

3 **MEASURING PERFORMANCE OF 15 METROPOLITAN CITIES OF INDIA**

4

5 **ABSTRACT**

6 Around the world, sustainable development has become a top policy discussion as  
7 countries struggle to maintain or enhance economic growth without compromising the  
8 future. Nowhere is the issue more pressing than in India, where urban areas and their  
9 economies are expected to grow rapidly over the next few decades and where resource use  
10 and environmental quality are already raising grave concerns. Sustainable development,  
11 economic growth that improves the lives of the people without exhausting the environment  
12 or other resources, is especially critical in developing countries, where mass urbanization is  
13 taking place at a time when man's impact on the environment has reached a critical  
14 juncture. The study investigates if the present pattern of urban development in India in the  
15 creation of mega cities is sustainable. The indicators represent a primary tool to provide  
16 guidance for policy makers and to potentially assist in decision-making and monitoring  
17 local strategies/plans. The outcome of the study will contribute to the design of policies,  
18 tools, and approaches essential for planning to attain the goal of sustainable development  
19 and the social cohesion of metropolitan regions.

20 **Keywords:** Affordability, Environment, Sustainable Development, Urban Sustainability  
21 Index.

22

## 23 1. INTRODUCTION

24 India is growing fast. Economic reforms and policies have already  
25 unleashed investment and growth is offering its citizens rich opportunities.  
26 Although the Indian economy has been resilient so far, the key issue now is  
27 how to sustain this momentum. Turning around its cities and releasing their  
28 dynamism will be critical to India's future economic growth.

29 Unlike many countries that are grappling with aging populations and  
30 rising dependency ratios, India has a young and rapidly growing population  
31 - a potential demographic dividend. A study conducted by McKinsey  
32 Global Institute claims that cities could generate 70% of net new jobs  
33 created to 2030, produce more than 70% of Indian GDP, and drive a near  
34 4x increase in per-capita incomes across the nation.<sup>1</sup>

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- 35 • **5 times - India's GDP** is expected to increase by 2030
  - 36 • **590 million people** will be living in cities
  - 37 • **270 million net increase** in working-age population
  - 38 • **70% of net new employment** would be generated in cities
  - 39 • **91 million urban households** would be middle class, up from 22 million  
40 people today
  - 41 • **68 cities** will fall in the million+ category, up from 53 today
  - 42 • **\$1.2 trillion investment** is required to meet the projected demand of  
43 Indian cities
  - 44 • **30 rural dwellers**, shift to cities every minute
  - 45 • **800 million m<sup>2</sup> of residential & commercial space** needs to be built
  - 46 • **1/3<sup>rd</sup> of the urban population** will face the affordable housing challenge  
47 by 2025
  - 48 • **7400 KMs of metros & subways** need to be constructed, 20 times the  
49 capacity added in last decade
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50 Urbanisation is now commonly regarded as one of the most important  
51 social processes and has enormous impact on the environment at local,

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<sup>1</sup> McKinsey Global Institute 2010: India's urban awakening - Building inclusive cities, sustaining economic growth

52 regional and global scales. It is now widely acknowledged that the impact  
53 of urbanisation will continue to bring about major global and local changes  
54 in economic, environmental and social arenas.

55         Around the world, sustainable development has become a top policy  
56 discussion as countries struggle to maintain or enhance economic growth  
57 without compromising the future. The issue is most pressing in India and  
58 China, where resource use and environmental quality are already raising  
59 grave concerns. Fortunately, national and local leaders have responded to  
60 the challenge by making sustainable development a high priority.

61         Sustainable development, economic growth that improves the lives of  
62 the people without exhausting the environment or other resources, is  
63 especially critical in developing countries, where mass urbanization is  
64 taking place at a time when man's impact on the environment has reached a  
65 critical juncture. Because of the exceptional growth rates they are  
66 witnessing, cities in the developing world are the focal point of this  
67 struggle for sustainable growth.

68         The main aim in this study is to investigate if the present pattern of  
69 urban development in India in the creation of mega cities is sustainable.  
70 This is proposed to be done by performing an indicator-based evaluation of  
71 15 most populous cities of India against international benchmarks and for  
72 the purpose we chose Copenhagen, honoured as the Most Sustainable City  
73 of the World.

74         Using a new metric, the **Urban Sustainability Index**, we've found  
75 mixed results for this nascent effort. While India's current model of urban  
76 growth does not meet global benchmarks for sustainability, but there are  
77 positive examples of sustainable development that could be copied  
78 elsewhere in India. Without doubt, most cities in India lag those in  
79 developed countries across most measures of sustainability, though many  
80 are showing positive trends and are trying to improve.

