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Assessment of social sustainable development in urban India by a composite index

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Abstract

India has experienced rapid urbanisation with the rate growing from 26 percent in the 1990–2000 decade, to 30 percent in the 2000–2010 decade putting massive pressure on basic infrastructure and services. The objective of this paper is to develop a social sustainable framework and a composite index which is tailor-made to assess the Indian cities. Since social sustainability cannot be developed in isolation this paper examines urban sustainability in an integrated manner with its four dimensions of social, economic, environmental and institutional and maps the criteria at three levels i.e. policy, theoretical, and practical levels. The three tiered hierarchical model is tested in the state of Odisha where the social sustainability can be put to test in the best context as the urbanisation is growing at a stupendous speed and the infrastructure growth does not match up. Using the framework it is possible to obtain a composite index for Urban Social Sustainability whose model can be applied to all Indian cities with contextual changes. The dimensional index score and thematic index score obtained from the model helps in benchmarking the cities and identifying gaps so that it can inform national policy and planning. The social sustainability index together with the indices on the other three dimensions would help in making well informed judgement in the allocation of resources.

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Keywords: Urban social sustainability; Composite index; Hierarchical model; Sustainability indicators; Integrated framework

1. Introduction

1.1. Background

India has experienced phenomenal growth of its cities. The rate of urbanisation has grown rapidly from 26 percent

in the 1990–2000 decade, to 30 percent in the 2000–2010 decade. Projecting this growth rate by 2030, the urban population will be 40 percent of the total projected population of 1470 million. This scale of urbanisation will put massive pressure on city's natural resources and in the provision of basic infrastructure and services.

When we look at the background of the sustainability issues we see that a lot of study has been done since 1987 with the Brundtland commission report when a number of efforts worldwide were made to construct the Sustainability development indicators but in India not a single city has registered any initiative for indicator development till

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date (Salk et al., 2008). In 1992, governments of 178 countries met at Rio de Janeiro, for UN conference of Environment and Development (also known as the Earth Summit) which was convened to address the urgent problems of environment protection and socio-economic development.

1.2. Need for forming an urban sustainability index

Considering economic growth alone, undermines the quality of life. Indicators studied over a period of time, mark the distance and direction from the target. Urban Sustainability as given by UNCSO has four components namely Economical, Environmental, Social and Institutional. The UNCSO framework for determining the Urban Sustainability is a 3 tiered hierarchical model with several themes under each dimension and each theme has several indicators under it. Indicators help in knowing the direction and distance from the target and urban sustainability index obtained by an aggregation of all the indicators shows where the link between economy, environment and society is weak. It gives a quantitative and measurable definition to the progress in urban sustainability. The quantitative values are easy to understand and grasp by policy makers.

India has developed a series of projects and programs which can be classified as important elements of National Sustainable Strategy. It however has not yet developed or published a comprehensive and consistent sustainable strategy (Von Hauff et al., 2013) The Five Year Plans provide medium-term strategies for overall development. The Ministry of Urban Development has come up with a Report on the development of Sustainable Habitat Parameters on Urban Development (Government of India, 2011).

A lot of global initiatives have been taken by World Bank, UN Habitat, Asian Development Bank etc. which measure the urban sustainability across countries. Although globalisation – in the sense of the increasing exchange of products, services and concepts – does contribute to a convergence of solutions and problems, there is also a country specific explanation for the constraints encountered in the development of implementation of a sustainable strategy in India (Von Hauff et al., 2013). Hence it is important to develop a custom made sustainability framework for India, to address the problems which are typical to India.

1.3. Benchmarking Indian cities with global cities on sustainability

Indian cities like Mumbai and New Delhi perform averagely as seen by the City Prosperity Index, a global initiative by UN Habitat, which maps 50 cities across the world on Urban Sustainability with its 5 thematic indices of Productivity, Quality of Life, Infrastructure, Equity and Environment. An excerpt of 6 cities (State of World Cities Report, 2012) classified into 3 groups based on their ranking (Refer Table 1) shows that the Indian cities perform weakly on the Economic and Environmental dimension but are quite balanced and consistent on the Social dimension (Quality of life, Equity and Infrastructure Indices) whereas the top rung cities of Vienna and Tokyo show balanced high score on all five indices with very low income inequality.

1.4. Definition of sustainable urban development

Probably the earliest and most comprehensive definition of sustainable development is given by Brundtland Commission, as “Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

‘Sustainable urban development’ (SUD) has often been used interchangeably with ‘urban sustainability’ (Richardson, 1994; Maclaren, 1996). They may be differentiated, however, because sustainability implies a desirable state or set of conditions whereas SUD implies a process by which sustainability can be attained (Maclaren, 1996). More formally, SUD has been defined as (Wheeler, 1998): “development that improves the long-term social and ecological health of cities and towns.”

Urban sustainability is defined as the challenge to “solve both the problems experienced within cities and the problems caused by cities”, recognising that cities themselves provide many potential solutions. The dimensions of Urban Sustainability are established as (Drakakis-Smith, 2000) “Sustainable urbanisation refers to the well-balanced relationship between the social, economic and environmental agents in society, so as to accomplish sustainable urban development.”

Table 1
Benchmarking Indian cities with Global cities on sustainability.

Groups	City prosperity index	Cities	Productivity index	Quality of life index	Infrastructure index	Environment index	Equity index
A	0.925	Vienna	0.939	0.882	0.996	0.932	0.883
	0.906	Tokyo	0.925	0.931	0.989	0.936	0.828
B	0.709	Mexico	0.743	0.764	0.900	0.866	0.405
	0.793	Moscow	0.806	0.813	0.960	0.908	0.550
C	0.694	Mumbai	0.645	0.739	0.745	0.632	0.715
	0.636	New Delhi	0.596	0.690	0.786	0.448	0.712

Data Source: State of World's Cities 2012–13, UN-Habitat

1.5. Research question

Since the focus of this paper is to assess the social sustainable development it is important to understand that social sustainability framework cannot be developed in isolation but has to be obtained from the comprehensive sustainability framework under the 4 dimensions of Social, Economic, Environmental and Institutional. Each of the three dimensions is a co-equal component for sustainable growth. They should not be considered in isolation and each must be integrated from the start in developing a sustainability framework (Von Hauff et al., 2013).

After developing the integrated Sustainability model, the Social dimensional model has to be developed with themes and indicators under each theme. Hence the research question is how to assess the social sustainable development by Urban India with a Composite Index (Urban Social Sustainability Index) which will inform the National Policy and Planning. The framework has to be custom-made for India to address its typical problems.

