4 Reshape the Sustainable State-of-the-Art Development of Smart Cities

Tarana Afrin Chandel

4.1 INTRODUCTION

During and post-World War II, Dr. Vannevar Bush, US Director of the Office of Scientific Research and Development was serving his duties. He observed that industrial cities of America were facing problems regarding the infrastructure and population to support a 19th- and 20th-century economy [1]. City problems were documented [2–4] and were taken seriously. Decades passed away in resolving these issues. Setting a new framework for financial transformations, and innovations in science and technology, it took decades from redevelopment to usage [5, 6]. A composite (Architecture, Finance) structure along with new innovations in science and technology shaped the model as the concept of smart growth [7] and exploded the transformation toward smart cities [8]. In the 20th century the population also increased rapidly. The population which was 1.5 billion in the 19th century has reached up to 7 billion in 2010 [9]. A better hope of life and efforts to move toward urban civilization, have opened the way for megacities globally. Smart cities appeared as a new idea to overcome the issues regarding the enhanced population, fast development, employment, and enhance lifestyle. All these lightening achievements made people migrate toward cities. In a wide range, smart cities stimulate sustainable financial development. The concept of a smart city varies from people in different cultures. The basic concept of a "smart city" is referred to as the use of digital and ICT-based technology to upgrade the efficiency and performance of urban services and develop new financial opportunities in the cities [10]. With the augmentation of smart cities, initiatives are taken around the world keeping in view about the cost and benefits of smart cities among people, places, and the environment. According to Organization for Economic Cooperation and Development (OECD), smart cities are defined as the initiative or the advancement toward effective digitalization to upgrade the lifestyle of the people and provide sustainable services making a framework of multi-stakeholder process, keeping the environment safe [10]. Smart cities in terms of business are inter-operable systems having 59% sustainability, especially when water and energy are taken into consideration [11] require 57% intercity connection, 46% sustainable transport, 43% private-government collaboration [11]. In this regard, prototype planning was done, turning toward multiple-story towers leading toward

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European post-war architecture, which dominated at the end of the 19th century [12]. Implementing this prototype planning in their architecture, forming a new city along with software application, sensor-based embedded system having digital knowledge and information, with improved clean and green environmental surroundings are required to address the constraints of sustainable developments in the urban area [13].

4.1.1 Concept of Smart City Model

The word "smart" refers to the daily usage of products having attractive features such as smart TV (LED, Android) for entertainment, smart cars (e-vehicle, hybrid-vehicle) for transport, and smartphones for connecting the world. At the end of the 19th century, the word smart city became prominent and spread widely toward urban planning [14]. The word "smart city" is generally referred to as innovatively modern cities, efficient for "competitiveness" and "sustainability", by integrating various parameters of development such as economics, mobility, environment, people, living, and governance, becoming self-sustained [14]. At the beginning of 20th century, the 2030 agenda came into existence. The 2030 agenda showed clear development for the bright future of the next generation. Smart cities played a vital role in fulfilling the standards of sustainable development goals (SDGs) [15]. The author Tarana A. Chandel defines sustainable development as 3P, i.e., People, Profit, and Planet [16]. People, Profit, and Planet refer to Social, Economic, and Environment, respectively [16]. United Nations Economic Commission for Europe (UNECE) supported the implementation of the 2030 Agenda in realistic results-oriented in the areas of transportation, ecosystem, finance, renewable energy, commercial, agroforestry, residential, and community [17]. This multidisciplinary framework addressed to integrate the 17 goals of SD and adopt an innovative way of operation that bifurcate the boundaries. It was broadly divided into four major categories given below.

i. Sustainable use of renewable resources
ii. Sustainable smart cities for all group of live
iii. Sustainable transportation, smart integration, and connecting globally
iv. Smart observation and evaluation progress regarding SDGs

4.1.2 Sustainability a Strategic Plan of Smart Cities

The development of smart cities requires the participation of diversified policy makers and stakeholder along with huge resources. This plan is necessary for effective development. The strategic plan aims to analyze a long-term vision that unites the community onto one platform [18] and explain the values of citizen well-being, and economic development [18], paying emphasis on equality, unity, and interaction across various domains [19]. A strategic plan for the development of a smart city has been done considering many perspectives. This strategic plan is divided into three sections, i.e. adoption of smart innovative technology, policy framework and implementation, and governance for a smart city. The deployment of information and communication technologies (ICTs) is very important for developing and improvement of services and infrastructure of urban areas [20, 21]. This technical network

improves the infrastructure and enhances the administrative and communication services in the community. Administration and communication services work on the internet of things (IoT), i.e. sensor-based networking, data collection through videos, and internet, from a large and undefined network of people, i.e. feedback of communal services, online complaints, emergency alert systems that send messages to cell phones, smart metering systems, etc. Technical innovations involve engineering, information technology, data science. These fields play a vital role in the research and development of the application-based smart city.