### 81 **1.1. A Tale of 100 Smart Cities:**

82 The new Government's agenda is to build 100 Smart Cities in India. It is a  
83 monstrous ambition that is fast becoming a social and economic imperative  
84 as at least 50 per cent of Indians are set to live in urban areas by 2050, as  
85 against just 32 per cent today. India must provide for these 814 million  
86 people in cities with minimum disruption and least chaos. The existing  
87 cities have failed to do so for lack of focus or planning. Rs.40 lakh crores  
88 of investments required to build basic infrastructure, including transport,  
89 water and sanitation, in all urban areas, including 500 cities and smart  
90 cities.

#### 91 **Benchmarks<sup>2</sup>:**

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- 92 • Availability of high frequency mass rapid transport system **within**  
93 **800 m** of areas having 175 persons/ha or higher density, **connecting**  
94 **95%** of employment, institutional and public services
  - 95 • **135 L of per capita** supply of water to **100% households** with 24x7  
96 direct supply
  - 97 • **100% households** should have access to **toilets**
  - 98 • **100% efficiency** in the collection & treatment of **waste water**
  - 99 • **100%** collection, segregation & recycling of **solid waste**
  - 100 • **100% households** have electricity, telephone & wireless internet
  - 101 • **100% access** to telemedicine facilities, **30 mins. emergency**  
102 response time, **500 beds hospital** per lakh population
  - 103 • **1 school** per lakh & **1 college** per 10 lakh population
  - 104 • Adherence to **green building norms**, rainwater harvesting, rooftop  
105 solar- panels
- 

106

## 107 **2. OBJECTIVE**

108 The objectives of the study are:

- 109 a. creating an urban sustainability index covering all the relevant  
110 sectors of a typical city
- 111 b. establishing a benchmark indicator base from a benchmark city

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<sup>2</sup> [http://indiansmartcities.in/downloads/Benchmarks\\_for\\_Smart\\_Cities1.pdf](http://indiansmartcities.in/downloads/Benchmarks_for_Smart_Cities1.pdf)

- 112 c. develop a database for the 15 cities selected for the study using
- 113 similar methodology
- 114 d. comparing and evaluating the indicators with benchmark indicators
- 115 using gap analysis approach
- 116 e. comparing the cities among themselves and with the benchmark city

117 The remainder of this report will look in more detail at the components  
118 of the Urban Sustainability Index. In this context the social, economic,  
119 physical and environmental sub-systems of an urban system will be studied  
120 and analyzed.

121

### 122 **3.LITERATURE REVIEW**

123 There is considerable overlap between aspects of social sustainability  
124 and concepts like ‘sustainable community’, Such communities are widely  
125 envisaged to provide a setting for long-term human activity and interaction  
126 that is equitable, inclusive and sustainable in the broader sense of the term  
127 (economically and environmentally as well as socially). Dempsey(2009)  
128 examines the underlying principles of social sustainability and their  
129 interpretation and provides a definition of social sustainability with  
130 particular reference to the British urban context.

131 Seyfang (2009) studied the community action for sustainable housing  
132 with the view point of constructing buildings with low-carbon emission.  
133 Seyfang addressed this problem by investigating the scope and potential of  
134 a previously unsearched sustainable housing initiative, to contribute to  
135 building low-carbon, sustainable communities.

136 Singh and Pandey (2012) forecasted the urban growth of India for the  
137 year 2050 if, sustainable housing is adapted. He studied that India will be  
138 the most populous country, with a projected population of 1.69 billion,  
139 compared with China’s 1.30 billion.The model results for India shows on  
140 average a 4.84% urban land expansion growth rate with 30% from

141 population growth and around 23% from growth in GDP per capita for the  
142 period 1970 to 2000.

143 Chakrabarty (2001) analyzed the urban crisis of India and suggested  
144 the new initiatives required to be adapted to attain sustainable cities in  
145 India. He inferred in this study that the unplanned and uncontrolled growth  
146 of large cities has had negative effects on urban dwellers and their  
147 environment.

148 Ding G.K. (2008) *Sustainable construction—the role of*  
149 *environmental assessment tools*, an overview of environmental building  
150 assessment methods: Building designers and occupants have long been  
151 concerned about building performance. Separate indicators, or benchmarks  
152 based on a single criterion, have been developed to monitor specific  
153 aspects of environmental building performance such as air quality and  
154 indoor comfort. The building research establishment environmental  
155 assessment method (BREEAM) in 1990 was the first such comprehensive  
156 building performance assessment method. It was the first environmental  
157 building assessment method and it remains the most widely used. The  
158 BREEAM system has been constantly updated and extended to include  
159 assessment of such buildings as existing offices, supermarkets, new homes  
160 and light industrial buildings. An environmental building assessment  
161 method reflects the significance of the concept of sustainability in the  
162 context of building design and subsequent construction work on site. It  
163 provides a way of structuring environmental information, an objective  
164 assessment of building performance, and a measure of progress towards  
165 sustainability.

