Chapter 1
COVID-19: An Opportunity for Smart and Sustainable Cities in India

Meet Fatewar and Vaishali

Abstract The major portion of the world’s population, i.e. around 55%, resides in urban settlements, which is expected to increase to 68% by 2050. Economic development is always given more preference over environmental sustainability. The COVID-19 pandemic is the result of ignorance to have an adequate number of basic infrastructure facilities including healthcare infrastructure and less importance to sustainable environment. The number of confirmed COVID-19 cases are more in the high-density settlements both at global and national level. Therefore, it becomes crucial to develop Indian cities, which are sustainable and capable to fulfil the needs of the citizens by providing smart solutions. A smart city provides smart services to the residents by using Information and Communication Technology, Information Technology, Internet of Things, Artificial Intelligence, and Machine Learning as an integrated part of governance for development. Hence, it is essential to develop smart sustainable cities followed by smart regions, which are well synchronised with the digital technology, as a precautionary measure before an epidemic becomes a pandemic through spatial-statistical analysis. The aforesaid digital model of smart cities is capable of reducing the impact of the COVID-19 pandemic by analysing the real-time data, which can further be extended to smart regions.

Keywords COVID-19 · Smart city · Smart regions · Sustainable cities · Pandemic

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C. Chakraborty et al. (eds.), The Impact of the COVID-19 Pandemic on Green Societies, https://doi.org/10.1007/978-3-030-66490-9_1
1.1 Introduction

The urban settlements of the world are already facing multifaceted problems and a new challenge of COVID-19 seems to be the worst nightmare. As per the estimate of United Nations Department of Economic and Social Affairs (UNDESA) in 2018 [34], 55% of the world’s total population resides in the urban settlements and the share of urban population is expected to increase to 68% by 2050. The infectious diseases are either originating from the urban settlements or transmitting rapidly due to high population density [19]. New York (USA), Madrid (Spain), Milan (Italy), Moscow (Russia), and Sao Paulo (Brazil) are some of the worst COVID-19 affected cities in the world [41]. Therefore, it is important to ensure that urban settlements are well prepared to combat any infectious disease.

The urban population is concentrated in the large metropolis cities and its surrounding areas in many countries including India [12]. The pandemic is expanding continuously all around the globe and impacting adversely the demographic profile of India. On the one hand, cities provide better infrastructure facilities and more employment opportunities. Whereas, on the other hand, cities have also become more vulnerable during the pandemic. In India, a high number of confirmed COVID-19 cases has been reported in the cities including metropolis such as Ahmedabad (Gujarat), Delhi (NCT of Delhi), Chennai (Tamil Nadu), and Mumbai (Maharashtra), etc. [25]. Thus, it becomes important to develop smart cities and smart regions, which are sustainable and capable to fulfil the needs of the present as well as future generations, by providing smart solutions.

A smart city provides smart services to the residents by using Information and Communication Technology (ICT), Information Technology (IT) services, Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) as an integrated part of governance for development [18, 32, 43]. It leads to the integrated development of physical, institutional, social, and economic infrastructure through retrofitting, redevelopment, greenfield development, and pan-city development [10]. However, a sustainable city focuses to reduce the ecological footprint through environmental management. It aims to provide a safe and healthy environment to the people along with the economic growth of the nation. Moreover, ICT has significantly helpful to attain sustainable development through Digital Citizen Participation (DCP), giving rise to the concept of Smart Sustainable City [3]. Though, as per the Indian Smart Cities Mission Statement and Guidelines (2015), sustainable environment is considered under one of the core infrastructure elements. Therefore, the term sustainable is silent in the case of Indian smart cities. Additionally, smart cities have laid down its foundation on high-density development. Thus, the smart cities need to be well synchronised with the digital technology to take precautionary measures, before an epidemic becomes a pandemic, through spatial-statistical analysis. The contribution of the chapter lies in developing a digital model for Indian smart cities by integrating spatial data with digital technology. Moreover, the research tries to assess the impact of the COVID-19 pandemic at global, national, state, and district
level through spatial-statistical analysis, in order to efficiently turn the weakness into the opportunities for the future smart cities of India.

Section 1.2 describes the major sources used for data collection besides the research design adopted by the authors in the research. Section 1.3 illustrates the etymology of COVID-19 from a mysterious pneumonia to an epidemic, which later declared as a pandemic by the World Health Organisation (WHO). The impact of the pandemic is also analysed through descriptive and analytical research at the global level. Section 1.4 focuses on the spatial-statistical analysis at national and state level supported by the available literature. The analysis helps to perceive the consequences of the COVID-19 pandemic on India’s demographic structure. Section 1.5 explains the need of smart and sustainable cities and emphasises the importance of latest digital technology in the modern era. The performance of districts having identified smart cities has been assessed along with the government initiative to combat against the COVID-19 pandemic. Section 1.6 highlights the major issues, which are identified through the research. Then, Sect. 1.7 discusses the recommendations formulated to overcome the identified issues and needs to create smart regions. In addition, a future digital model is proposed, which can be replicated under the same and different geographical locations, to reduce the adverse effect of a pandemic on the smart and sustainable cities. At last, Sect. 1.8 concludes the chapter with a summary.

1.2 Data Collection and Research Design

The 27 weeks (from 11 January 2020 to 17 July 2020) data have been analysed to examine the impact of COVID-19 across the globe. The data shared by WHO has been used for the analysis of the COVID-19 pandemic at the world level. The data has been downloaded by the authors on 18 July 2020, which is last updated at 7:47 pm Central European Summer Time (CEST) on 17 July 2020. The day-wise data of the pandemic before 11 January 2020 is not available on the WHO website, which acts as one of the limitations. As a result of which, the authors are compelled to rely on articles to get the initial spreading details of the COVID-19. Furthermore, WHO does not provide the state-wise data of COVID-19 for India. Therefore, ‘Coronavirus Outbreak in India’ website is referred to get the COVID-19 data at national, state, and district level. In the case of India, 24 weeks data has been collected and analysed, i.e. from 30 January 2020 to 15 July 2020, as the first confirmed case of COVID-19 has been reported on 30 January 2020 in the state of Kerala [26]. The COVID-19 data at the city level is not available as of 20 July 2020 on the official website of India i.e. ‘Coronavirus Outbreak in India’. Thus, city-level analysis is beyond the scope of this chapter. Furthermore, the demographic profile of the country is collected from the Census of India, which is available on the website of Office of the Registrar General & Census Commissioner, India (ORGI).

The analytical research is a combination of both quantitative and qualitative analysis. The data is analysed by using big-data sets through spatial-statistical and geospatial analysis at world level, all-India level, state level, and district level. The accessible
data sets do not allow for spatial analysis at a scale smaller than district due to the non-availability of data at the city level. Therefore, the districts having smart cities are identified and their data is compared with the remaining districts of the respective state of India. The spatial and non-spatial issues are identified based on the analysis. Finally, the digital model is proposed along with the recommendations to overcome the identified issues with the help of latest digital technology.

