factor 3 which is statistically less significant in comparison to factor 2. Smart cities are selected to serve a specific purpose, i.e., acting as growth centres. Hence, it is of interest to see whether they also tend to follow the principle of inclusive growth. Since large cities are more productive, resulting in higher growth, the negative association between size and the incidence of lower caste population (representing disadvantaged classes), suggests that the proposed smart cities are not germane to deliver inclusive growth. It would have been appropriate to take the percentage of slum population instead of the percentage of disadvantaged castes. But information on slum population for each of the smart cities is not available, for which we have been rather compelled to consider the caste data. It has also been observed widely that much of the distress migration comprises low caste population in India (Chandrasekhar and Mitra, 2018). Other evidence also suggests that many poor households are not able to migrate to large cities (Mitra and Murayama, 2009). Further, only in factor 3 (for the smart cities) the male and female work participation rates and the percentage of work force engaged in services and non-household manufacturing are somewhat positively associated with each other though in the case of class 1 cities the pattern is decipherable in factor 2 itself. In other words, the proposed smart cities do not unravel a strong employment generating tendency.

Table 4: Factor Analysis Result for Class1, Million plus and Smart Cities

	Class I cities (466)			Million Plus (53)			Smart Cities (94)		
Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
Sex ratio of the population	0.4348	0.2258	-0.0234	0.5669	0.2953	-0.26	0.4276	0.0072	0.1757
Percentage SC/ST population: male	0.0428	0.0407	0.9962	-0.1085	-0.0052	0.9919	0.1583	0.9782	0.0956
Percentage SC/ST population: female	0.0584	0.0458	0.9946	-0.1035	0.0021	0.9909	0.1724	0.9747	0.0965
Male literacy rate	0.1515	0.8619	0.0878	0.895	0.2218	-0.079	0.2413	0.1046	0.8715
Female literacy rate	0.1507	0.8848	0.0333	0.8945	0.2634	-0.155	0.2567	0.1752	0.8551
Children up to age 6 per 1000 women	-0.2892	0.4445	-0.0553	-0.4158	-0.3815	0.1714	-0.3243	0.1709	-0.3118
Percentage main workforce: male	0.3548	0.1593	-0.0007	0.089	0.3077	-0.084	0.192	-0.2125	0.264
Percentage main workforce: female	0.9449	0.119	0.055	0.1804	0.8955	0.0319	0.9147	0.1641	0.2286
Sex ratio of the main workforce	0.9635	0.116	0.0677	0.3207	0.9295	-0.013	0.9131	0.2609	0.2017
Percentage share of non-agriculture (excluding household manufacturing) activities in total male work force	-0.0208	0.3057	0.0724	0.1707	0.0998	0.0738	0.1612	0.0546	0.3843
Per share of non-agriculture (excluding household manufacturing) activities in total female work force	-0.2661	0.3474	0.0761	0.2693	-0.3083	0.1747	-0.0961	0.1102	0.2429
Deprivation index	-0.1366	-0.2665	0.0743	0.0714	-0.3083	0.1747	-0.1272	0.112	-0.0981
Log population	0.0905	0.0827	-0.1014	0.046	0.0892	-0.177	-0.2111	-0.162	-0.0737
Eigen Value	4.2161	2.39517	1.9827	4.45	2.17	1.71	4.61599	2.4618	1.668
Percentage Explain	0.418	0.237	0.197	0.42	0.2	0.16	0.45	0.24	0.16

5. Conclusion

Smart city mission is the first holistic urbanisation programme of the Indian government with defined priorities and vision plan for each cities. Government may be lacking in giving a single definition of smart city but this also gives each city freedom to incorporate its own vision of smartness. The decentralised planning differentiated this project from other urban infrastructure development projects like JNNURM where centre and state government released fund only for pre-determined infrastructure development projects.

From one point of view the selection of the smart cities seems problematic because some of them are very large and are about to get saturated. Though one may argue that it is an attempt to take advantage of the agglomeration economies already existing in these cities, the diseconomies which may have become substantial, given the age of the cities also need to be considered. Rather some of the census towns located in the close vicinity of the large cities could have been considered in large number. Only a handful of them (five or so) which are part of city urban agglomeration appears in the list of smart cities.

The problems of very large cities have to be mitigated before making further investment, to reap new benefits. Nevertheless, for the first time it seems the government policy very explicitly has recognised the productivity augmenting effects of urbanisation, particularly the economic efficiency of the big cities. Otherwise, the major concern in the past has been for concentration, and the regional policy always argued against it. Though all the class I cities are not included in the list of smart cities the present government has introduced the programme called AMRUT which cover 500 such cities. Hence, the urban policy seems to have recognised in a balanced manner what economic theory has been arguing for a long time and on the other the equity issues.

Our results suggest that the cities under smart city project have better quality of urban infrastructure and amenities. Smart cities also show low variation in deprivation index compared to the observed variation in the deprivation index of all class I cities, indicating very similar type or quality of urban life in the selected or proposed smart cities. Since the deprivation index comprises housing characteristics, access to basic amenities and certain types of assets, they are qualified to reflect of well-being of the residents. In comparison to all urban centres the proposed list of smart cities are more uniform or homogeneous in terms of available infrastructure and quality of life irrespective of city size. Our paper, however, highlights that the proposed smart cities are not highly inclusive. Hence, the success of the project may lead to overall growth but whether it would allow migrants from low income households to enter such space and access new livelihood opportunities is a major area of concern. Since many of the public utilities will be priced in order to ensure quality, it is less likely that the objective of inclusiveness will be served by the proposed smart cities. Hopefully the other urban scheme called AMRUT will be able to address this issue effectively as the spatial ambit under this programme is much larger. Making Indian urbanisation more inclusive is definitely a major policy challenge for the present government.

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