2. Methodology

The study was conducted with the following objectives:

- (a) To find out what are the drivers/themes under Urban Social Sustainability after studying the Urban Sustainability as a composite framework encompassing social, economic, environmental and institutional dimension and then focusing on the Social dimension.
- (b) To form a hierarchal framework of Urban Social Sustainability by obtaining the indicators under each of the themes derived from above by
 - i. Mapping theoretical definitions, global practices and Indian policy regulations.
 - ii. Making a gap analysis of India's performance vis-a-vis the world aggregate performance on sustainability indicators.
- (c) Benchmarking the City performance with the state's urban performance and Urban India's performance on Social sustainability and identifying the themes in which the city underperforms.

The Research methodology was:

- i. Developing a thematic comprehensive framework of Urban Sustainability with the 4 dimensions of Economic, Social, Environmental, and Institutional after mapping Policy, Global Practice and theoretical definitions.
- ii. Obtaining a theoretical model for Urban Social Sustainability with its themes and indicators under each theme.
- iii. Sampling procedure of the state and cities on which the model will be tested.

- iv. Data collection from secondary sources for the cities.
- v. Creation of a composite Urban Social Sustainability Index.
 - a. Normalisation of indicator values.
 - b. Giving weights to indicators through expert survey and confirming the results with weights obtained from factor analysis.
 - c. Linear aggregation of indicators under each theme to obtain theme index.
 - d. Obtaining the directionality of the scores.
 - e. Linear aggregation of thematic index to obtain composite dimension index value.
- vi. Testing the model through Multivariate Analysis.
- vii. Analysis of the results for problem diagnosis and improvement.

2.1. Forming a framework for urban sustainability

The four dimensions of Social, Economic, Environmental and Institutional need to be discussed in relationship with each other because there is a need for integrated sustainable development. In the absence of a National sustainable strategy, the Report of the Sub Committee on Development of Sustainable Habitat Parameters in the Field of Urban Planning by Town and Country Planning Organization, Government of India, Ministry of Urban Development (Govt of India Report, 2011), formed the basis of sustainable urban policy guidelines. The global initiatives taken for mapping were Social Progress Index (Stern et al., 2014), Global Urban Indicator database (UN-Habitat, 2000), Millennium Development Goals (UN-Habitat, 2009), City Data Book (Asian Development Bank, 2001), Global City Indicator (World Bank, 2008), FEEM Sustainability Index (Carraro et al., 2009), International Urban Sustainability Indicators List (Shen L-Y et al., 2011). In Table 2 after mapping the themes for each of the dimensions (Social, Economic, Environmental and Institutional) under global practices and India's Sustainability Strategy, the resultant framework obtained gives the common themes which can be applicable for India.

2.2. Forming a framework for urban social sustainability

To form an Urban Social Sustainability model, in Table 3, a mapping was done for each theme between theory, Policy and practice and a gap analysis was done on the resultant indicators to show the potential weak zones where India falls behind the world aggregates and hence those indicators had necessarily to be included in the model. The theoretical basis was obtained from relevant literature study. If there was mapping on three or more areas it justified the inclusion in the resultant framework. The criteria for selection of indicators were that it should follow the Bellagio practices (Hass et al., 2002) of being policy

Table 2
The Urban Sustainability Framework for India.

Themes	SPI	GUID	MDG	CDB (ADB)	Global city indicator	FEEM SI	IUSIL	Policy relevance with NSS	Common themes
<i>Social dimension</i>									
Health	✓	✓	✓	✓	✓	✓	✓	✓	✓
Access to basic needs	✓	✓		✓	✓		✓	✓	✓
Housing	✓	✓		✓	✓		✓	✓	✓
Personal safety	✓	✓		✓	✓		✓	✓	✓
Education	✓	✓	✓	✓	✓	✓	✓	✓	✓
Equity	✓	✓	✓	✓	✓		✓	✓	✓
Demography				✓		✓	✓	✓	✓
Poverty			✓	✓	✓	✓	✓	✓	✓
Culture							✓		
Recreation							✓		
Pedestrian public space							✓		
Access to credit							✓		
<i>Economic dimension</i>									
Infrastructure for economic development	✓			✓	✓	✓	✓	✓	✓
Transport efficiency		✓		✓	✓		✓	✓	✓
Income and distribution	✓	✓		✓	✓	✓	✓	✓	✓
Stability of growth							✓	✓	✓
<i>Environmental dimension</i>									
Soil pollution	✓	✓	✓	✓	✓		✓	✓	✓
Air pollution	✓		✓		✓	✓	✓	✓	✓
Water pollution	✓	✓	✓	✓	✓		✓	✓	✓
Green spaces					✓		✓	✓	✓
Energy consumption					✓	✓	✓	✓	✓
Land use patterns		✓		✓	✓		✓	✓	✓
Disaster mitigation					✓		✓		
Noise pollution							✓		
Geographically balanced settlement							✓		
Freshwater							✓		
Biodiversity							✓		
<i>Institutional dimension</i>									
Personal rights and choice	✓						✓		
Governance and participation		✓		✓	✓		✓	✓	✓
Local government		✓		✓	✓		✓	✓	✓

Source: Social Progress Index (Stern et al., 2014), Global Urban Indicator database (UN-Habitat, 2000), Millennium Development Goals (UN-Habitat, 2009), City Data Book (Asian Development Bank, 2001), Global City Indicator (World Bank, 2008), FEEM Sustainability Index (Carraro et al., 2009), International Urban Sustainability Indicators List (Shen L-Y et al., 2011), Report of the Sub Committee on Development of Sustainable Habitat Parameters MOUD (Government of India, 2011).

Table 3
The Indian Urban Social Sustainability framework – mapping practice, policy and theory.