1.3 COVID-19: A Pandemic

The first case of an outbreak of mysterious pneumonia was reported in November 2019 at Huanan Seafood Wholesale Market, Wuhan, Hubei, China. The symptoms associated with the mysterious pneumonia were fever, fatigue, dry cough, and occasional gastrointestinal. Later, the pathogen of the outbreak was identified as a novel beta-coronavirus and named as 2019 novel coronavirus (2019-nCoV). As per the official data, the first confirmed case of 2019-nCoV had been reported in China in the first week of December 2019. The local health authority of the city had announced the epidemiologic alert in the area on 31 December 2019. Thus, the market area was shut down as a precautionary measure to control the spread of nCoV-19 on 1 January 2020. Outside China, the first case was reported in Thailand on 13 January 2020. After that, the 2019-nCoV was started spreading across the world in the few weeks of January 2020. Ultimately, WHO had declared the outbreak constitutes a Public Health Emergency of International Concern (PHEIC) on 30 January 2020. The nCoV-19 outbreak expanded to at least 25 countries till 6 February 2020. WHO had given the name to the disease as Coronavirus Disease-2019 (COVID-19) on 11 February 2020. The virus, which causes the COVID-19, was named as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses (ICTV) on the same date, i.e. 11 February 2020 [37, 39, 40]. Finally, WHO had declared the disease as a ‘Pandemic’ due to increase in the number of COVID-19 confirmed cases all across the globe (in 114 countries) on 11 March 2020 [38] (Fig. 1.1).

1.3.1 Current Scenario in the World

The COVID-19 outbreak has made it clear, that today’s urban settlements are not well prepared to combat an epidemic and pandemic. The urban settlements have now become either the originator of infectious diseases or propagate it exponentially because of the high population density and urbanisation rate, e.g. the COVID-19 pandemic emerged in Wuhan city of China [17]. Later, the virus spread through different modes of transport based on the travelling behaviour of an individual at both international and domestic level through airways and domestic public transport, respectively [19]. Economic development has always given more importance
over environmental sustainability. It leads to an increase in the level of urbanisation, creates an ecological imbalance, degradation of environment, and so on. All such phenomenon has the ability to accelerate the process of virus transmission from one person to another [4]. Globally, the total number of confirmed COVID-19 cases has exceeded 13.61 million mark with a Case Fatality Rate (CFR) of around 4.30% (0.58 million people) till 17 July 2020 [35]. Out of the six regions on the globe, the American region is the worst affected region due to the COVID-19 pandemic. The maximum number of confirmed cases and death due to COVID-19 have been recorded in the American Region with 52.55% (7.15 million) and 50.85% (0.29 million), respectively, followed by Europe and Eastern Mediterranean Region (Table 1.1). However, the CFR of the world has decreased significantly from 15 to 4.30% [20].

The analysis of COVID-19 data has given some valuable insides about the spread of SARS-CoV-2. The trend shows that, in the initial 6 weeks, the number of cases increased at a constant rate and followed a linear curve. From the 6th week onwards, the trend showed an exponential hike in the total number of confirmed COVID-19 cases. However, some regions were able to control the spread of COVID-19 and slow down the transmission of SARS-CoV-2 from the 12th week onwards as best exemplified by Europe Region (Figs. 1.2 and 1.3).

In the EURO, there was a sudden change in the graph from exponential to almost linear after the 12th week onwards due to the decrease in the average number of reported COVID-19 cases per week. Furthermore, the WPRO was able to control the situation within the initial 6 weeks. As a result of which, the WPRO has registered the minimum number of COVID-19 cases in the region. But the AMRO was not able to control the spread of SARS-CoV-2 in the initial 14 weeks. In turn, AMRO had registered the maximum number of confirmed cases per week and experienced an exponential increase in the total number of cases from the 15th week onwards (Figs. 1.2 and 1.3). From the analysis, it is observed that the three weeks period is

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**Fig. 1.1** Etymology of COVID-19. *Source* Authors, data from [37, 39, 40]
Table 1.1  Region-wise existing scenario of the COVID-19 pandemic

| S. No. | Region name                      | Region code | Confirmed cases (in No.) | Confirmed death (in No.) | CFR (in %) |
|--------|----------------------------------|-------------|--------------------------|--------------------------|------------|
| 1      | American Region                  | AMRO        | 7,154,840                | 297,855                  | 50.85      | 4.16      |
| 2      | Europe Region                    | EURO        | 3,008,972                | 205,482                  | 35.08      | 6.83      |
| 3      | Eastern Mediterranean Region     | EMRO        | 1,346,982                | 33,281                   | 5.68       | 2.47      |
| 4      | South-East Asia Region           | SEARO       | 1,308,441                | 32,100                   | 5.48       | 2.45      |
| 5      | African Region                   | AFRO        | 543,122                  | 9,130                    | 1.56       | 1.68      |
| 6      | Western Pacific Region           | WPRO        | 253,495                  | 7,866                    | 1.34       | 3.10      |
| 7      | Other                            | Other       | 741                      | 13                       | 0.00       | 1.75      |
| 8      | Total                            |             | 13,616,593               | 585,727                  | 100.00     | 4.30      |

Source Based on Authors calculation, data from [35]

Fig. 1.2  Region-wise COVID-19 cumulative cases in the world. Source Authors, data from [35]

very crucial, which lasts from the 12th to 15th week, in order to control the spread of the COVID-19 pandemic by taking appropriate measures. Moreover, the number of new cases per week in SEARO and AFRO regions is increasing continuously week after week; whereas, EMRO region shows a decline from the 23rd week onwards.
The AMRO has also recorded the highest number of death due to COVID-19 with 0.29 million till 17 July 2020 followed by EURO and EMRO with 0.21 million and 0.03 million, respectively (Fig. 1.4). The exponential increase led to more fatalities as the AMRO was not able to check on the transmission of SARS-CoV-2 during the initial 14 weeks. As a consequence of which, the total number of deaths in the AMRO is increasing linearly. On the other hand, EURO has recorded the maximum number
of deaths per week for the initial 15 weeks in the world but, after that, managed to control the situation in the latter weeks (Fig. 1.5). Additionally, lesser number of deaths are recorded in EMRO, SEARO, AFRO, and WPRO due to less number of confirmed COVID-19 cases as compared to AMRO and EURO.

Presently, the world neither has any vaccine to cure SARS-CoV-2 nor validated treatment for COVID-19 [40]. Therefore, WHO has suggested to quarantine (or home quarantine) the patient for 14 days or 2 weeks [36]. The positive results of 2 weeks quarantine period are clearly visible in the case of EURO. The number of fatalities due to COVID-19 had decreased significantly in European Region during the 14th week, i.e. just 2 weeks after the region had also been able to reduce the number of COVID-19 cases per week. The same trend was visible till the 27th week (17 July 2020). However, the American Region was able to control the exponential increase in the new number of registered COVID-19 cases into the linear one (more or less) from the 13th week onwards. The positive impacts of the change in graph were also visible in the number of new deaths during the 15th week and thereafter (i.e. just after 2 weeks). Thus, the impact on the control of COVID-19 spread is visible after a period of 2 consecutive weeks, which results in the reduction of fatality cases.