4.1.3 Technology-Based Smart City

Worldwide internet users have increased in the last few decades shown in Figure 4.1. Internet technology along with other communication networking strategies, the IoT became the best platform in developing smart cities. The terminology "Internet of Things" describes an intersection of technologies that permit to access data generated and provided by other devices via wired or wireless internet networks [22].

4.1.3.1 Internet of Things

The major framework for a smart city is based on the IoT. Some have expressed the framework of smart city as three models, four models, and five models. The three models expressed by Balakrishna in 2012 include gathering, sharing, and executing the plan [23]. Some authors have also briefed it as three models, i.e. perception, networking, and application [23, 24]. The four models involve the sensing model, transmission model, processing model, and the application model [25]. Some authors define the same thing using various other nomenclatures. They defined the above

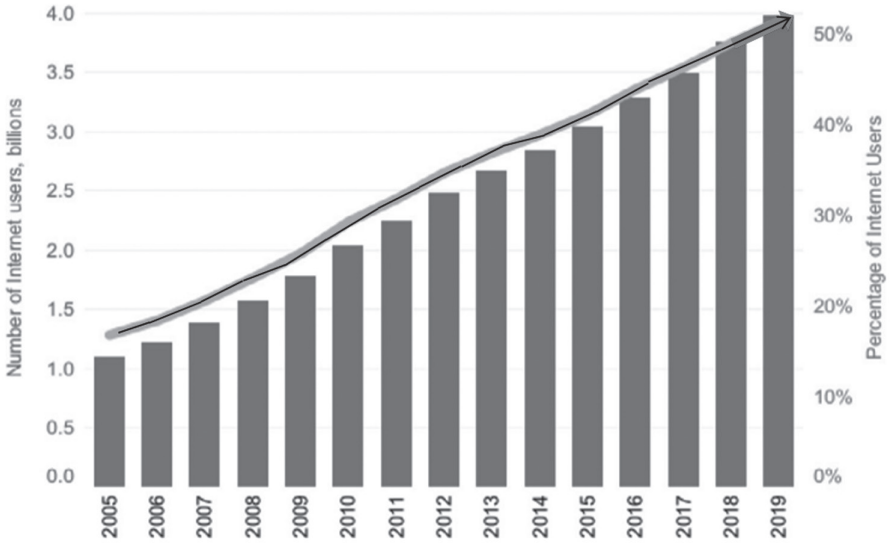

FIGURE 4.1 Internet users globally since 2005.

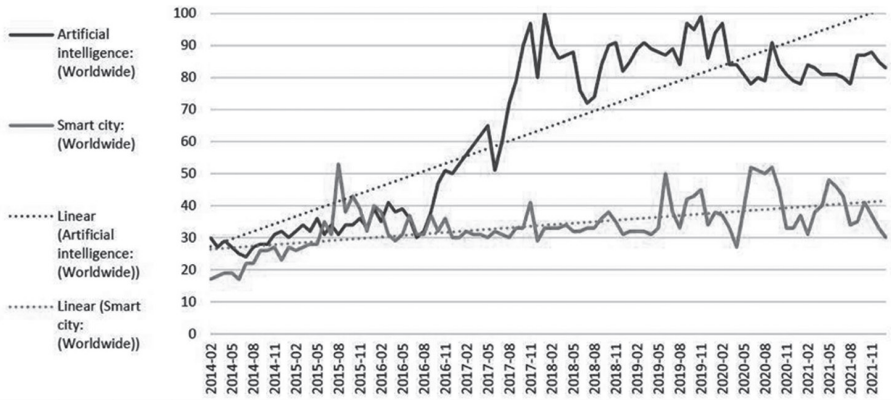

FIGURE 4.2 Smart City and AI increasing from 2014 till 2021 [27].

four models as the data acquisition model, data vitalization model, common data and service model, and application model [26]. Further research suggested it as five model structures, i.e. perception layer, networking layer, servicing layer, utility layer, and trading layer [24].