Indicators	SPI	GU I D	MDG	C D B	Global city indicator	Policy relevance with national sustainable strategy	Theoretical base	Resultant framework	Gap analysis	
									Urban India average	Urban World average
<i>Indicators of demography</i>										
Population net density (persons/sqkm)		✓		✓		✓	✓	✓	12,100	4400
Age pyramid (dependency ratio) (percent)				✓		✓	✓	✓	55.6	54
Population growth rate (percent)				✓		✓	✓	✓	1.64	1.21
Average household size (no)				✓		✓	✓	✓	5.3	4.44
Household formation rate (percent)				✓		✓	✓	✓	46.8	26.9
Informal settlements (slum formation) (percent)				✓			✓	✓	38.1	45.4
<i>Source for theoretical base – population expansion putting pressure on infrastructure (Dixon, 2011) demographic change (Colantonio and Dixon, 2009). Source for data: UN-Habitat Report (2011), World Development Indicators (2011) and India Human Development Report (2011)</i>										
<i>Indicators of education</i>										
Adult literacy rate (percent)		✓	✓	✓		✓	✓	✓	62.8	80.9
School enrolment rate (primary) (percent)		✓	✓	✓	✓	✓	✓	✓	116.9	106.9
School enrolment rate (secondary) (percent)			✓	✓	✓	✓	✓	✓	60	68.4
School dropout rate (primary and secondary) (percent)						✓		✓	34.2	18
Access to advanced education (no)	✓			✓				✓	25	*
School children/classroom Student/teacher ratio (primary and secondary) (no)				✓	✓			✓	40.7	23.05
<i>Source for theoretical base – enrolment rate, literacy (Global City Indicators, 2008), basic education (Mahadevia, 2001) social mixing and cohesion (Colantonio and Dixon, 2009). Source for data: India Human Development Report, 2011</i>										
<i>Indicators of health</i>										
Birth rate (no per 1000)	✓			✓		✓	✓	✓	18.3	19.5
Death rate (no per 1000)	✓			✓		✓	✓	✓	5.8	7.89
Infant mortality rate (no)			✓			✓	✓	✓	50	44
Child Mortality rate (no)		✓	✓	✓	✓	✓	✓	✓	66	61
Maternal mortality ratio (no)	✓	✓	✓	✓	✓	✓	✓	✓	254	273
Family planning rate (percent)			✓	✓		✓	✓	✓	46	61
Male female ratio at birth (males per 100 females)						✓		✓	108.5	108.5
No of persons per hospital bed					✓	✓		✓	268	290
Child Immunisation (percent)							✓		70	83
<i>Source for theoretical base – mortality, healthcare delivery, nutritional status, health status and risks [18], adequate provision and access to adequate public health facilities (Mahadevia, 2001). Source for data : World Development Indicators (2011) and India Human Development Report (2011)</i>										

(continued on next page)

Table 3 (continued)

Indicators	SPI	GU I D	MDG	C D B	Global city indicator	Policy relevance with national sustainable strategy	Theoretical base	Resultant framework	Gap analysis	
									Urban India average	Urban World average
<i>Indicators of equity</i>										
Income inequality –share of poorest in national income		✓	✓	✓	✓	✓	✓		8.1	6.35
Child labour (percent)			✓		✓	✓	✓	✓	1.6percent	9.3percent in Asia
Employment rate by gender (no)		✓	✓		✓	✓	✓	✓	35.7	56.8
Ratio of boys to girls in primary, secondary and tertiary education (no)		✓	✓			✓	✓	✓	100 boys to 92 girls (sec) 77,5 girls (tert)	100 boys to 96 girls
Proportion of women councillors (percent)		✓	✓			✓	✓	V	11	19
<i>Source for theoretical base – gender equity in employment, promote social integration and support disadvantaged groups, Empowering people (Colantonio and Dixon, 2009) participation (Colantonio and Dixon, 2009) Human rights and gender (Colantonio and Dixon, 2009). Source for data: World Development Indicators (2011), India Human Development Report (2011) and ILO (2011)</i>										
<i>Indicators of housing</i>										
Land price/income ratio (no)		✓		✓		✓	✓	✓	*	*
Housing price/income (no)		✓		✓	✓	✓	✓	✓	*	*
Percentage unauthorised housing and land (percent)		✓		✓		✓	✓	✓	*	*
Percentage of population in durable houses (percent)		✓			✓	✓	✓	✓	81	78.43
Percentage of population in self owned houses (percent)		✓	✓	✓		✓		✓	67	57.1
Distribution of urban poor housing in HIG and MIG schemes				✓		✓	✓		*	*
No of homeless people (percent)				✓			✓	✓	0.24	1.4
Housing shortage (percent)	✓			✓		✓	✓	✓	37.7	*
Overcrowding		✓					✓		*	*
Evictions		✓							*	*
Secure tenure		✓	✓	✓		✓			*	*
Housing finance		✓					✓		*	*
Housing rent to income					✓		✓		*	*
<i>Source for theoretical base – access to water and sanitation facilities (Global City Indicators, 2008), authorised electrical connections and interruptions, nutrition (Stern et al., 2014) quality of service provision and access to civic amenities and a clean safe and healthy living environment for all, safe and sufficient drinking water (Mahadevia, 2001). Source for data: World Development Indicators (2011)</i>										
<i>Indicators of poverty</i>										
Above poverty line households (percent)		✓	✓	✓	✓	✓	✓	✓	73.5	78.4
Expenditure on poverty reduction				✓		✓	✓	✓	*	*
Average MPCE (Rs)			✓						1052	*
<i>Source for theoretical base – combating poverty, sustainable livelihoods (Mahadevia, 2001) social capital (Colantonio and Dixon, 2009). Source for data: India Human Development Report (2011) and 68th National Sample Survey</i>										

Indicators of safety

No of police officers per 1 lac population (no)				✓	✓		✓	173	*
Crime rate per 1 lac population (no)	✓	✓		✓	✓		✓	581.1	3300
No of fire-fighters per 1 lac population				✓	✓			*	*
Accident rate per 1 lac population (no)	✓			✓	✓	✓	✓	14.7	27.2
Urban violence	✓	✓		✓				*	*

Source for theoretical base – homicides, crime rate, fire and emergency response, law enforcement [18] freedom from violence and intimidation based on social identity (Mahadevia, 2001). Source for data: UN-Habitat Report (2011)

Indicators of access to basic services

Percentage households with piped water connections (percent)	✓	✓	✓	✓	✓	✓	✓	52 percent network coverage 62 percent treated supply	63 percent network coverage 91 percent treated supply
Percentage households with electricity connections (percent)	✓	✓		✓	✓		✓	92.68	76.7
Percentage households with sewerage network (percent)	✓	✓	✓	✓	✓		✓	32.68	61
Percentage households with telephone connections (percent)	✓	✓		✓	✓		✓	64	81
Government expenditure per capita on each service				✓	✓			*	*
Water consumption				✓	✓			*	*
Price of water								✓	✓
Price of electricity								✓	✓
Quality of electrical supply								✓	✓
Percentage households with toilet connections (percent)	✓			✓	✓		✓	74	80
Percentage households with solid waste collections (percent)	✓			✓	✓		✓	38.23	*

*Source for theoretical base – access to water and sanitation facilities (Global City Indicators, 2008), authorised electrical connections and interruptions, nutrition (Stern et al., 2014) quality of service provision and access to civic amenities and a clean safe and healthy living environment for all (Mahadevia, 2001) safe and sufficient drinking water (Mahadevia, 2001). Source for data: World Development Indicators (2011), India Human Development Report (2011), Service Level Benchmarking (2011) and data unavailable**

relevant, simple, understandable and valid. There should be availability of time series data which is cost effective i.e. good quality affordable data. All data for comparison were of 2011. The original framework started with 47 indicators but after Factor analysis the indicators were reduced to 27 which were collinear, consistent and comprehensive. It was important that the framework was not indicator rich and information poor (OECD, 2008). After analysing each theme as input indicators, process and outcome indicators, the framework included the outcome indicators as there is lack of consensus on how the input leads to outcomes. While referring to Table 3 the discussion will be limited to the final 27 indicators finally chosen because they address the typical problems of India. India's problems are very specific and hence cannot be addressed by anyone of the global frameworks.