In the world, the United States of America (USA) is the most affected country due to COVID-19. The share of confirmed COVID-19 cases of USA in the world is more than one-fourth (25.50%) with 3.4 million cases followed by Brazil and India with 1.9 million and 1.0 million, respectively, till 17 July 2020. Surprisingly, the top 20 worst affected countries constitute 81.70% of the world’s total confirmed COVID-19 cases (Table 1.2).

The impact of the pandemic is more in the high population density areas as compared to the low population density areas as observed in metropolis. As a result
Table 1.2 Most affected countries by COVID-19 pandemic in the world

| S. No. | Country name               | Total cases (in No.) | Total death (in No.) | CFR (in %) |
|--------|---------------------------|----------------------|----------------------|------------|
| 1      | United States of America  | 3,472,659            | 136,753              | 23.35      |
| 2      | Brazil                    | 1,966,748            | 75,366               | 23.35      |
| 3      | India                     | 1,003,832            | 25,602               | 23.35      |
| 4      | Russian Federation        | 759,203              | 12,123               | 23.35      |
| 5      | Peru                      | 337,724              | 12,417               | 23.35      |
| 6      | South Africa              | 324,221              | 4,669                | 23.35      |
| 7      | Chile                     | 323,698              | 7,290                | 23.35      |
| 8      | Mexico                    | 317,635              | 36,906               | 23.35      |
| 9      | The United Kingdom        | 292,556              | 45,119               | 23.35      |
| 10     | Iran                      | 267,061              | 13,608               | 23.35      |
| 11     | Pakistan                  | 259,999              | 5,475                | 23.35      |
| 12     | Spain                     | 258,855              | 28,416               | 23.35      |
| 13     | Italy                     | 243,736              | 35,017               | 23.35      |
| 14     | Saudi Arabia              | 243,238              | 2,370                | 23.35      |
| 15     | Turkey                    | 216,873              | 5,440                | 23.35      |
| 16     | Germany                   | 200,843              | 9,082                | 23.35      |
| 17     | Bangladesh                | 196,323              | 2,496                | 23.35      |
| 18     | Colombia                  | 165,169              | 5,814                | 23.35      |
| 19     | France                    | 163,550              | 30,032               | 23.35      |
| 20     | Argentina                 | 111,160              | 2,072                | 23.35      |
| 21     | Rest of the World         | 2,491,510            | 89,660               | 23.35      |
| 22     | Total                     | 13,616,593           | 585,727              | 23.35      |

Source: Based on Authors calculation, data from [35]

of which, a greater number of confirmed COVID-19 cases are registered in the densely populated cities of the world, i.e. London (UK), Madrid (Spain), Milan (Italy), Moscow (Russia), New York (USA), and Sao Paulo (Brazil). The cities which were once promising to improve the urban infrastructure, provide a better quality of life along with a safe and healthy environment have astonishingly crashed. The pandemic has not only shuddered the economy of the cities and metropolis, but also led to interrupt the global production, demand and supply chain, and consumption networks of the urbanised areas [9, 41]. Thus, compact development and competitive business environment with inadequate infrastructure facilities affect the city’s sustainability.
1.4 Assessment of COVID-19 in India

The first case of COVID-19 has been recorded in the Kerala state of India on 30 January 2020 [26]. From the first confirmed COVID-19 case in India, it took 58 days to reach the 1,000 mark (on 29 March 2020). Whereas, India had crossed the cumulative sum of 10,000 COVID-19 cases in just another 16 days (on 14 April 2020). The confirmed cases figure breached the mark of 1,00,000 (0.1 million) in the next 35 days (20 May 2020). As of 17 July 2020, the total number of COVID-19 cases in India had crossed the 1 million mark in another 59 days [23]. However, the first death due to COVID-19 had been reported on 12 March 2020 in India [30]. The Honourable Prime Minister (PM) of India, Shri Narendra Modi, had announced one-day Janta Curfew as a precautionary measure to control the spread of COVID-19. After the successful trial of one-day Janta Curfew, the lockdown was extended till 14 April 2020 under Phase-1. The citizens were informed about the do’s and don’ts while stepping out from the premises. Social distancing was suggested by the Government of India (GoI) to slow down the rate of disease transmission. The exponential increase in the number of COVID-19 cases had led the further extension of lockdown under Phase-2 (15 April to 3 May 2020), Phase 3 (4 May to 17 May 2020), and Phase 4 (18 May to 31 May 2020). For the purpose of controlling the spread of SARS-CoV-2 virus, GoI had divided the districts into three major zones based on the number of COVID-19 cases, i.e. (i) Red Zone: areas with high number of cases besides doubling rate of less than 4 days; (ii) Orange Zone: areas with few cases and no increase in new cases; (iii) Green Zone: areas with no case. The list of restricted and permissible activities had also been issued by the GoI for all the three aforesaid zones. Finally, GoI had proposed some relaxation and implemented Unlock-1 (1 June to 30 June 2020) followed by Unlock-2 (1 July to 31 July 2020) with a complete shut down of educational and recreational space [21] (Fig. 1.6).

Fig. 1.6 COVID-19: Chronology of changes in India, 2020 Source Authors, data from [21, 23, 26]
As per the analysis, it is observed that the number of reported cases is less due to a lesser number of testing in the initial six weeks. After that, the reported cases have started to increase in an exponential number. However, as of 15 July 2020, India has managed to improve the recovery rate and decrease the CFR with 63.3% and 2.6%, respectively (Fig. 1.7).

1.4.1 State-Wise Analysis of COVID-19 in India

In India, the spread of SARS-CoV-2 virus is increasing day after day. The highest number of COVID-19 cases has been confirmed in the state of Maharashtra (second most populous state of India) followed by Tamil Nadu and Delhi with 0.27 million (2.7 lakh), 0.15 million (1.5 lakh), and 0.11 million (1.1 lakh), respectively. However, Lakshadweep is the only UT in India, which has not recorded a single COVID-19 case. The maximum number of active cases is also observed in Maharashtra (0.11 million) and Tamil Nadu (0.04 million). Whereas, Delhi has managed to control the situation more efficiently as compared to the other top two most affected states of India with 17,807 active cases and slipped to number four in the tally. While, 20 states and 6 UTs (excluding Lakshadweep) are having less than 8,000 active cases within the respective geographical boundaries, which is a good symbol for one of the most populated countries of the world (Table 1.3). Interestingly, out of the 28 states and 8 UTs, only 1 state and 5 UTs are able to test more than 3% of its population. Goa (state) has tested around 6.81% of its total population followed by Dadra and Nagar Haveli and Daman and Diu (UT), and Ladakh (UT) with 6.38% and 5.69%,
### Table 1.3  State-wise COVID-19 status, India