Figure 4.2 shows the number of smart cities and artificial intelligence (AI) increasing from 2014 to 2021 [27]. Cities are recognized as smart if they fulfill the criteria of SDGs. Some of the goals outline the smart city.

These are as smart lifestyle, smart learning, smart employment, smart fitness, smart transport, smart ecosystem, smart finance and smart governance as shown in Figure 4.3. In major countries, smart city model is based on the applications of AI.

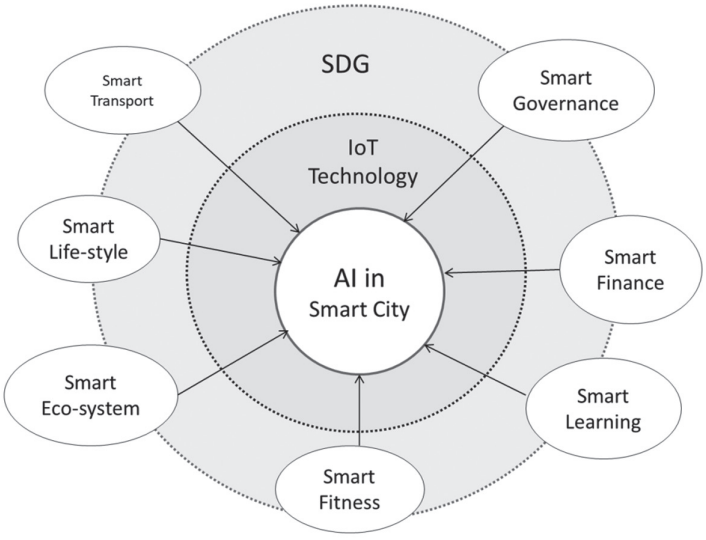

FIGURE 4.3 Sustainable development goals for smart City [27].

The statistical data in the New York Smart Schools Commission Report 2018 shows that the AI company will be of $190 billion by the end of 2025 [27]. The worldwide investment in launching and processing of AL system costs $57.6 billion with 75% deployment computing application [27]. China is on top in developing smart cities globally. The city has the facilities of a public place with a metering device, CCTV, and embedded system for monitoring, data mining, all analysis done based on AL [28, 29]. China is having approximately 800 small-scale actively planned programs on smart cities globally. AI in China is working smoothly since 2015 and the government has taken measure steps toward research in AI and transforming AI in China as a new era [30]. AI may upgrade the future of smart cities by enhancing the livelihood of the community people, by joining machine learning (ML), robotics, and many other technologies. AI algorithm is successful depending upon big data for the operation of a useful task. The information is obtained with the help of mechanical and digital technologies that help to store data, process it, and transfer it to give a satisfactory solution to a problem. Table 4.1 shows the involvement of AL in various domains of SDG for the smart city [31, 32].

Approximately more than 1.6 billion IoT components along with other devices were used developing in smart cities in 2017, showing a 39% hike since 2015 [32]. Approximately 3.3 billion IoT tools and components were used [33] with an expansion of 43% [18] in 2018.

4.1.3.2 Artificial Intelligence

AI was introduced by John McCarthy, a computer scientist in 1979 [34]. He defined AL as the combination of science and engineering for designing intelligent machines [35]. It can also be defined as the simulation of human intelligence in a machine, processed to do work according to human action. Brynjolfsson and McAfee have contended in their book "The Race Against the Machine" (Brynjolfsson & Andrew, 2012). Features of AI include ML, nature deep learning (DL), vision, speech, robotics, and expert system. These features are used in developing smart cities. It is mandatory

TABLE 4.1
Involvement of AL in Various Domain of SDG for Smart City [31, 32]