2.2.1. Demography

Demographic growth is the single most important criteria which make all infrastructure resources scarce. Except City Data Book (by Asian Development Bank), demography as a theme is absent in most of the global initiatives. India is the second most populous country in the world with more than one sixth of the world's population. Though the world population has increased by 15 percent between 2000 and 2011, India's population has increased by 18 percent in the same period. Referring to Table 3 the final indicators under the demography framework were

1. *Population growth rate*: Exponential rate of growth of population was 1.64 during 2001–2011, higher than world growth rates of 1.21
2. *Household formation rate*: This rate has gone up in the recent years 2001 onwards because of the rise of nuclear families and is almost double the world aggregate.
3. *Informal settlements*: The rise in population and migration has led to the rise in slum population and this is significant because India houses 15 percent of the world's slums. It magnifies the urban divide.

2.2.2. Education

The end result of education is development of human capital and in India there is a lot of regional and group disparity in education benchmarks. There has been disparity between males and females and scheduled caste and scheduled tribes in India. Referring to Table 3 the final indicators under the housing theme were

1. *School enrolment rate (primary and secondary)*: It is higher than the world average in the primary level but lower than the world average in the secondary level.
2. *Access to advanced education (college density)*: It is the college density i.e. the number of degree colleges per 1 hundred thousand eligible population (18–23 years of age)

3. *Student/teacher ratio (primary and secondary)*: India is performing better than the world average.

2.2.3. Health

There has been a positive trend in the increase in health infrastructure in terms of hospitals, dispensaries and public health centres (Sample Registration System, 2011). In spite of the government expenditure on health showing a substantial increase, the indicators on mortality rates, though constantly falling, show much scope for improvement.

But the positive trend is that though the world birth rate has fallen by 4 percent in the period between 2000 and 2011, India's birth rate has fallen by 16 percent. Looking at the vital rates for India the birth rates and death rates have been decreasing in both urban and rural areas. Referring to Table 3 the final indicators under the health theme were

1. *Birth rate*: Birth rate in urban India is lower compared to world average of 19.5 per thousand.
2. *Infant mortality rate*: The Infant mortality rate in India is much higher compared to world average of 44 per thousand.
3. *Child mortality rate*: The Indian under five mortality rate is higher compared to world (there is a large variation in the developed economies and developing economies)
4. *Maternal mortality ratio (MMR)*: Though the MMR has come down from 301 in 2001 to 254 in 2004 it is still very high compared to world standards.
5. *Death rate*: Death rate in urban India was lower than world aggregate of 7.89 per thousand.

2.2.4. Equity

Although there is significant improvement in GDP, there is massive gap between the poorest and richest people. This is important because it will show the government success in achieving agenda of inclusive growth. There is a lot of regional and group specific disparities and imbalance between various social groups and regions. Sex ratio at birth is indicative of favour towards the male child. The 2011 census reveals 914 females to 1000 males. India has gender inequality rank of 112 in the world. Referring to Table 3 the final indicators under Equity theme were

1. *Child labour*: The child labour has declined from 20 percent (1993–94) to 4.2 percent (2005) and in 2011 it was at 1.6 percent
2. *Sex ratio for work participation rate*: Percentage of women employed is very low compared to the world average.
3. *Proportion of women councillors*: No of women councillors of India is 9.2 percent compared to 16.2 percent of the world, in spite of the 33 percent reservation for women in parliament which significantly points out the gender inequality

2.2.5. Housing

The demand for affordable housing, along with urban poverty, has led to the emergence of slums in India. It is important to achieve significant improvements in housing requirements of slum dwellers. Housing policies and outcomes affect such broad socioeconomic areas as health, education and productivity. Referring to Table 3 the final indicators under the housing theme were

1. Land Price per Income ratio for affordability the housing to income ratio should not be greater than 4 in EWS (Economically weaker section) and LIG (Low Income Group) and for this land cost is a prime constituent.
2. Percentage of housing on unauthorised land has increased due to rising slum population
3. Percentage households in self owned houses are higher than the world average.
4. Housing shortage is very acute in Urban India in the affordable housing category.

2.2.6. Poverty

The national poverty gap ratio at 4.8 is one of the highest in the world though it has consistently fallen over the years. Referring to Table 3 the final indicators under Poverty theme were

1. *Above poverty line households*: 28.6 percent of people in the country live below the national poverty line out of which 25.7 percent are in urban areas. It does not perform well compared to world average.
2. Average Monthly Per Capita Consumption Expenditure because consumption is a more valid measure of inequality than income

2.2.7. Safety

Global studies show that 60 percent of all urban residents in developing countries have been victims of crime at least once over the past five years. Urbanisation, particularly in the developing world, has been accompanied by increased levels of crime, violence, and lawlessness (UN-Habitat Report, 2011). But India performs well compared to world standards in safety. Referring to Table 3 the final indicators under the safety theme were

1. Crime rate per a hundred thousand population-Crime rate in India is much lower than the world average.
2. Accident rate per a hundred thousand population-Road accident fatality in million plus cities was lower than world average.

2.2.8. Access to basic services

Access to reliable supplies of safe drinking water and sanitary disposal of excreta are two of the most important

means of improving human health. Referring to Table 3 the final indicators under the Access to basic services theme were

1. Network coverage (water supply) and households with tap water from treated source both are lower than world average and needs improvement.
2. Percentage households with toilet facilities and improved sanitation are also much lower than world average.
3. Percentage households with sewerage network is also lower compared to the world.
4. Percentage households with electrical connections-It has risen from 89 percent in 2000 to 93 percent in 2011 which is a positive trend and is higher compared to the world.
5. Percentage households with landline and mobile telephone connections-The percentage of population with telephone connections has gone up from 0.60 percent in 1991 to 64 percent in 2011 which is huge jump in connectivity.

2.3. State of odisha for testing the framework

The state of Odisha has been purposively sampled for testing the framework because it is one of the least urbanised states at 16.68 percent (2011) which is much lesser compared to national average of 27.82 percent But the state, in recent times is getting rapidly urbanised as seen by the decadal growth rate of 30.28 (which almost matches national average of 32.60). Though the state population has grown by 14 percent between 2001 and 2011, the urban population has grown by double the rate wherein the sustainability impact can be studied in the best context to see if the infrastructure services match the growth in population.

The sampling frame are the cities having a Municipal Corporation. Out of the five cities having Municipal Corporations, four cities have been studied, with Bhubaneswar and Cuttack following a similar demographical pattern and Berhampur and Sambalpur following another pattern. While Bhubaneswar being the capital is a new and planned city, Cuttack is a heritage city with a 1000 year old history. Bhubaneswar has extensive scope for growth because of its location and topography but the city of Cuttack is limited between two rivers with a saucer shaped topography. While Berhampur is a commercial centre Sambalpur acts as a residential hub for the rapidly industrialised area of Jharsguda. Hence these two pairs of cities can be compared and contrasted on sustainability.