| S. No. | State name       | State population (in Million) | Sample tested (in Thousand) | Share of tested population (in %) | Confirmed cases (in Thousand) | Test positivity rate (in %) | Active cases (in Thousand) | Recovered cases (in Thousand) | Recovery rate (in %) | Deceased cases (in No.) | CFR (in %) |
|--------|------------------|-----------------------------|-----------------------------|----------------------------------|--------------------------------|-----------------------------|----------------------------|---------------------------|-------------------|------------------------|------------|
| 1      | Maharashtra      | 112.4                       | 1413.2                      | 1.26                             | 275.6                         | 19.50                       | 111.8                      | 152.6                     | 55.37             | 10,928                 | 3.96       |
| 2      | Tamil Nadu       | 72.1                        | 1736.7                      | 2.41                             | 151.8                         | 8.74                        | 47.3                       | 102.3                     | 67.39             | 2,167                  | 1.43       |
| 3      | Delhi            | 16.8                        | 736.4                       | 4.40                             | 117.0                         | 15.89                       | 17.8                       | 95.7                      | 81.80             | 3,487                  | 2.98       |
| 4      | Karnataka        | 61.1                        | 902.0                       | 1.48                             | 47.3                          | 5.24                        | 27.8                       | 18.5                      | 39.08             | 933                    | 1.97       |
| 5      | Gujarat          | 60.4                        | 487.7                       | 0.81                             | 44.6                          | 9.15                        | 11.2                       | 31.3                      | 70.21             | 2,080                  | 4.66       |
| 6      | Uttar Pradesh    | 199.6                       | 1277.2                      | 0.64                             | 41.4                          | 3.24                        | 14.6                       | 25.7                      | 62.21             | 1,012                  | 2.45       |
| 7      | Telangana        | 35.2                        | 208.7                       | 0.59                             | 39.3                          | 18.85                       | 13.0                       | 26.0                      | 66.08             | 386                    | 0.98       |
| 8      | Andhra Pradesh   | 49.5                        | 1218.0                      | 2.46                             | 35.5                          | 2.91                        | 16.6                       | 18.4                      | 51.84             | 452                    | 1.27       |
| 9      | West Bengal      | 91.3                        | 649.9                       | 0.71                             | 34.4                          | 5.30                        | 12.7                       | 20.7                      | 60.07             | 1,000                  | 2.90       |
| 10     | Rajasthan        | 68.6                        | 1123.9                      | 1.64                             | 26.4                          | 2.35                        | 6.4                        | 19.5                      | 73.77             | 530                    | 2.00       |
| 11     | Haryana          | 25.4                        | 400.2                       | 1.58                             | 23.3                          | 5.82                        | 5.3                        | 17.7                      | 75.80             | 319                    | 1.37       |
| 12     | Bihar            | 103.8                       | 337.2                       | 0.32                             | 20.2                          | 5.98                        | 6.5                        | 13.5                      | 67.08             | 157                    | 0.78       |
| 13     | Assam            | 31.2                        | 589.2                       | 1.89                             | 19.8                          | 3.35                        | 6.8                        | 12.9                      | 65.24             | 53                     | 0.27       |
| 14     | Madhya Pradesh   | 72.6                        | 540.5                       | 0.74                             | 19.6                          | 3.63                        | 5.1                        | 13.9                      | 70.80             | 682                    | 3.47       |
| 15     | Odisha           | 41.9                        | 353.8                       | 0.84                             | 14.9                          | 4.21                        | 4.3                        | 10.5                      | 70.32             | 101                    | 0.68       |
| 16     | Jammu and Kashmir| 12.3                        | 474.1                       | 3.86                             | 11.7                          | 2.46                        | 5.1                        | 6.3                       | 54.32             | 206                    | 1.77       |
| 17     | Kerala           | 33.4                        | 453.7                       | 1.36                             | 9.6                           | 2.11                        | 4.9                        | 4.6                       | 48.50             | 36                     | 0.38       |

(continued)
Table 1.3 (continued)

| S. No. | State name            | State population (in Million) | Sample tested (in Thousand) | Share of tested population (in %) | Confirmed cases (in Thousand) | Test positivity rate (in %) | Active cases (in Thousand) | Recovered cases (in Thousand) | Recovery rate (in %) | Deceased cases (in No.) | CFR (in %) |
|--------|-----------------------|-------------------------------|------------------------------|-----------------------------------|-------------------------------|---------------------------|----------------------------|---------------------------|----------------------|------------------------|-----------|
| 18     | Punjab                | 27.7                          | 421.6                        | 1.52                              | 8.8                           | 2.09                      | 2.7                       | 5.9                       | 66.68                | 221                    | 2.51      |
| 19     | Jharkhand             | 33.0                          | 196.1                        | 0.59                              | 4.6                           | 2.33                      | 2.0                       | 2.5                       | 54.47                | 38                     | 0.83      |
| 20     | Chhattisgarh          | 25.5                          | 222.1                        | 0.87                              | 4.6                           | 2.05                      | 1.2                       | 3.3                       | 72.96                | 20                     | 0.44      |
| 21     | Uttarakhand           | 10.1                          | 102.5                        | 1.01                              | 3.8                           | 3.69                      | 0.8                       | 2.9                       | 77.89                | 50                     | 1.32      |
| 22     | Goa                   | 1.5                           | 99.2                         | 6.81                              | 3.0                           | 2.97                      | 1.3                       | 1.7                       | 56.73                | 18                     | 0.61      |
| 23     | Tripura               | 3.7                           | 92.3                         | 2.51                              | 2.3                           | 2.47                      | 0.7                       | 1.6                       | 70.32                | 3                      | 0.13      |
| 24     | Manipur               | 2.7                           | 65.9                         | 2.42                              | 1.7                           | 2.58                      | 0.6                       | 1.1                       | 63.53                | 0                      | 0.00      |
| 25     | Puducherry            | 1.2                           | 27.9                         | 2.24                              | 1.6                           | 5.72                      | 0.7                       | 0.9                       | 55.70                | 21                     | 1.32      |
| 26     | Himachal Pradesh      | 6.9                           | 105.7                        | 1.54                              | 1.3                           | 1.27                      | 0.4                       | 1.0                       | 72.04                | 10                     | 0.75      |
| 27     | Ladakh                | 0.3                           | 15.6                         | 5.69                              | 1.1                           | 7.32                      | 0.2                       | 1.0                       | 84.41                | 1                      | 0.09      |
| 28     | Nagaland              | 2.0                           | 27.4                         | 1.38                              | 0.9                           | 3.29                      | 0.6                       | 0.3                       | 38.58                | 0                      | 0.00      |
| 29     | Chandigarh            | 1.1                           | 10.1                         | 0.95                              | 0.6                           | 6.16                      | 0.1                       | 0.5                       | 74.15                | 11                     | 1.78      |
| 30     | Dadra and Nagar Haveli and Daman and Diu | 0.6 | 37.4 | 6.38 | 0.6 | 1.49 | 0.2 | 0.4 | 66.49 | 2 | 0.36 |
| 31     | Arunachal Pradesh     | 1.4                           | 34.6                         | 2.50                              | 0.5                           | 1.42                      | 0.3                       | 0.2                       | 31.16                | 3                      | 0.61      |
| 32     | Meghalaya             | 3.0                           | 24.9                         | 0.84                              | 0.3                           | 1.35                      | 0.3                       | 0.0                       | 13.65                | 2                      | 0.59      |