166 The academic perspective on policy & practice in India of affordable  
167 housing, has been examined and it starts with the question that why is  
168 Affordable Housing Important? First is the progressive urbanization hand  
169 in hand with a growing urban population, from 109 million in 1971 to 377  
170 million in 2011 toward a whopping 600 million by 2030. Second, rising  
171 incomes have led to the expansion of the middle class. This has led to a  
172 spike in demand for housing that is affordable but also includes basic

173 amenities. Third, the real estate sector is a major component of Indian  
174 economy. At Rs.170 crores, it has contributed 4.5 percent crore in India's  
175 GDP and employed 7 percent of the urban workforce in 2006-07. Housing  
176 is the largest component of the financial sector and construction sector as  
177 well.

178 Mahadevia, D. (2001) *Sustainable urban development in India: An*  
179 *inclusive perspective*, Mahadevia emphasises that the move towards a  
180 'sustainable city' has to be an 'inclusive approach' based on 4 pillars:

- 181 • environmental sustainability;
- 182 • social equity;
- 183 • economic growth with redistribution and
- 184 • political empowerment of the disempowered.

185 This holistic approach incorporates all dimensions of development,  
186 including the interests of the poor and the disempowered. It would  
187 challenge the existing unequal systems, from global to local that have led  
188 to unsustainable development.

189 Reddy and Balanchandra (2013) *Benchmarking Urban Sustainability*  
190 *- A Composite Index for Mumbai and Bangalore*, the study involving  
191 Mumbai and Bangalore and three other megacities for comparison  
192 demonstrates the value of benchmarking and provides a better  
193 understanding of the practical and data-related aspects of benchmarking  
194 cities for sustainability. The study demonstrates the value of these  
195 comparisons in the context of four dimensions - economic, environmental,  
196 social and governance. Measuring the sustainability of urban regions poses  
197 many challenges. It must be noted that the selection of indicators should be  
198 done with the clear understanding of the needs where these are going to be  
199 applied.

200 Sustainability issues are inherently interconnected, and any approach that  
201 needs implementation requires the administration to think across various  
202 sectors, viz., housing, transportation, education and workforce, and energy  
203 policy and act collaboratively to construct feasible sustainability plans.

204            *The Urban Sustainability Index: A New Tool for Measuring China's*  
205 *Cities*, Analysis using the Urban Sustainability Index and subsequent field  
206 visits has shown that some Chinese cities are making clear strides toward  
207 sustainable development. Their success is based not only on execution  
208 capabilities, but on an unwavering focus on industrial restructuring,  
209 designing sensible transit systems and green space, pushing improvements  
210 through standards, monitoring and pricing, and exploring ways to make  
211 industries more resource efficient. The best performing cities displayed a  
212 clear, long-standing commitment to achieve their sustainable 'vision'.  
213 However, no deterministic relationship between economic growth and  
214 performance on our Index, our research exposed an unmistakable  
215 opportunity for other cities in China to learn from the practices of their  
216 better-performing peers.

217            **World Bank (2013)** *Urbanisation beyond Municipal Boundaries:*  
218 *Nurturing metropolitan economies and connecting peri-urban areas in*  
219 *India*, India's policy makers may want to pay immediate attention to three  
220 priority areas as they try to harness economic efficiency and manage  
221 spatial equity associated with urbanization. **First**, to enhance productivity,  
222 invest in the institutional and information foundations to enable land and  
223 housing markets to function efficiently, while deregulating the intensity of  
224 land use in urban areas. **Second**, to improve liveability, rationalize the  
225 rules of the game for delivering and expanding infrastructure services, such  
226 that providers can recover costs yet reach out to poorer neighbourhoods and  
227 peripheral areas. **Third**, for better mobility, invest in improving  
228 connectivity between metropolitan cores and their peripheries, as these are  
229 the areas that will attract the bulk of people and businesses over the  
230 medium term.

231            Land policy, infrastructure services, and connectivity—integrated  
232 improvements in this triad can help India reap dividends from improved  
233 spatial equity and greater economic efficiency that comes with  
234 urbanization.