SDG for Smart City	Involvement of AI
Smart transport	Intelligent traffic management system, smart parking, sustainable transport
Smart learning	Smart classroom, learning tool, smart library, student tracking management system
Smart fitness	Smart hospital, smart healthcare, e-health record, patient monitoring
Smart ecosystem	Clean and green energy, smart agriculture, weather and air quality monitoring, clean water and sanitation, waste management system
Smart live-style	Smart homes and commercial, architecture, smart learning, smart protection
Smart finance	e-Commerce, smart retail shopping, smart supply chain distribution, smart commercial services
Smart governance	e-Governance, policy framework and decision making, disaster management system, urban planning

to have big data for the functioning of smart cities. Big data involves 3V, i.e. volume, velocity, and variety [36]. Volume refers to gigantic data, velocity refers to the speed at which data is processed via algorithm, and variety refers to data collected from different sources. AL and big data are linked together. AL can work on big data collected from different sources as non-human system experiments and imitating human behavior [37]. AL can examine the data and predict it and generate solutions for technologies used in developing smart city. AI in supervised ML, data collected is used to manage AI for finding solutions of raw data. AL will perform the task according to the software program done in it. On the other hand in unsupervised ML, data that is not classified or labeled is sent to AI to find the hidden characteristics in the data [38].

4.1.4 Sustainable Transport for Smart Cities

Responding to mobility in urban areas, transport is very challenging for cities. Corresponding to UNEP, transport is accountable for carbon emission gas globally [39] causing congestion and pollution and declining the standard of life [39]. Sustainable transportation occurs as the basic gear for the development of smart cities, present for long time [40]. Köhler [41] guesses sustainable transport as a global concept. Integration of reliable transport is very must for sustainable development in smart cities. In this regard, connectivity between infrastructure, human, and social capital is very must for better livelihood of the community. Thus we can say that sustainable transport is the driving force for developing smart cities. It leads toward resources for labors, benefiting individuals and globally. Moreover, transport links better lifestyle with community, place, education, and employment and fitness [42–44]. Now we can say that transport impels social and commercial developments. Transport using non-renewable energy sources affects the environment causing pollution in the ecosystem. To overcome these effects, sustainable transport is required. Therefore, sustainable transport shown in the figure is global sustainability that fulfills today's requirements without harming future generations.

The first conference on Global Sustainable Transport held on 26 November 2016 [45]. This conference was opened in Turkmenistan. In this conference, all the stakeholders from the government and private sectors, civil sector, from United Nations and other organizations were brought onto a single universal platform. The conference was carried for two days, discussing about the multiple task of the integrated and cross-cutting nature of transport. This meeting was supporting the 2030 Agenda held in Perris for Sustainable development [45]. Such transport can form a bridge in-between people far away, coming closer under one umbrella. Sustainable transport can open the doors toward growth, employment, women empowerment, decline in poverty and death rate, and improve economic development. Sustainable transport is a gateway of smart cities emphasizing safe and healthy ecosystem, resolving many problems, and integrating the policymaker and stakeholders that are associated with the SDGs. Smart cities commonly use ICT to predict and direct urban problems. Smart technology can improve sustainable transport. Latest trendy technologies such as the IoT, AI, and cloud computing (CC) [46] where large data can be stored are bringing new lights toward sustainable transport making a smart city. Addressing the weather change, improving the ecosystem, changing oil-based vehicles to renewable energy-based

transport, and using public transport instead of individual vehicles, require big data services. This big data is challenging for public transport operators. The motive of big data is to help industries and academics for identifying the problem and designing a model for sustainable urban transport services. In the current scenario, sustainable transport is dependent on SDGs.. Transport has created jobs, becoming a gateway toward technology application and management, advancing toward the environment safety and healthy ecosystem, improving mobility and connecting people under an umbrella. The latter has enhanced tourism, making better relations globally and improving the economy. These goals helped in achieving equality, respect among people, and multinational benefits along with equalizing the interest among the countries.

Since all countries are not in a situation to invest money in sustainable transport and fulfill the sustainability goals, the speakers involving ministers, upper-class officials, experts and delegates debated for agreement, to reinforce partnerships globally, finding a solution to meet the Paris Agreement on climatic sustainability [45].