(continued)
| S. No. | State name                      | State population (in Million) | Sample tested (in Thousand) | Share of tested population (in %) | Confirmed cases (in Thousand) | Test positivity rate (in %) | Active cases (in Thousand) | Recovered cases (in Thousand) | Recovery rate (in %) | Deceased cases (in No.) | CFR (in %) |
|-------|--------------------------------|------------------------------|-----------------------------|----------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|----------------------|-----------------------|----------|
| 33    | Mizoram                        | 1.1                          | 17.2                        | 1.57                             | 0.2                           | 1.39                        | 0.1                         | 0.2                         | 66.81                | 0                     | 0.00     |
| 34    | Sikkim                         | 0.6                          | 13.4                        | 2.20                             | 0.2                           | 1.66                        | 0.1                         | 0.1                         | 39.19                | 0                     | 0.00     |
| 35    | Andaman and Nicobar Islands    | 0.4                          | 19.1                        | 5.02                             | 0.2                           | 0.92                        | 0.0                         | 0.1                         | 73.86                | 0                     | 0.00     |
| 36    | Lakshadweep                    | 0.1                          | 0.0                         | 0.00                             | 0.0                           | 0.00                        | 0.0                         | 0.0                         | 0.00                 | 0                     | 0.00     |
| 37    | Unassigned*                    | 0.0                          | 0.0                         | 0.00                             | 1.5                           | 0.00                        | 1.5                         | 0.0                         | 0.00                 | 0                     | 0.00     |
| 38    | India                          | 1,210.2                      | 14,435.5                    | 1.19                             | 970.2                         | 6.72                        | 331.1                       | 613.7                       | 63.26                | 24,929                | 2.57     |

*Source* Authors Calculation, data from [6, 7, 27, 33]

*Note* refer [13] for official definition of Unassigned State
respectively. While, Bihar, with 0.32%, has tested the least percentage of its total population.

Presently, the average recovery rate of India is observed to be around 63.26% (as of 15 July 2020). In India, the recovery rate of individual states varies from 13.65% in Meghalaya to 84.41% in Ladakh. The recovery rate of India has been improving continuously since the 9th week onwards. Out of the 28 states and 8 UTs of India, 15 states and 6 UTs have a recovery rate more than the national average. Furthermore, there are only two UTs, which have registered a recovery rate of more than 80%, i.e. Ladakh and Delhi with 84.41% and 81.80%, respectively. The Kerala state of India, which recorded the first case of COVID-19, has recorded a recovery rate of 48.50%. Moreover, Maharashtra with 10,928 deaths is the only state, which has reported more than 10,000 deaths due to COVID-19. In India, 4 states and 1 UT (excluding Lakshadweep) have not recorded any death case due to COVID-19, whereas, 23 states and 6 UTs (excluding Lakshadweep) have recorded less than 1,000 deaths each within the respective geographical boundary. India is also able to maintain a continuous decrease in the CFR in the last 4 weeks. The average CFR of India is 2.57%, which is lesser than the average CFR of the world, i.e. 4.30%. In India, the highest CFR is recorded in the state of Gujarat followed by Maharashtra and Madhya Pradesh with 4.66%, 3.96%, and 3.47%, respectively. Additionally, 23 states and 6 UTs (excluding Lakshadweep) of India are having CFR less than the national average.

From the spatial-statistical analysis, it is clear that some North-East (NE), Northern states, and UTs of India have performed much better and have fewer cases of COVID-19 as compared to the other part of the nation. In the whole nation, 5 states and 3 UTs (excluding Lakshadweep) have recorded less than 1,000 COVID-19 cases. Interestingly, all the 5 states with less than 1,000 belong to the NE region, i.e. Sikkim (222), Mizoram (238), Meghalaya (337), Arunachal Pradesh (491), and Nagaland (902); whereas, UTs are distributed unevenly, i.e. Andaman and Nicobar Islands (176), Dadra and Nagar Haveli and Daman and Diu (558), and Chandigarh (619), throughout the nation (Fig. 1.8).

Moreover, Southern and Western states are the most affected states of India followed by Central and Eastern states. It is because of the high number of confirmed COVID-19 cases in Maharashtra (Southern state) and Tamil Nadu (Western state), which further act as hotspot for the neighbouring states. Additionally, usually the Himalayas, NE regions, and islands are having less connectivity with other parts of the country and have scattered settlements with low population density. It is one of the major reasons behind the COVID-19 free UT of India, i.e. Lakshadweep, and lesser number of confirmed COVID-19 in Andaman and Nicobar Islands, Northern regions, and NE region of India.

As per Kapoor et al. [15], in India, the total number of hospital beds is around 1.9 million. Out of which, the share of Intensive Care Unit (ICU) is about 5% (95,000). Whereas, only 50% (48,000) of the ICU beds are equipped with ventilators. From the 28 states and 8 UTs of India, the maximum number of hospital beds and ventilators are concentrated in only 7 states with a share of approximately 65.2%, i.e. Uttar Pradesh (14.8%), Karnataka (13.8%), Maharashtra (12.2%), Tamil Nadu (8.1%),
West Bengal (5.9%), Telangana (5.2%), and Kerala (5.2%). Interestingly, all the aforesaid states have recorded a high number of confirmed COVID-19 cases and death as compared to other states.

In India, the total number of people tested till 15 July 2020 is 14.45 million, which is equivalent to just 1.19% of the total population of India, with a test positivity rate of around 6.72% (0.97 million). Out of the total recorded cases, 0.33 million are active cases, whereas, the average recovery rate of the nation is 63.26% (0.61 million). However, 2.57% (24,929) people died due to COVID-19. As per the author’s estimate based on the current trend, after testing the total population of the nation, the total number of confirmed COVID-19 cases may rise to 81.33 million or even more. Out of the total confirmed cases, around 2.1 million people may either in a
critical condition or die. Thus, the people, who are in critical condition, need ICU beds with ventilator facility. However, at present, India has around 48,000 ICU beds and ventilators. It means that India can only provide ICU beds with ventilators to approximately 2.30% of total critical cases at a time. Therefore, the country does not seem to be ready to combat any health emergency, especially an epidemic and/or a pandemic (COVID-19).

1.5 Smart and Sustainable Cities

The cities are considered as the engines of economic growth along with social development [16]. The metropolitan areas around the cities have begun with a number of initiatives aimed to upgrade the urban infrastructure and associated services, in order to improve the environment, uplift social conditions, and enhance economic growth. As a result of which, the new concept of smart and sustainable cities has evolved over a period of time [14]. Smart cities improve quality of life by providing sustainable environment with the help of efficient use of digital technology, which follows the fundamentals of spatial intelligence [8].

The digital technology used to build a smart city also helps to innovate new solutions to resolve the problems of everyday life, more effectively in less time, by analysing the big data [31]. Smart city provides smart services to the residents by converging the use of digital technology, such as Information and Communication Technology (ICT), Information Technology (IT) services, Internet of Things (IoT), Machine Learning (ML), and Artificial Intelligence (AI), as an integrated part of governance for development [18, 32, 43]. Whereas sustainable city focuses on reducing the ecological footprint through environmental management. It intends to develop a clean and healthy environment to the people along with the economic growth of the nation. Moreover, ICT has significantly been helpful to attain sustainable development through Digital Citizen Participation (DCP), giving rise to the concept of Smart Sustainable City [3].