235

236 **4. METHODOLOGY**

237 **4.1. Measuring Sustainability**

238 The Urban Sustainability Index was created to fill a gap in current analysis  
 239 of sustainable development. In recent years, there have been many efforts  
 240 designed to compare economic growth and environmental sustainability.<sup>3</sup>

241 Table 1: Various definitions of sustainability

<b>NAME</b>	<b>DEFINITION</b>	<b>DATASOURCE</b>
<b>Bruntland Report</b>	Meeting the needs of the present generation without compromising the ability of future generations to meet their needs	World Development Report 1984
<b>SustainLane</b>	Maintaining standards of living & structural preparedness to meet the environmental challenges of an uncertain future	U.S. Census Bureau, surveys & interviews
<b>UN</b>	The integration of economic, social and environmental issues in decision and policy making	National publicly available data
<b>World Bank</b>	No explicit definition, but implicitly defined by a selection of indicators used to measure sustainability	Self-reported data on website with city member enrolment
<b>OECD</b>	Competitive green growth as defined through considerations of urban form, lifestyle and energy sources	Various development and multilateral agencies
<b>Siemens</b>	Acting responsibly on behalf of future generations to achieve economic, environmental and social progress	National statistics, city authorities, national environmental bureaus
<b>Yale Columbia</b>	Society's capacity to improve its environmental performance over time	WHO; Experts from Yale and Columbia
<b>National</b>	Greenness as defined by household carbon	Chinese statistical

<sup>3</sup> McKinsey Global Institute 2013: The Urban Sustainability Index: A New Tool for Measuring China's Cities

<b>Bureau of Economic Research, China</b>	emissions	yearbooks
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242 Little work is available to measure the sustainability of developing  
243 country cities, where the challenge is most acute. In Urban Sustainability  
244 Index an attempt is made to address this gap. Selected indicators are  
245 worked upon that are more readily available in developing economies and  
246 more relevant. For example, the index looks at basic needs such as water  
247 availability, which varies widely in developing countries, but would be  
248 near universal in developed economies.

#### 249 **4.2. The Urban Sustainability Index – Scope**

250 The Urban Sustainability Index (USI) is designed to measure relative  
251 performance over time of Indian cities across a common set of  
252 sustainability categories. A comprehensive 4-part definition of sustainable  
253 development encompassing 15 individual indicators is composed to gauge  
254 not only the environmental sustainability of the cities being analysed, but  
255 also the level of services required to handle a growing urban population  
256 and each city’s resource efficiency. These indicators represent the best set  
257 of data for commonly accepted indicators that are available in India from  
258 both national and local sources.

259 The Index measures a city’s performance against 4 aspects that are  
260 critical to sustainable development:

261 **Basic Needs:** Decent income for a good standard of living, affordable  
262 living space, adequate healthcare and education are priority needs that help  
263 sustain an urban population.

264 **Resource Efficiency:** Low carbon emissions, efficient use of water &  
265 energy and high gross domestic output contribute to better functional  
266 resource management, providing overall benefits.

267 **Environmental Health:** Lessening exposure to harmful pollutants and  
 268 heightening water treatment and waste management efficiency helps induce  
 269 cleaner and healthier urban environments.

270 **Built Environment:** Increased liveability and efficiency of communities  
 271 comes with equitable access to green space and public transportation, as  
 272 well as efficient population distribution.

273 Table 2: 4 part index of urban sustainability

<b>CATEGORY</b>	<b>DEFINITION</b>	<b>INDICATORS</b>	<b>DESCRIPTION</b>
<b>BASIC NEEDS</b>	Able to sustain a decent standard of living	Housing Affordability	Affordability index (n)
		Income	Per-capita income (\$)
		Education	Literacy rates (%)
		Healthcare	Healthcare access (n)
<b>RESOURCE EFFICIENCY</b>	Efficient management of fundamental resources	Power	Electricity consumption MU/GDP (\$)
		Water supply	Per-capita water supply (lit/day)
		Output	GDP/km <sup>2</sup>
		GHG Emissions	CO <sub>2</sub> kTons/GDP(\$)
<b>ENVIRONMENTAL CLEANLINESS</b>	Cleaner air, water & lesser solid waste	Air Pollution	Concentration of SO <sub>x</sub> , NO <sub>x</sub> & PM <sub>10</sub> (µg/m <sup>3</sup> )
		Sewage Treatment Rate	Waste water treatment capacity (%)
		Waste Management	Per-capita domestic waste collected & treated

			(kg/day, %)
<b>BUILT ENVIRONMENT</b>	Density, transit orientation, green space	Population Distribution	Persons/km <sup>2</sup>
		Mass Transit Accessibility	Accessibility index (n)
		Public Green Space	Per-capita green space (m <sup>2</sup> )

274

### 275 **The Cities**

276 The following cities of India have been selected on the basis of their  
 277 population as per 15<sup>th</sup> Census of India, 2011. Due to limitations forced  
 278 upon by unavailability of data and time, the number of cities have been  
 279 restricted to 15, the top ones when sorted according to population.