4.1.5 Sustainable Smart Learning

Today, it is necessary to understand education as an integral part by which students can achieve technical skills, ability, proficiency, and perspective leading toward an active and powerful process of social marginalization. Smart education is the fourth goal in the 2030 Agenda for SDGs [47], aiming to improve the lifestyle of people via the teaching-learning process [48], solving the major problems of the nation [48]. This goal in turn helps to teach the civilians, how to live in society [49] and bring the nation's economy to top globally. Education also enhances personal and professional development. For the sake of achieving these goals, we require government, private agencies, organizations and entrepreneurs, to take opportunity and responsibility regarding the enforcement and dissemination of sustainability literacy [50, 51]. Considering higher education, which represents cultural heritage, has major liability when incorporating sustainability during curricular design. Such a framework has a huge impact on social, environmental, and economic developments [52–54]. At the same time, the educational move toward sustainability is increasing research in the field of science [55], technology, and management. Twenty-five years earlier, Segovia proposed a pedagogical model known as the "Intelligent Classroom" [56]. An intelligent classroom is based on eight important parameters of the teaching-learning process. These are as follows: goal or motive, methodology, succession, mentor's role, scholar's role, assessment, context, and smart learning environment. In the last parameter, i.e. context we observe a new teaching-learning environment (NTLE) process.

4.1.5.1 Teaching-Learning Environment

NTLE process refers to the maintenance of the environment, equipment capabilities, and culture. For sustainable learning, it is required to safeguard the system at a particular level without draining the resources and preventing from being afraid of system failure. Sustainable education is also referred to as a reliable and continuous technical working system.

The question arises that what additional features make new learning-teaching (NELT) environment. As far as this question is a concern, no particular benchmark

is set for it. For basic primary schools, we can use computers, multimedia screens, projectors, and free internet facilities to revolutionize education with IoT [57].

As per the record of National Home Education Research in America, more than 1.6 million children are taking home-school education [57]. IoT-based education systems are transforming education into a new learning-teaching environment. Smart classrooms for schools include advanced technology devices such as whiteboards, interactive learning games, cameras, and technology-based assessments along with feedback options for a sustainable education system [57]. Thus in other words we can say the schools or universities having ICT-based educational infrastructure, physical as well as virtual learning classrooms, self-learning management systems (SLMS) and sustainable resource management systems (SRMS) are considered as smart school/smart-university [58, 59]. A smart teaching-learning environment (STLE) is an intersection of adopting learning content, recommended learning tools or strategies, interaction with users via ubiquitous computing devices and detecting the real-world content as shown in Figure 4.4 [59].

Smart teaching and learning environments conducted by ICT, along with innovative technologies such as IoT and AI, help us achieve quality education, thus fulfilling SDG-4, which is part of the 2030 Agenda, i.e. Parris Agreement on sustainability development goals. This 2030 Agenda has 17 sustainability development goals [58, 60, 61]. The concept of smart learning-teaching having the goal of providing excellent education (goal 4), gender equality (goal 5), clean water and sanitation (goal 6), declining inequality (goal 10), and sustainable societies (goal 11) can be obtained at broad spectrum.

4.1.5.2 Technologies Used for Smart Education

The use of technologies in the education sector is becoming typical globally. IoT, AI, ML, and DL are different technologies often used in the education sector. The application of these technologies is making smart education system.

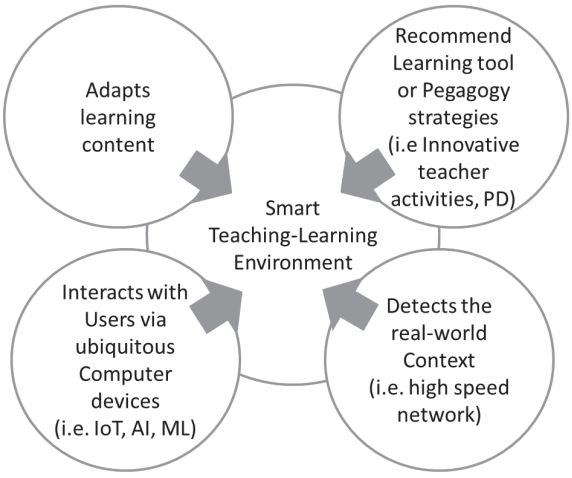

FIGURE 4.4 Green smart teaching-learning environment [59].