2.4. Creation of a composite Urban Social Sustainability index

Most of the data for the cities has been obtained from the relevant municipalities (Comprehensive Development Plans), NUIS (National Urban Information System) and

Census data as of 2011. Other sources of data are Government reports like District Statistical Handbook, District Information system for education, Annual Health Survey, District health survey, Odisha Economic Survey etc.

2.4.1. Normalisation of indicator values

In real-life situations, indicator values have different measurement units (income in local currencies, electricity in KWh, etc.). For developing composite indicators, it is essential to transform the values of all these indicators into some standard form. Thus, for each of the indicators included in the analysis, a relative indicator is estimated using the actual, minimum and maximum sustainability threshold values. For comparing best case and worst case scenario, 4 cities of comparable population, character and regional setting have been taken.

The relative indicator is developed using a scaling technique where the minimum value is set to 0 and the maximum to 1. The equation used for this is

Relative indicator

$$= \frac{\text{Actual value} - \text{Minimum threshold value}}{\text{Maximum threshold value} - \text{Minimum threshold value}}$$

Source: OECD (2008)

2.4.2. Giving weights to indicators

Weights to the indicators were obtained by doing expert survey with a questionnaire using Analytical Hierarchical Process and doing a pair wise comparison matrix. The weights so obtained almost matched with the weights obtained from Factor analysis confirming the validity of the expert survey and choice of indicators.

2.4.3. Linear aggregation of indicators

The composite thematic value can be found by

$$Ti = \sum_{k=1} W_k X_{ik} = W_1 S_{i1} + W_2 S_{i2} + + \dots \dots W_m S_{im} \quad (1)$$

where *Ti* the overall score of theme *i* and *x_{ik}* the Relative indicator value *i* for criterion *j* of which *w_j* is the weight.

2.4.4. Obtaining the directionality of the scores

Value judgements are necessary in deciding the vector qualities (that is the direction) of the indicator scores (Voogd, 1983). That is whether a particular theme is contributing to the sustainability or negating it. For some themes a higher criterion score implies a better sustainability whereas for other themes, a higher criterion score might imply lesser sustainability. The first kind of criteria is called Benefit criteria whereas the second type can be denoted as Cost criteria. Of the eight themes under Social Sustainability, there are four themes under the Benefit Criteria, namely Education, Access to basic Services, Equity, Poverty (Alleviation). The remaining four themes under Cost Criteria are namely Demography, Health, Safety, and Housing. If the scores have to be formulated according

to higher the better, the following transformation will have to take place.

1. Directed Standardised score = Standardised score (for Benefit Criteria)
2. Directed Standardised score = 1 – Standardised score (for Cost Criteria)

The benefit and cost criterion were decided after expert consultation.

2.4.5. Linear aggregation of the thematic index to obtain composite dimension index

The overall score of dimension value for Urban Social Sustainability is obtained by multiplying the score of each criterion (cost and benefit) by the weight of that criterion, and then adding all those weighted scores together.

$$USSI = m \sum_{j=1} W_j X_{ij} = W_1 S_{i1} + W_2 S_{i2} + + \dots \dots W_m S_{im} \quad (2)$$

where, USSI is the overall score of dimension (Urban Social Sustainability Index) and *x_{ij}* the score of option *i* for criterion *j* of which *w_j* is the weight. The inputs in the model are both weights and scores. This linear aggregation is the summation of weight × standardised score for benefit criterion themes, and weight × (1 – standardised score) for cost criterion themes. The weights are obtained from factor analysis by using the shared covariance. From the matrix of factor loadings, the square of the factor loadings represents the proportion of the total unit variance which is explained by the factor. The final USSI scores for the 4 cities are given in Table 4.

2.4.6. Testing the model through multivariate analysis

Cronbach Alpha is the coefficient of reliability based on the correlation between individual indicators. It is the most common estimate of internal consistency. The acceptable threshold is 0.6. Majority of the themes have a very high internal consistency between the indicators under it (value greater than 0.7). This shows a good correlation (Ref. Table 5A). Though 2 of the 8 themes are less than 0.6 it can be ignored, as has been followed in the Social Progress Index (Stern et al., 2014). Testing the themes under the Social Sustainability dimension also revealed a strong alpha value of 0.615 (Ref. Table 5C and Table 5D).

The purpose of conducting a Factor Analysis was to investigate the overall structure of the indicators under each theme and assess the suitability of the data set (by means of suitable multivariate methods like Principal Components Analysis). Also factor analysis gives the weights to be given to the individual indicators under each theme and themes under the Social dimension which matched with the weights given by the expert survey and confirmed the expert opinion.

The preliminary test is to check the suitability of the data. The sample adequacy by Kaiser–Meyer–Olkin mea-

Table 4
USSI Scores for 4 cities of Odisha.

Theme	Weights from factor analysis	Bhubaneswar directed standardised score	Cuttack directed standardised score	Berhampur directed standardised score	Sambalpur directed standardised score
DEMOGRAPHY	0.16	0.34	0.67	0.84	0.53
HEALTH	0.11	0.19	0.48	0.14	0.4
SAFETY	0.13	0.71	0.85	0.71	0.44
HOUSING	0.08	0.55	0.7	0.92	0.67
EDUCATION	0.14	0.56	0.43	0.61	0.47
ACCESS TO BASIC SERVICES	0.08	0.34	0.46	0.39	0.36
EQUITY	0.16	0.45	0.59	0.6	0.85
POVERTY	0.15	0.59	0.62	0.22	0.0
USSI		0.4777	0.6109	0.5613	0.4702

Data Source: Census India (2011), District Census Handbook (2011), District Information system for education (2011), Annual Health Survey (2011), Government of Odisha (2011), 68th National Sample Survey (2011), National Crime Records Bureau (2011), Service Level Benchmarking (2011) – Ministry of Urban Development, National Urban Database.

Table 5
Statistical analysis.