280 Table 3: Selected 15 cities for the study

#	CITY	STATE	POPULATION 2011
1	<b>Mumbai</b>	Maharashtra	18414288
2	<b>Delhi</b>	National Capital Region	16314838
3	<b>Kolkata</b>	West Bengal	14112536
4	<b>Chennai</b>	Tamil Nadu	8696010
5	<b>Bengaluru</b>	Karnataka	8499399
6	<b>Hyderabad</b>	Telangana	7749334
7	<b>Ahmedabad</b>	Gujarat	6352254
8	<b>Pune</b>	Maharashtra	5049968
9	<b>Surat</b>	Gujarat	4585367
10	<b>Jaipur</b>	Rajasthan	3073350
11	<b>Lucknow<sup>4</sup></b>	Uttar Pradesh	2901474
12	<b>Nagpur</b>	Maharashtra	2497777
13	<b>Indore</b>	Madhya Pradesh	2167447
14	<b>Coimbatore</b>	Tamil Nadu	2151466

<sup>4</sup> Failing to gather data and very close proximity both in distance and data, Kanpur is skipped from the list.

15	Kochi	Kerala	2117990
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### 282 4.3. Framework

283 In real-life situations, indicator values have different measurement units  
 284 (income in local currencies, electricity in KWh, etc.). For developing  
 285 composite indicators, it is essential to transform the values of all these  
 286 indicators into some standard form. Thus, for each of the indicator included  
 287 in the analysis, a relative indicator is estimated using the actual and the  
 288 sustainability threshold values. For each indicator, a minimum and  
 289 maximum threshold value will be determined. The relative indicator is  
 290 developed using a scaling technique where the minimum value is set to 0  
 291 and the maximum to 1.

292 The equation used for this is:

$$\text{Relative Indicator} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

293 ... equation (1)

294 This Relative indicator is referred to as ‘*Dimension Index*’.

295 The next step is to derive the composite indicator dimensions from  
 296 appropriate indicators belonging to that particular dimension. There are  
 297 two ways to develop the composite indicator dimensions. One is to use the  
 298 weights of the indicators in relation to a given dimension and combine the  
 299 indicators to form a composite indicator dimension. The other is where the  
 300 indicator weights are not available, the composite dimension index is  
 301 computed as the root mean square of the relative indicator variables  
 302 belonging to that particular dimension.

303 The equation used is as follows:

$$D_j = \sqrt{\frac{\sum_i V_{ij}^2}{i}}$$

304 ... equation (2)

305 where,  $D_j$  = Dimension of type ‘j’

306  $V_{ij}$  = Variables 'i' belonging to dimension 'j',  $i = 1, 2, \dots, I$   
307  $I$  = Number of variables in a dimension

308 The Urban Sustainability Index can be computed using the above mentioned  
309 formula for each city.

310

#### 311 **4.4. Creating Circles of Sustainability**

312 As stated, the indicators of sustainability for each of the dimensions that is  
313 being determined for the 15 cities will be compared with the benchmark  
314 indicators from a few selected cities of the world (discussed next). The  
315 maximum and minimum values are derived from the best and the worst  
316 values obtained for a given indicator by those cities. Then, the standardized  
317 indicator dimensions for the specific study city (one of the 15) and the  
318 sustainable city will be mapped on a radar diagram. The distance between  
319 the two points of a given dimension for the two cities gives the prevailing  
320 gap. The dimension gaps for the study city suggest how far they are from  
321 achieving the level of a benchmark sustainable city, and also provide  
322 insights into the dimensions seriously lacking. Thus, the quantified gaps in  
323 dimensions as well as individual indicators can provide greater insights  
324 into the reasons for the existence of such sustainability gaps, targets that  
325 need to be fixed to bridge them and strategies that need to be adopted for  
326 achieving these targets.

327 For the present study, the indicator data were gathered mainly from  
328 secondary sources of information such as journal papers, reference books,  
329 government reports, project reports, websites of concerned government  
330 departments and ministries, websites related multilateral agencies and  
331 variety of databases from the internet.

#### 332 **4.5. The Benchmark Cities**

333 For the purpose of obtaining maximum and minimum values, we select the  
334 cities Beijing, China and Copenhagen, Denmark. Reason for choosing these

335 two cities is obvious – Copenhagen<sup>5</sup> has the honour of being called as the  
336 most sustainable city of the world, thanks to the government efforts and  
337 mass awareness and on the other hand, Beijing<sup>6</sup> which is notorious for  
338 being one of the most polluted cities in the world owing to its massive  
339 industrialisation and urbanisation.