In India, the total population has increased from 1.03 billion in 2001 to 1.21 billion in 2011 with a decadal growth rate of around 17.64% [6]. Out of the total population (1.21 billion), 31% population (0.62 billion) resides in urban settlements and contributes 63% of India’s Gross Domestic Product (GDP). The urban population is expected to be increased to 40% with the contribution of 75% of India’s GDP by 2030. It can be achieved with the overall development of physical, institutional, social, and economic infrastructure facilities in the nation [2]. Therefore, a new concept of Smart Cities Mission (SCM) has emerged, which is launched by the Ministry of Urban Development (MoUD) on 25 June 2015 as a Centrally Sponsored Scheme (CSS), to achieve the desired growth and development in a city [1].

The objective of the SCM is to develop future cities with the provision of adequate infrastructure facilities along with a sustainable environment, which in turn provides a better quality of life through the application of smart solutions. The focus is to create a sustainable and inclusive city development model, which can be replicated
in other parts of the nation [10]. In India, 100 smart cities have been selected across the nation under four rounds. Tamil Nadu state of India is having the maximum number of smart cities followed by Uttar Pradesh and Maharashtra with 11, 10, and 8, respectively (Fig. 1.9).

The SCM has adopted two approaches for the development of Indian smart cities, i.e. Area Based Development (ABD) and pan-city development. The ABD encourages the compact development of the city, based on the three models, i.e. (i) retrofitting development: focuses on the city improvement (for an area more than 500 acres); (ii) redevelopment: follows the process of city renewal (for an area more than 50 acres); and (iii) greenfield development: emphasises on city extension (for an area more than 250 acres). Whereas, the pan-city development provides smart

Fig. 1.9 Location of 100 selected smart cities (round-wise) in India. Source Authors, data from [28]
Table 1.4  Selected cities under SCM, India

| S. No. | Round No. | Month, year | No. of selected cities | Population impacted (in million) | Area based development cost (in Rs. billion) | Pan city solution cost (in Rs. billion) | Total cost (in Rs. billion) |
|--------|-----------|-------------|------------------------|-----------------------------------|---------------------------------------------|----------------------------------------|----------------------------|
| 1      | Round 1: Light House | Jan. 2016 | 20                     | 37.3                              | 371.23                                      | 109.41                                 | 480.64                     |
| 2      | Round 1: Fast Track  | May 2016  | 13                     | 9.4                               | 259.74                                      | 38.21                                  | 297.95                     |
| 3      | Round 2     | Sep. 2016  | 27                     | 25.5                              | 425.24                                      | 113.79                                 | 539.03                     |
| 4      | Round 3     | Jun. 2017  | 30                     | 23.7                              | 469.79                                      | 105.15                                 | 574.94                     |
| 5      | Round 4     | Jan. 2018  | 10                     | 3.7                               | 116.05                                      | 22.58                                  | 138.63                     |
| 6      | Total       |             | 100                    | 99.6                              | 1,642.05                                     | 389.14                                 | 2,031.19*                  |

Source: Authors, data from [22, 28, 29]

Note: * denotes the cost excluding other costs, i.e. Operation and Maintenance (O&M), contingency, etc.

solutions for the existing infrastructure problems with the use of latest digital technology. Additionally, sustainable environment is considered under one of the core infrastructure elements. Therefore, the term sustainable is used silently under the SCM of India. The government will spend Rs. 1 billion (Rs. 100 crores) per city per year within a span of 5 years (from 2015–16 to 2019–20). The contribution of the Central government is limited to Rs. 480 billion (Rs. 48,000 crores) over a period of five years [1, 10]. The total estimated project cost required for the development of 100 smart cities is around Rs. 2,050.18 billion (including other costs such as Operation and Maintenance (O&M), contingency, etc.). Out of which, 80.8% (Rs. 1,642.05 billion) is assigned for the development under ABD and the remaining 19.2% (Rs. 389.14 billion) is assigned for pan-city development (Table 1.4).

1.5.1 Smart City Analysis

From the 100 smart cities identified under SCM, 49 cities are located in just 6 states of India, such as Tamil Nadu (11), Uttar Pradesh (10), Maharashtra (8), Karnataka (7), Madhya Pradesh (7), and Gujarat (6). All these 6 states are connected in a continuous manner spatially, starting from Uttar Pradesh in the North and ending at Tamil Nadu in the South (Fig. 1.10). In India, the share of total confirmed and active COVID-19 cases in the aforesaid 6 states is also high with 59.82% (0.58 million) and 65.81% (0.21 million), respectively.
Furthermore, the average recovery rate of these 6 states is 59.34%, which is lower than the average recovery rate at national level, i.e. 63.26%. The same trend has been observed in the total number of deaths. From the total deaths (24,929), 71.41% (17,802) deaths are reported in these 6 states of India (Table 1.5). Hence, high number of confirmed cases, active cases, and deaths are recorded in the aforesaid 6 states along with the lower recovery rate. Whereas, in the remaining 22 states and 7 UTs (excluding Lakshadweep), the percentage of confirmed and active cases is 40.68% and 34.19%, respectively.

The COVID-19 data at the city level is not available on an open-access portal of India (as of 15 July 2020). Therefore, the data at the district level has been analysed by
Table 1.5  Impact of COVID-19 in the states of selected smart cities

| S. No. | State name       | No. of smart cities | Confirmed cases (in No.) | Active cases (in No.) | Recovered cases (in No.) | Death recorded (in No.) |
|--------|------------------|----------------------|--------------------------|-----------------------|--------------------------|-------------------------|
| 1      | Tamil Nadu       | 11                   | 151,820                  | 47,343                | 102,310                  | 2,167                   |
| 2      | Uttar Pradesh    | 10                   | 41,383                   | 14,628                | 25,743                   | 1,012                   |
| 3      | Maharashtra     | 8                    | 275,640                  | 111,801               | 152,613                  | 10,928                  |
| 4      | Karnataka       | 7                    | 47,253                   | 27,849                | 18,467                   | 933                     |
| 5      | Madhya Pradesh  | 7                    | 19,643                   | 5,053                 | 13,908                   | 682                     |
| 6      | Gujarat          | 6                    | 44,648                   | 11,222                | 31,346                   | 2,080                   |
| 7      | Sub-Total        | 49                   | 580,387                  | 217,896               | 344,387                  | 17,802                  |
|        |                  |                      | (59.82%)**               | (65.81%)**            | (59.34%)##               | (71.41%)#               |
| 8      | Remaining states & UTs | 51                  | 389,782                  | 113,220               | 269,348                  | 7,127                   |
| 9      | Total            | 100                  | 970,169                  | 331,116               | 613,735                  | 24,929                  |

Source  Authors Calculation, data from [7]
Note 1. Percentage of Confirmed Case is marked with *; 2. Percentage of Active Cases is marked with **; 3. Average recovery rate of top 6 affected states is marked with ##; 4. CFR is marked with #

The authors. The district-level data has been collected and compared with the national-level data. In India, the total number of districts are 640 [5]. The 100 smart cities have been distributed in the 97 districts (15%) of the nation. The share of COVID-19 confirmed cases in these 97 districts is around 52.65% (0.51 million). Moreover, out of the total death (0.02 million) due to COVID-19, 54.18% (0.01 million) people died in these 15% (97) districts of India. Additionally, the share of COVID-19 cases registered in the districts of identified smart cities with the remaining districts of the respective state is high in all aforesaid 6 states as compared to the remaining state of India (Fig. 1.11). All these states are also having a high number of confirmed COVID-19 cases in the state as well as in the respective districts of identified smart cities. Hence, as per the analysis, it is observed that the impact of the COVID-19 pandemic is comparatively more in the states having more number of smart cities.