Table 5 A Cronbach α for Themes		Table 5 C Cronbach α for Dimension						
Theme	Cronbach Alpha Value	Reliability Statistics						
Demography	0.759	Cronbach's Alpha	.615	N of Items				
Education	0.430	Cronbach's Alpha Based on Standardized Items	.582	8				
Health	0.904							
Equity	0.431							
Housing	0.723							
Poverty	0.933							
Safety	0.851							
Access to basic needs	0.651							
Table 5 B KMO, Bartlett value for themes		Table 5 D Cronbach α for Dimension						
Theme	KMO Value	Bartlett's significance value	Item-Total Statistics					
Demography	0.500	0.050	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	
Education	0.500	0.050	3.5670	.476	.594	.	.307	
Health	0.590	0.000	3.6130	.596	.249	.	.479	
Equity	0.509	0.050	3.4900	.471	.580	.	.309	
Housing	0.687	0.025	3.6400	.659	.266	.	.475	
Poverty	0.500	0.005	3.6330	.758	.105	.	.609	
Safety	0.500	0.037	BASICSERV	3.6970	.582	.678	.	.366
Access to basic needs	0.631	0.030	EQUITY	3.7310	.829	-.254	.	.606
			POVERTY	3.5460	.709	.396	.	.479
Table 5 E KMO, Bartlett value for Dimension		KMO and Bartlett's Test						
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.583						
Bartlett's Test of Sphericity	Approx. Chi-Square	35.919						
	df	28						
	Sig.	.005						

sure of Sampling adequacy should be greater than 0.500 (Ref. Table 5B and Table 5E). The second test is the Bartlett's test of sphericity where the significance level should be less than 0.05. Majority of the themes satisfy this test (Ref. Table 5B). The component extraction to extract as few factors as possible but efficiently explain the variance is done by Kaiser's criteria of Eigenvalue greater than 1 and is confirmed by the Scree test. The Correlation Matrix shows that variables which have a correlation of 0.3 and above are strongly correlated.

After checking the correlation structure of the data, and identifying the factors and factor loadings (which measures

the correlation between indicator and factor) the factors are rotated with varimax rotation (to get a simpler structure). The construction of weights from the matrix of factor loadings is done because the square of the factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor.

3. Comparative results analysis and discussion

Although data for a four city sample has been taken (Table 6) this paper will limit its discussion to the two cities of Bhubaneswar and Cuttack and benchmark the city per-

formance with Urban Odisha performance and Urban India performance and identify the themes in which the city underperforms. Weak areas have been diagnosed to understand the direct and indirect implications. In Fig. 1, the spider charts measure the eight thematic indices (taken from Table 6), indicating imbalances where policy interventions would be required. For instance Cuttack shows a more uniform and balanced score on all themes than Bhubaneswar.

As can be seen in Fig. 1 and Table 6 Bhubaneswar's weakest link is its performance in health. It is weaker than Urban Odisha on demographic control, health, safety and housing and only marginally better than Urban Odisha in education, access to basic services, equity and poverty. When compared to Urban India it is weak on health (by an alarming gap), education, access to basic services and poverty (by large gap).

Cuttack's weakest link is its performance in health and education where it falls behind both urban Odisha and Urban India (by a huge gap). It is weaker than Urban Odisha on health, education and at par with Urban Odisha in safety and housing. When compared to Urban India it is weak on health and education, almost at par with respect to access to basic services and poverty.

3.1. Diagnosis of weak sectors for Bhubaneswar and Cuttack with theme implications

3.1.1. DEMOGRAPHY

High population growth rate puts pressure on services, infrastructure and economic opportunities. If household formation rate, is higher than population growth rate, it indicates housing demand thereby putting pressure on the housing requirements. A high Informal settlements percentage is indicative of the rural to urban migration and standard living conditions.

As can be seen in Table 6 for Bhubaneswar, with a demographic index value of 0.34 (almost half of Cuttack's demographic index at 0.67) it is a prime weak zone. Bhubaneswar's population growth rate (37.5 percent) is the single most important consideration which magnifies the intensity of demographic problems. Slum formation rate (34 percent) is the second area of concern.

3.1.2. Education

Student enrolment and retention is a strong indicator of development. Impact of Education (Secondary) on fertility is a well established hypothesis and plays a great role for population phenomena. Access to advanced education is a strong indicator of human settlements development and economic growth. Student teacher ratio (Primary and Secondary) indicates the adequacy of teacher availability and the strength and quality of an education system.

As can be seen in Table 6, with a Education index of 0.56, Bhubaneswar does not perform well on this sector with respect to Urban India on account of low school enrolment at Primary and Secondary level.

Cuttack performs more weakly with an Educational Index of 0.43 on account of its low school enrolment at Primary level (88 percent) and high dropout ratio (16.64 percent). The adult literacy level is lower than the state and national level.

3.1.3. Health

Infant mortality is a powerful indicator of quality of life in cities. High infant mortality is directly correlated to low health facilities. High child mortality is directly correlated to low environmental indicators such as the level of wastewater treatment and sewerage and sanitation facilities. High proportion of Maternal mortality ratio points to poor medical care because it shows death in women due to pregnancy related causes. High birth rate is the primary reason for the booming population which in turn puts pressure on the infrastructure. Low death rate again magnifies the population pressure.

As can be seen in Table 6 Bhubaneswar performs very badly with a health index value of 0.19, on account of its very high Infant mortality rate (69 per thousand), Child mortality rate (83 per thousand) and Maternal mortality ratio (276 per 1 hundred thousand live births), pointing towards low health facilities, sanitation and sewerage conditions.

With a health index value of 0.48, Cuttack performs better on account of it being the medical hub with a large government hospital. The only area of concern is the high maternal mortality ratio (276 per 1 hundred thousand live births).

3.1.4. Equity

A high percentage of child labour is indicative of high level of poverty and fallout of inequitable wealth distribution. Sex ratio for work participation rate is a prime indicator of gender equity in employment. Proportion of women councillors is indicative of women's participation in the decision making process. With an index value of 0.45 and 0.59 respectively, Bhubaneswar and Cuttack perform average on this theme.

3.1.5. Housing

Land cost forms a major component for any housing, hence land cost per income is very significant in cities where developed land is in short supply. This reflects in affordable housing even though the land is obtained at a subsidised rate. For affordability the housing cost by income ratio should not be greater than 4 in EWS (Economic Weaker Section), LIG (Lower Income Group) category. A high slum population results in unauthorised construction and pressure on the infrastructure.

As can be seen in Fig 1, with a housing index value of 0.55, Bhubaneswar underperforms with respect to Urban Odisha on account of its high land costs (land price per income ratio being 0.28). This compounds the issue of affordable housing (housing cost to income ratio of 4.9) and adds to housing shortage. Hence there is a need for planned peripheral development which will allow the city

Table 6
Comparative true and relative indicator values for themes under Urban Social Sustainability for the four sample cities.