340

## 341 **5. RESULTS**

### 342 **5.1. Profile of the selected Cities:**

343 Here a comparison is made of each city against Copenhagen and along with  
344 that maximum values obtained from India, irrespective of cities, and  
345 average value of all indices across cities is shown in the radar diagrams.

346 4-point radar

- 347 - Copenhagen (COP) = Blue line
- 348 - India Maximum (MAX) = Yellow line
- 349 - City = Green Line

350 14-point radar

- 351 - India average (AVG) = Lighter shade of Green
- 352 - India Maximum (MAX) = Medium shade of Green
- 353 - City = Dashed & bold, dark Green Line

354 Post city profiles, all the cities are depicted in one graph for each  
355 parameter. These diagrams are useful for inter-city comparison of specific  
356 indicators.

### 357 **5.2. City performance by Index**

358 Table4:City performance by Index.

CITY	CODE	USI	RANK
Mumbai	MUM	53.06	1
Delhi	DEL	43.64	11

<sup>5</sup> [http://www.siemens.com/entry/cc/features/greencityindex\\_international/all/en/pdf/report\\_en.pdf](http://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/report_en.pdf)

<sup>6</sup> <http://edition.cnn.com/2013/01/14/world/asia/china-smog-blanket/index.html>

<b>Kolkata</b>	KOL	52.86	2
<b>Chennai</b>	CHE	52.02	3
<b>Bengaluru</b>	BEN	48.33	5
<b>Hyderabad</b>	HYD	43.07	12
<b>Ahmedabad</b>	AHM	44.59	9
<b>Pune</b>	PUN	42.57	14
<b>Surat</b>	SUR	44.18	10
<b>Jaipur</b>	JAI	48.37	4
<b>Lucknow</b>	LUC	45.17	8
<b>Nagpur</b>	NAG	47.06	7
<b>Indore</b>	IND	38.33	15
<b>Coimbatore</b>	COI	42.80	13
<b>Kochi</b>	KOC	48.26	6
<b>Copenhagen</b>	COP	86.06	-
<b>India Average</b>	AVG	46.29	-

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360 Table 5: City wise Composite Indices

<b>PARAMETERS</b>	<b>MUM</b>	<b>DEL</b>	<b>KOL</b>	<b>CHE</b>	<b>BEN</b>
<b>URBAN INFRASTRUCTURE</b>	43.46	49.62	61.38	59.67	63.57
<b>ENVIRONMENTAL CLEANLINESS</b>	45.71	24.76	28.53	36.90	39.27
<b>RESOURCE EFFICIENCY</b>	69.08	54.12	60.55	50.92	40.62
<b>BASIC REQUIREMENTS</b>	50.11	40.16	54.13	57.52	45.93
	<b>HYD</b>	<b>AHM</b>	<b>PUN</b>	<b>SUR</b>	<b>JAI</b>
<b>URBAN INFRASTRUCTURE</b>	47.68	37.06	38.25	45.75	61.73
<b>ENVIRONMENTAL CLEANLINESS</b>	43.84	46.97	40.77	41.28	36.94
<b>RESOURCE EFFICIENCY</b>	42.21	49.83	40.33	43.87	48.24
<b>BASIC REQUIREMENTS</b>	37.99	43.46	49.98	45.68	43.09

	LUC	NAG	IND	COI	KOC
<b>URBAN INFRASTRUCTURE</b>	56.55	55.54	44.71	53.10	65.18
<b>ENVIRONMENTAL CLEANLINESS</b>	40.76	43.77	37.36	34.32	42.47
<b>RESOURCE EFFICIENCY</b>	41.08	43.56	34.07	40.29	25.18
<b>BASIC REQUIREMENTS</b>	40.19	44.30	36.33	41.30	51.28