Also, the states with maximum number of smart cities are dynamic in nature, i.e. Delhi (National Capital of the country), Maharashtra (Nashik: Wine Capital of India; Pune: Queen of Deccan; Nagpur: Orange City; Thane: City of Lakes), Tamil Nadu (Coimbatore: Manchester of South India; Chennai: Health Capital of India; Madurai: Temple City; Tiruchirappalli: Rock Fort City; Tirunelveli: Oxford City of South India), Uttar Pradesh (Agra: City of Taj; Allahabad: Abode of the God; Kanpur: Leather City of the World; Lucknow: City of Nawabs; Varanasi: Religious Capital of India), etc [24]. Thus, the vibrant function of cities has become a node for the surrounding areas, which attracts the major part of the population from the surrounding areas as well as neighbouring districts. In turn, the process leads to more interaction and increases the overall population density of the cities and regions. As
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Fig. 1.11 Impact of COVID-19 in the districts of identified smart cities, India. *Source* Authors, data from [7]. *Note* 1. Lakshadweep is the COVID-19 free UT as no case has been registered as of 15 July 2020; 2. District-level data is not available for the state of Telangana and NCT Delhi (UT); 3. Ladakh (UT) does not have any smart city

a consequence of which, the rapid transmission of SARS-CoV-2 has been recorded in the states having more number of smart cities.

1.6 Issues

The issues have been identified based on the spatial-statistical analysis supported by the literature. The identified issues are categorised into two categories, i.e. spatial and non-spatial. The spatial issues are related to the land-use of variegated activities in
the cities, which are described as follows: (i) **High Density (Compact Development):** the impact of the COVID-19 pandemic is observed more in the cities having high population density both at the international and national level. The compact development with inadequate infrastructure facilities increases the spread of the virus in the city; (ii) **Limited focus on Smart Cities:** In India, the states having more number of smart cities are the most affected states due to pandemic. The less focus on the regional development and surrounding areas puts extra pressure on the city healthcare facilities and increases the process of transmission of virus; (iii) **Good Connectivity:** The states with good connectivity to other parts of the nation, have reported a large number of confirmed COVID-19 cases along with high fatality rate. However, the disadvantage of lesser connectivity of Himalayas, NE regions and islands is proved to the biggest advantage during a pandemic for such regions; and (iv) **City Functionality:** the dynamic nature and vibrant function attracts more people in the cities and increases the speed of transmission of infected due to more interaction during the pandemic situation.

Additionally, the non-spatial issues are linked with the complex nexuses of societies, authorities, and departments, which are as follows: (i) **Less Awareness:** neither the people nor the government was aware of the deadliest virus and its impact on the physical and mental health of a human being. It has led to an increase in the number of cases frequently all around the globe; (ii) **Immoral Behaviour:** people are either hiding the personal travelling history details or not obeying government orders, which has increased the transmission of virus exponentially; (iii) **Low Testing Percentage:** India is able to test only 1.19% of its total population till 15 July 2020, with a test positivity rate of around 6.72%. Thus, it is a major challenge with such a populous country to test its total population with a limited number of health infrastructure facilities; (iv) **Inadequate Healthcare Infrastructure:** With a population of more than 1,210 million, India has lesser number of ICU beds with the ventilator. The states constitute the major portion healthcare facilities have registered higher COVID-19 cases is also a major concern; (v) **Non-Availability of Latest Demographic Data:** Census of India conduct the survey and collect data once in ten years. The last census has been carried out before 9 years, i.e. in 2011. Thus, the non-availability of demographic data is one of the major concerns as all the infrastructure facilities including healthcare infrastructure are provided based on the settlement population threshold limit; and (vi) **Data Discrepancy:** State government and Urban Local Bodies (ULBs) have failed miserably to maintain the demographic record of their respective region/settlements. The people do not share the correct personal information with authorities. As a result of which, more than 1,500 COVID-19 cases are under the unassigned category as of 15 July 2020.
1.7 Recommendations

The cities are known for the complex nexus of economic activities and constantly changing demographic profile. To build the cities, which can provide a safe and secure place for its citizens during the pandemic situation is a bigger challenge for the planner as well as GoI. However, the smart city can respond in a much better way by integrating the latest digital technology and DCP with the governance system. The authors have formulated the recommendation to keep the adverse impact of any epidemic or pandemic minimum, which are as follows:

(i) **Smart Region**: the government shall focus on the development of smart regions besides smart cities [42]. The compact development in the smart region shall be supported by the provision of adequate infrastructure facilities (including healthcare). Digital technology will be used as an integrated part of planning, which includes the use of ICT, IT services, IoT, ML, and AI.

(ii) **Consolidation of Spatial and Non-Spatial Data**: the two forms of data, i.e. spatial data and non-spatial data, will be consolidated by using the latest digital technology. (a) **Spatial Data**: includes the consolidation of spatial plans at different hierarchy based on the order of settlements. The detailed spatial plans shall be prepared on Geographic Information System (GIS) at grassroots levels, i.e. wards, and linked with the city, district, state, and national. The potential areas to be utilised under any pandemic situation shall also be marked spatially on the spatial plan. It will enable the government to geo-tag the patient’s location and identify the hotspot areas; (b) **Non-Spatial Data**: includes the demographic profile of the city including big data related to infrastructure such as number of beds, ICU, ventilators, and so on. The interlinkage of spatial and non-spatial data with the help of digital technology, i.e. through Geographic Information System (GIS), will provide the real-time status of each settlement of the nation. It will be a revolutionary step and help to stop any pandemic-like situation at the initial stage.

(iii) **Mobility Control**: the interaction of people is more in high population density areas as compared to the low and medium population density areas, which increases the speed of transmission of the virus from one person to another. Thus, the travelling behaviour of the citizens shall be monitored spatially by geo-tagging their locations during the pandemic situation. The different users will be allowed to go out at a different time to reduce the spread of the virus.

(iv) **Convergence of Government and Non-Government Institutes**: all the staff of government and non-government institutes shall be converged for the mitigation and response phase of a pandemic. The convergence will be carried at both levels, i.e. horizontal and vertical. (a) **Horizontal Convergence**: includes the identification of staff in different departments but at the same or equivalent designation. (b) **Vertical Convergence**: identifies the staff within the same department but at different hierarchies. The identification of staff will be carried out in advance by an appropriate government as a precautionary measure to control the spread of virus at the initial stage.
(v) **Digital Data Collection:** In the future smart cities and smart regions, smartphones shall be used as the major source of primary data collection instead of conducting census once in 10 years. Through Global Positioning System (GPS), the position will be geo-tagged by using internet services. In this way, the real-time demographic data shall be available with the government along with the updated contact number and email id of an individual.