Theme	No	Indicator	Unit	Bhubaneswar		Cuttack		Berhampur		Sambalpur	
				True value	Rel. value	True value	Rel. value	True value	Rel. value	True value	Rel. value
DEMOGRAPHY	1	Population growth rate (decadal 2001–11)	%	37.5	0.75	22.9	0.38	15.6	0.19	19	0.28
	2	Household formation rate	%	41.4	0.59	20.5	0.04	27	0.21	37	0.47
	3	Informal settlements	%	34	0.61	36.3	0.73	22	0.00	39.8	0.91
		DEMOGRAPHY INDEX VALUE (DIRECTED STANDARDISED)			0.34		0.67		0.84		0.53
EDUCATION	1a	School enrolment rate (primary)	%	88.53	0.13	88.06	0.12	101.8	0.27	108.5	0.35
	1b	School enrolment rate (secondary)	%	101.0	0.47	139.9	1.00	97.51	0.42	106.4	0.55
	2	Access to advanced education (college density)	Nos	53	0.38	39	0.25	55	0.41	111	1.00
	3a	Student/teacher ratio (primary)	No	32.85	0.99	28.32	0.64	32.04	0.93	27.23	0.56
	3b	Student/teacher ratio (secondary)	No	39.18	0.78	21.87	0.00	43.21	0.96	27.91	0.27
	EDUCATION INDEX VALUE (DIRECTED STANDARDISED)			0.56		0.43		0.61		0.47	
HEALTH	1	Birth rate	%	18.3	0.60	20	0.75	17.1	0.50	19.1	0.67
	2	Infant mortality rate	No	69	1.00	37	0.32	67	0.96	43	0.45
	3	Child mortality rate	No	83	0.89	48	0.32	90	1.00	54	0.42
	4	Maternal mortality ratio	Nos	276	0.70	276	0.70	311	0.88	253	0.58
	5	Death rate	%	7.3	0.84	5.4	0.50	7.2	0.82	7.6	0.89
	HEALTH INDEX VALUE (DIRECTED STANDARDISED)			0.19		0.48		0.14		0.4	
EQUITY	1	Child labour	%	3.6	0.36	4	0.47	3.3	0.28	4.2	0.53
	2	Sex ratio for work participation rate	Nos	297	0.90	237	0.38	252	0.51	307	0.99
	3	Proportion of women councillors	%	40.29	0.29	52.54	0.76	55	0.86	58.62	1.00
		EQUITY INDEX VALUE (DIRECTED STANDARDISED)			0.45		0.59		0.60		0.85
HOUSING	1	Land price per income ratio	No	0.28	1.00	0.27	0.96	0.03	0.07	0.01	0.00
	2	Percentage of housing on unauthorised land	%	20.7	0.46	8.12	0.10	4.8	0.00	32.4	0.80
	3	Percentage households in self owned houses	%	53.81	0.00	54.2	0.01	56.85	0.10	64.49	0.36
	4	Housing shortage	%	18.5	0.23	7.63	0.00	15.45	0.16	17.96	0.22
	HOUSING INDEX VALUE (DIRECTED STANDARDISED)			0.55		0.7		0.92		0.67	
POVERTY	1	Above poverty line households	%	75	0.58	74.1	0.55	54.7	0.04	53.1	0.00
	2	Average MPCE per household	Rs	809	0.59	832	0.68	758	0.40	652	0.00
		POVERTY INDEX VALUE (DIRECTED STANDARDISED)			0.59		0.62		0.22		0
SAFETY	1	Crime rate per 1 lac population	No	194	0.12	120	0.00	152	0.05	279	0.26
	2	Accident rate per 1 lac population	No	84.2	0.46	59.27	0.30	94.08	0.52	149.1	0.86
		SAFETY INDEX VALUE (DIRECTED STANDARDISED)			0.71		0.85		0.71		0.44
ACCESS TO BASIC SERVICES	1a	a. Coverage connections-water supply	%	51.7	0.72	49.4	0.68	34.7	0.40	42	0.53
	1b	b. Percentage households with tap water from treated source	%	47	0.00	68	0.56	64	0.45	76	0.78
	2	Percentage households with toilet facilities	%	75	0.31	84	0.61	85	0.64	65.63	0.00
	3	Percentage households with sewerage connections	%	34.5	0.46	2	0.03	0	0.00	0	0.00
	4	Percentage households with electrical connections	%	86.22	0.00	94.36	0.65	94.4	0.66	95.08	0.71
	5a	a. Percentage households with landline telephone connections	%	4.78	0.46	4.91	0.50	4.29	0.32	4.22	0.30
	5b	b. Percentage households with mobile telephone connections	%	64.78	0.53	66.39	0.64	71.7	1.00	59.31	0.15
		BASIC SERVICES INDEX VALUE (DIRECTED STANDARDISED)			0.34		0.46		0.39		0.36

Data Source: Census India (2011), District Census Handbook (2011), District Information system for education (2011), Annual Health Survey Bulletin 2011–12, Government of Odisha (2011), 68th National Sample Survey (2011), National Crime Records Bureau (2011), Service Level Benchmarking (2011) – Ministry of Urban Development, National Urban Database.