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365 Table 6: Benchmarks

<b>PARAMETER</b>	<b>CODE</b>	<b>MAX</b>	<b>MIN</b>	<b>H/L</b>
<b>Population Density (/KM<sup>2</sup>)</b>	DENS	22000	2700	L
<b>Per-capita Income (\$)</b>	INCOM	60578	5004	H
<b>GDP per Sq.KM (\$/KM<sup>2</sup>)</b>	GDP/SQKM	484	25	H
<b>CO2 Emissions/GDP (ton/mi\$)</b>	CO2/GDP	242	21	L
<b>Sulphur Dioxide (µg/M<sup>3</sup>)</b>	SO2	90	3	L
<b>Nitrogen Dioxide (µg/M<sup>3</sup>)</b>	NO2	130	13	L
<b>Particulate Matter (µg/M<sup>3</sup>)</b>	PM10	250	11	L
<b>Water Supply (MLD)</b>	WATER	355	36	H
<b>Sewage (MLD)</b>	SEWAG	334.7	20	H
<b>Waste Generation KG/capita</b>	WASTE	0.84	0.15	L
<b>Sewage Treatment Dummy</b>	TREAT	8	0	H
<b>Electricity Units/GDP (MU/mi\$)</b>	ELE/GDP	125	34.72	L
<b>Public Transport Index</b>	TRANS	5	0.25	H
<b>Health Care Index</b>	HEALT	600	50	H
<b>Literacy Rate (%)</b>	LITER	100	42	H
<b>Housing Affordability Index</b>	HOUSE	5	0.1	H
<b>Per-capita Green Space (M<sup>2</sup>)</b>	GREEN	35.8	0.04	H

366

## 367 **6.DISSCUSSION**

368 What follows is a quick summary of results respective of cities:

### 369 **1. Mumbai**

370 With an urban sustainability score of 53.06, Mumbai ranks on top of the 15  
371 cities besides being one of the most populated city in the world, the  
372 financial capital of India manages to come at the top, owing to efficient  
373 usage of resources and high gross domestic product. Also, the per-capita air  
374 pollution, sewage treatment and waste management is good among the  
375 selected Indian cities. Mumbai has the lowest affordability in the country.

### 376 **2. Delhi**

377 A 43.64 score of urban sustainability makes the National Capital of India a  
378 below average performer. Delhi showed worst indices among Indian cities  
379 in terms of environmental cleanliness, no doubt it is called as the most  
380 polluted city in the world<sup>7</sup>. Delhi has the highest population (21.75  
381 million), ahead of Mumbai, and 2<sup>nd</sup> highest GDP in the country but high  
382 levels of air pollutants and low levels of water & waste treatment makes it  
383 the most polluted city. Public transport systems in the city are good due to  
384 existence of Metro Rail.

### 385 **3. Kolkata**

386 2<sup>nd</sup> in terms of urban sustainability score (52.86) is the former capital of  
387 India. With a difference of 0.20 points than Mumbai, probably owing to  
388 lower environmental cleanliness, Kolkata stands at second position. The  
389 city showed best health care index, only after Chennai. The urban  
390 infrastructure of Kolkata is better than Mumbai or Delhi, because of  
391 relatively lesser population and larger area.

### 392 **4. Chennai**

393 The 4<sup>th</sup> largest metropolitan city of India, stands 3<sup>rd</sup> in urban sustainability  
394 (52.02) with just 1.04 points less than Mumbai. Overall Mumbai, Kolkata &  
395 Chennai, all 3 are the best performers among the selected Indian cities. The  
396 looking at the urban sustainability score of Copenhagen, Denmark at 87,

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<sup>7</sup> <http://www.bbc.com/news/magazine-32352722>

397 there's a long way to go. Chennai comes 1<sup>st</sup> when talking about basic  
398 requirements, as it shows highest per-capita income in the country due to a  
399 diverse industrial base.

#### 400 **5. Bengaluru**

401 The silicon valley of India is an above average performer with an urban  
402 sustainability score of 48.33, it holds 5<sup>th</sup> position. Due to recent  
403 developments, Bengaluru has good urban infrastructure to accommodate its  
404 people. In the rest 3 factors, the city is an average performer.

#### 405 **6. Hyderabad**

406 Hyderabad is a below average performer with a composite index value of  
407 43.07. The city is bad when it comes to basic requirements, it has one of  
408 the lowest health care index. On the other hand, Hyderabad is doing well in  
409 environmental cleanliness, the sewage treatment rate is highest amongst all  
410 the cities and the level of pollution is also less than the other mega cities.

#### 411 **7. Ahmedabad**

412 Ahmedabad is also a below average performing city with an urban  
413 sustainability score of 44.59. The city has the lowest number when  
414 considering urban infrastructure, most of it is because of high population  
415 density and poor public transportation facilities. This might change once  
416 the MEGA Metro Rail project comes into action. On the other hand,  
417 Ahmedabad has best environmental cleanliness index amongst the selected  
418 cities, surprisingly, ahead of Kochi.