(vi) **Dissemination of Knowledge:** The government will disseminate the knowledge and share useful information to its citizens through e-mails and messages for better functioning of smart cities. This process will be appropriate to reduce the transmission of the virus under any pandemic situation as well.

(vii) **Contact-Less or No-Touch Policy:** The contact-less or no-touch policy shall be adopted in day-to-day activities so that the transmission of disease under any adverse circumstances will be reduced. For example: booking online tickets followed by digital scanning of tickets through smartphones, automated sensor doors in the buses and at public buildings, voice-operated devices, and so on.

### 1.7.1 Personal and Non-personal Data

From the research, it is clear that the data plays a vital role in the development of smart cities and smart regions. So, it is important to understand the sensitivity of the data and use it without disclosing the personal identity of the citizens. Therefore, the data categorisation is essential. As per the document of ‘DataSmart Cities: Empowering Cities Through Data’, which has been published by the Government of India in 2019, the data can broadly be categorised into two categories, i.e. Personal Data and Non-Personal Data (NPD).

(i) **Personal data:** includes the information related to individuals, from which the individual can be identified. The information collected at a different time or from different sources, when collected together can lead to the identification of an individual, also consider a part of personal data. Such data is either not published by the government on the open-access platforms under any data set or must be anonymised before publishing; (ii) **Non-Personal Data:** consists of anonymous information, which does not possess any personally identifiable information. The non-personal data can also be prepared by excluding the personal identifier information from the personal data of an individual. Hence, it is important not to disclose the identity and maintain the privacy of the citizens.

Therefore, personal and non-personal data has been classified into five levels. Level 1 constitutes the data, which is available on open access portal for ‘Public Use’. It is the non-personal information, which can easily be downloaded or seen by anyone in the country. Level 2 refers to the data available for ‘Internal Use’ of ULBs. The Level 2 information is available to the ULBs and associated employees in order to deliver the public services efficiently. Level 3 constitutes the ‘Sensitive Data’, which has some attributes of individual personal information. At this level, the data is regulated through the laws and regulations by the ULBs or District or State or Central such as Privacy Law. Level 4 includes the ‘Protected Data’. It contains all the
identity details of the citizens of the country. Level 5 comprises the ‘Restricted Data’. It is the most sensitive data, which includes personal information besides the assets. The data of critical infrastructure and national security is also stored at this level. The data is accessible through a prescribed process, which is regulated by the respected ministry or department of Central and State government, respectively. Therefore, the breach of restricted data could prompt danger to life or a threat to national security. The City Data Cell, State Level Data Analytics and Management Unit, and Data Analytics and Management (DAM) Unit is proposed to monitor the process at city, state, and national level [11]. The data, under all the five levels, can easily be shared between the proposed 100 smart cities as well. All the non-personal information shall be linked with the GIS, which will allow to run the real-time spatial-statistical analysis by using digital technology.

1.7.2 Digital Model

To control the spread of an epidemic or pandemic, the best way is to stop the disease at the initial stage. It is possible by identifying the patients and individuals, who got infected. Therefore, a digital model is proposed by the authors, which can be used in the future smart cities and smart regions, to stop the spread of the virus during the initial stage. The working of the model is based on the digital system through the integration of latest technology, i.e. ICT, IoT, ML, AI, which will provide real-time information (Fig. 1.12). The medical report of a person is uploaded on a level 4 database. In the case of detection of any unknown infection or disease to the patient, the patient will be examined and quarantine in order to stop the spread. After the approval from the appropriate government, the level 5 information (such as travelling history, location tracking record of the last one month, and other personal details) can be checked out. Whereas, all the affected persons will be geo-tagged with the help of level 3 information.

The digital model will help to record the health status and its associated side effects, which might be visible after a certain period from the recovery. In a pandemic situation, such as COVID-19, the healthcare infrastructure facilities data can easily be extracted from the level 2 information. It will be useful to know the demand and supply gap in the healthcare infrastructure facilities at the very initial stage by doing real-time spatial-statistical analysis. However, only the non-personal data of patients will be uploaded on the open-access portal for citizens of the country. So, the citizens will be aware of the current pandemic scenario.

The information will be linked to the GIS for spatial-statistical analysis at the ward, city, district, state, and national level. The model will provide the day-wise real-time spatial-statistical analysis through AI. Therefore, the proposed digital model will be a critical tool to control the transmission or spread of disease at the initial stage for the future smart cities of India, which can be replicated under the same and different geographical locations.
1.8 Conclusion

This chapter intends to describe the effect of a pandemic on the world and analyse the impact of COVID-19 on the smart cities of India. In doing so, the big data has been analysed at the international, national, state, and district level through spatial-statistical analysis.

The continuous increase in the share of urban population has forced the world to rethink and reshape the concept of future cities. The cities are still not able to overcome the challenges and issues related to infrastructure and environmental sustainability. The pandemic has created a problematic situation by highlighting the drawbacks of high population density areas. The COVID-19 has adversely affected the economy of all countries. In India, the states and UTs having more number of smart
cities are worst affected by the pandemic. The same trend is visible at the district level. The districts with more number of smart cities have registered more number of COVID-19 cases as compared to the remaining districts of the respective state of India. However, the regions with less number of smart cities have performed better such as the Himalayas region, NE regions, and some UTs. Majorly, all the compact cities including smart cities, which are developed on the concept of high population density, good connectivity, and city functionality, have failed to sustain during the pandemic situation due to less awareness among the people, immoral behaviour of individuals, inappropriate healthcare infrastructure facilities, and non-availability of updated demographic data.

To resolve all such issues, a rearticulated model for assimilation and dissemination of data is required. The digital model uses two sets of data, i.e. personal data and non-personal data. It is important to maintain the privacy of an individual while using the personal and non-personal data set for analysis. Additionally, an appropriate government will collect the demographic details by using a smartphone as the smallest unit of data collection under DCP through the internet and locate the people’s location spatially through GPS. The integration of the collected information through digital technology on GIS will allow real-time spatial-statistical analysis. The digital model will be extended to cover other infrastructure facilities in all smart cities of the nation and can be replicated under the same and different geographical locations. Therefore, the smart sustainable cities will integrate the digital technology (to make the cities smart), infrastructure (including sustainable environment), and people (through DCP) under one umbrella. The aforesaid digital model of smart cities will allow to control the spread of the virus at the initial stage and reduce the impact of a pandemic by analysing the real-time data, which can further be extended to smart regions.

Acknowledgements The authors are grateful to Mrs. Priya Bhardwaj (Architect and Regional Planner) for her detailed comments and suggestions on the first draft of the chapter. The authors are also thankful to Ar. Suraj Panwar and Ar. Sandeep Kumar for providing help in data collection.

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