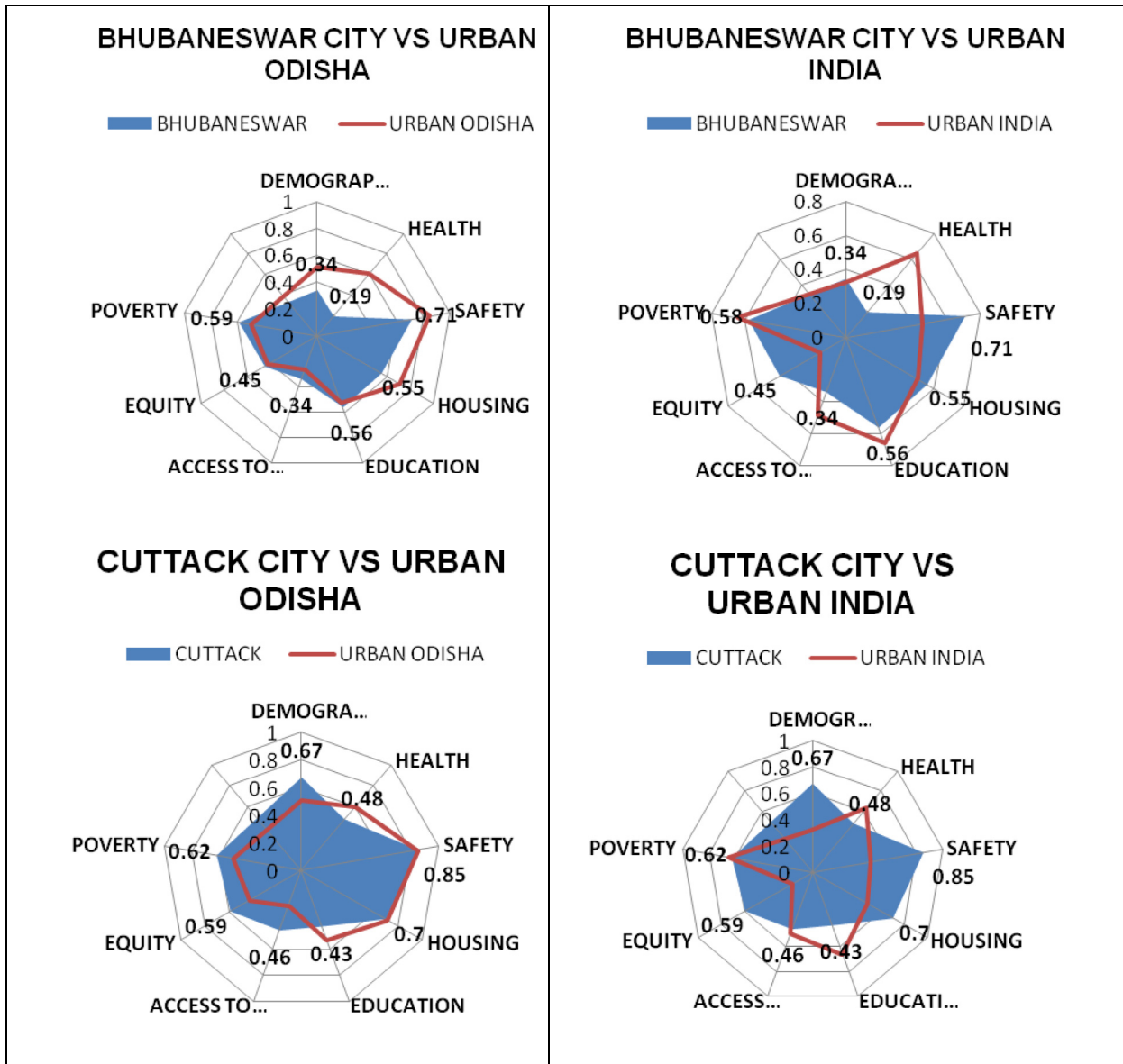


Fig. 1. Comparative social sustainability performance of Bhubaneswar and Cuttack. Data Source: Thematic indices values from Table 6.

growth and reduce the land inflationary pressure. Cuttack however performs much better at an index value of 0.70 because of lower housing shortage in affordable housing sector.

3.1.6. Poverty

Consumption level is a strong indicator of affordability. Percentage above Poverty line is a strong indicator of Poverty. As can be seen in Fig 1, with a poverty index of 0.59 and 0.62 respectively, Bhubaneswar and Cuttack underperform with respect to the national level as is apparent in the inherent poverty level of the state. This is fallout of the rural urban migration and slum prevalence in the cities.

3.1.7. Safety

It is measured by crime per hundred thousand of population which includes murder, dacoity, robbery, burglary,

theft, swindling, rioting and rape. The second indicator is road accident rate which is inclusive of injured and death cases.

As can be seen in Fig 1, Bhubaneswar underperforms in its crime rate with respect to Urban Odisha and has a safety index value of 0.71 on account of weaker neighbourhood interactions and community feeling. Cuttack performs marginally better at index value of 0.85 because being a 1000 year city, the neighbourhood feeling is stronger which results in community policing.

3.1.8. Access to basic services

The percentage of the city population served by a potable water supply and its area coverage is an indicator of city health, cleanliness and quality of life. Percentage of households with toilet facilities and sewerage connections have a lot of significance on sanitation facilities which

has impact on health also, especially in the Swachh Bharat Mahan context. Percentage households with electrical connections are an indicator of lawful provision of a basic urban service. The number of telephone connections is an indicator of communication technology connectivity.

As can be seen in Table 6, both cities perform badly on the Access to Basic Services Index but Bhubaneswar fares worse with a index value of 0.34. Bhubaneswar should work on increasing the percentage of household with potable water (presently 47 percent) because it is a basic necessity and Cuttack on having a sewerage network (presently at a dismal rate of 2 percent).

4. Conclusion

The objective of the research was to create an output based measure of Urban India's social sustainability which will enable benchmarking success or failure with peer cities at theme and dimension level and thus catalyse improvement. In India there are so many cross currents between urban growth and policy reality that these indicators help to increase awareness and highlight the problem areas, do a gap analysis by defining a time frame and make steady progress towards it. It will be a diagnostic evidence based tool needed to inform and empower policy makers, citizens, researchers and activists for measuring and monitoring sustainable development, for policy making and prioritisation of budget allocation between various sectors.

The theoretical construct was custom made for India by mapping Indian sustainability policies with global initiatives and theoretical definitions, and doing a gap analysis to identify India's weak sectors in comparison with world sustainability. It was tested in the state of Odisha which is at the bottom of the urban ladder but growing at a tremendous speed and hence an appropriate test site because the infrastructure is not growing at the same relative speed. The same framework with contextual additions or deletions would work elsewhere in India. The indicators are limited in number and easily available from Census and NUIS (National Urban Information System) data. The trends can be seen in a 10 yearly time-series data to map the progress. However one size cannot fit all. India being a vast country context plays a very important role and the generic framework may be improved on a case to case basis. The weights to the indicators may vary as per local conditions.

A holistic view of the system is to look at it as a combination of parts which are interacting among themselves (inter-dimensional and intra-dimensional). It is rare to find a city having equal score on all the indices, so policy interventions are required to balance between the various themes. For instance, the Access to basic services may be good but if there is inequitable distribution then the city may score less on the equity theme. Hence there are a lot of inter-linkages between the themes. The integrative process for measurement of sustainability has been done through integrative conceptual framework,

integration by selection of specific indicators and aggregation of the indicators. A very good example of this integrative mechanism in policy making is seen in Curitiba, Brazil. Here garbage collection by slum dwellers is encouraged by exchange of 6 bags of trash with 1 bag of grocery, instead of cash which fosters health and economical well-being so that productive workforce increases. Also planning high rise apartments along major bus routes (mass transit) is economical and environmentally sustainable and signifies intra-dimensional integration.

There is strong inter-relationship between the themes under the Social dimension. The vicious cycle begins with unplanned demographic growth as seen in the case of Bhubaneswar where the slum population forms more than a third of the total population growing at a rate of 19.5 percent per annum compared with the 5.75 percent per annum growth of city population. This rapid growth does not come with the corresponding urban infrastructure growth and this widens the urban divide. Because of the inequitable distribution (in terms of income, housing, health, basic services, education divide) the cascading effect on each of the themes continues. India's policy measures are rightly geared towards inclusive growth and slum prevalence wherein through a multi-pronged approach of skill building, increasing provision of basic services, community development and tenure security, the slums prevalence has fallen from 41.5 percent in 2000 to 28.5 percent in 2011, making it the second most successful country in the world after China in Slum improvement. There needs to be innovative strategies for slum prevention by scaling up successful projects.

Recently Bhubaneswar has been ranked the premier city of India from among the 28 smart cities, however the sustainability in the social sector as seen by the research leaves much to be desired. Sustainability scorecard of the cities reveals the actual sustainability position of the city and can be used to make politically informed judgments. It encourages public accountability and an integrated framework across all the dimensions, would go a long way in evaluating our cities.

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