#### 419 **8. Pune**

420 Pune ranks second last, only ahead of Indore. The sustainability index of  
421 Pune is 42.57. With an unprecedented growth in migration due to increasing  
422 IT settlements in the city, the present urban infrastructure is not able meet  
423 the requirements. The public transportation accessibility index is worst  
424 among all the cities. Pune should fast move on to other faster modes of  
425 transportation like Metro Rail to keep up the pace. The city has decent  
426 score when it comes to meeting basic requirements, with good health care  
427 and per-capita income.

428 **9. Surat**

429 The city of diamonds is below average performer with an index score of  
430 44.18. The city does not show good score in any of the 4 dimensions except  
431 in urban infrastructure, where it is even lesser. The city's development  
432 authority has joined hands with Microsoft Corporation to jointly develop it  
433 as a Smart-city.

434 **10. Jaipur**

435 Although ranked 4<sup>th</sup> among the selected cities, Jaipur is a just above  
436 performer, with urban sustainability score of 48.37. Because of relatively  
437 lesser population, the city does well only in urban infrastructure index, in  
438 rest 3, it has average scores. Recently Metro Rail system has been launched  
439 in the city.

440 **11. Lucknow**

441 The capital city of Uttar Pradesh is just below average performer with an  
442 urban sustainability score of 45.17. It does slightly above average in urban  
443 infrastructure, whereas below average in basic requirements. Lucknow  
444 shows highest electrical energy requirements per unit of GDP which is bad,  
445 also it is the most affordable city among the selected 15. It has alarming  
446 high levels of PM10 pollutants in the atmosphere and poor sewage  
447 treatment ratio (right next to Delhi). The per-capita solid-waste generation  
448 is lowest for Lucknow

449 **12. Nagpur**

450 Nagpur manages to stay above average with an urban sustainability score of  
451 47.06, it holds 7<sup>th</sup> position that way. The city is good in terms of  
452 environmental cleanliness; in the rest 3 dimensions it does average. Nagpur  
453 has lowest per-capita income among the selected city, due to low GDP.

454 **13. Indore**

455 With an exceptionally low score of 38.33, this city of Madhya Pradesh is  
456 the worst performer in terms of urban sustainability among all the selected  
457 cities of India. The credit goes to bad infrastructure facilities, poor usage  
458 of resources and above all not meeting the basic requirements. The city

459 shows lowest value of healthcare index and poor public transport  
460 accessibility,

#### 461 **14. Coimbatore**

462 Coimbatore has an urban sustainability score of 42.80, which holds it at  
463 last 3<sup>rd</sup> position. It has high electrical energy requirements per unit of GDP  
464 which is bad and high amount of per-capita solid-waste generation. The  
465 green cover per-capita value of the city is high.

#### 466 **15. Kochi**

467 This city in '*Gods Own Country*' is a decent performer with an urban  
468 sustainability score of 48.26, ranked at number 6. The city is best in terms  
469 of urban infrastructure but is, bizarrely, the worst in resource efficiency.  
470 Not to mention that it does well above in other 2 dimensions. The city has  
471 highest literacy rate, highest green cover per-capita, remarkably low levels  
472 of air pollutants and lowest population density among the 15 cities. Now  
473 coming to darker side, it has highest value of per-capita solid waste  
474 generation and high electrical energy requirement per unit of GDP – which  
475 keeps it from being called the Copenhagen of India.

#### 476 **7.CONCLUSION**

477 Subsequent analysis using the Urban Sustainability Index has shown that  
478 Indian cities are substantially lagging towards sustainable development. It  
479 is realised that the high performing cities or the mega-cities of the country  
480 are largely doing better than the smaller 'emerging' class of cities. But  
481 there still remains a long-standing commitment towards achieving the  
482 sustainable 'vision'. Moreover, a deterministic relationship between  
483 economic growth and performance based upon the index could not be  
484 established. The research exposed an unmistakable opportunity for other  
485 emerging cities in India to learn from the practices of their better  
486 performing peers, as well as successes further abroad. The challenge faced  
487 by rapidly growing cities in developing countries, especially in India and  
488 China, is enormous. Using the Urban Sustainability Index as a yardstick to  
489 measure success of cities in emerging markets will help highlight

490 initiatives that work and can help other cities achieve sustainable  
491 development.

492 This study involving the 15 most populated cities of India and 2  
493 other megacities of the world for comparison demonstrates the value of  
494 benchmarking and provides a better understanding of the practical and  
495 data-related aspects of benchmarking cities for sustainability. The study  
496 demonstrates the value of these comparisons in the context of four  
497 dimensions — basic necessities, efficient use of resources, environmental  
498 care and infrastructure. Although it is not an in-depth research of the urban  
499 performance of Indian cities, it is a relatively quick demonstration of using  
500 the existing data sets that benchmarking can be an effective tool in  
501 identifying areas for improvement.

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503

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