4.1.5.2.1 IoT for Sustainable Smart Education

The IoT devices are computing devices which is connected wirelessly to the network, gathering information in the form of data and transmitting it to other devices. IoT consists of both software and hardware. The IoT circuitry is based on sensors as a hardware device and transfers the information data bidirectional online via software technology. IoT benefits students as well as educators. The major benefit of IoT for educators and students is that "one can move beyond the conventional classrooms to the smart classroom environment". Students can learn from videos, webinars, discussion forums, group discussions. IoT helps educator to follow the assignments updated on students' digital planners. It also helps in locating the location of the students and controlling their movements by using real-time cameras making a safe environment and enhancing on-campus security. IoT also helps guardian to track their children's attendance record available in real-time. Wireless communication technology (WCT) and AI are the essential facilitator technologies for the IoT. IoT-based student management system can be done using Bluetooth technology along with IP-based closed-circuit television (CCTV). Entry and exit of students/teachers can be monitored by biometrics, i.e. fingerprinting and face recognition are used to identify the students/teachers. Nowadays, learning can be done in physical mode, online mode, and even hybrid mode. A classroom can be real and virtual. Mobile learning, e-learning, online learning, and distance learning are different pedagogies that have the same concept of making learning easier.

4.1.5.2.2 Machine Learning (ML) for Sustainable Smart Education

ML is a technique used for data analysis. An Australian named GovHack included many projects in the education of which one is ML [62]. This can be used by educators as well as policymakers to identify the risk of students being drop out of the campus. Using mathematical models AI can easily predict outcomes based on previous inputs. With the help of an algorithm, ML permits the system to find out invisible insight without being programmed [62, 63]. The process of learning begins with the data to be observed and comes out with better decisions or results. The process of ML is using an algorithm, can receive data or information, analyze it and finally gives the output within an adequate range. The working process of how ML finds a solution and gives results is shown in Figure 4.5 [63].

ML is classified into supervised ML, unsupervised ML, and reinforced ML shown in Figure 4.5 [64]. In supervised ML, future prediction is done with known input and output data. The result of supervised ML is not continuous, graphically non-linear. Unsupervised ML explores the information whether data is labeled or unlabeled. In reinforced ML, the interaction of information within the environment takes place, giving the result finally. Reinforced ML is used in robots, games, and in determining the position of a ship, i.e. navigation [64]. ML is a sub-array of artificial intelligence (AL) [64]. ML is a subfield of AI as shown in Figure 4.6.

4.1.5.3 Impact of COVID-19 on Education

The coronavirus disease originated in China in December 2019 [65]. The first instance of the virus was found in Wuhan, a city in China. After that, it spread all

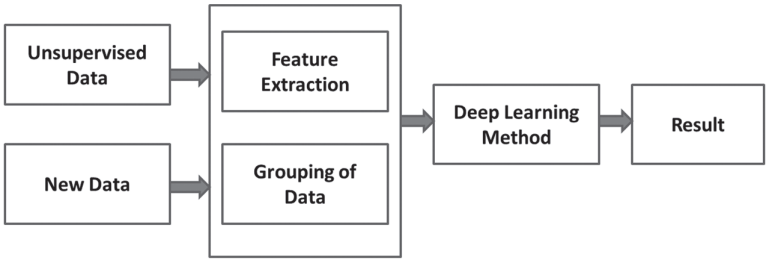

FIGURE 4.5 Process of machine learning [63].

over China. It has affected people irrespective of color, race, and gender [65]. 12 March 2020 was the day when World Health Organization (WHO) announces the coronavirus disease as COVID-19 [66]. WHO also declared a public health emergency of international concern (PHEIC) on 30 March 2020 [66]. Till then the disease spread as current and affected globally. Governments declared the closure of schools, colleges, and universities whether private or government both to maintain social distancing and decline the spreading of the disease. Disease spreading rate was high among children rather than adults, so educational institutes were closed as a preventive action globally. The conventional teaching method/offline mode of teaching, i.e. face-to-face interaction teaching switched toward online teaching. The government, as well as private educational institutes, is following e-learning. Some e-learning platforms are Google classroom, Zoom, WebEx and Skype. Online learning will help teachers as well as students. The evolution of digital systems has a great impact on social and economic development. With the enhancement of innovative technologies and digital devices conventional education system during COVID-19 has turned into digitize education system. Online learning has created hindrances because of internet unavailability, lack of appliances, i.e. mobile and laptops and also the environment of their homes. This has affected the quality of learning, students' understanding and ability and also teachers' performance.

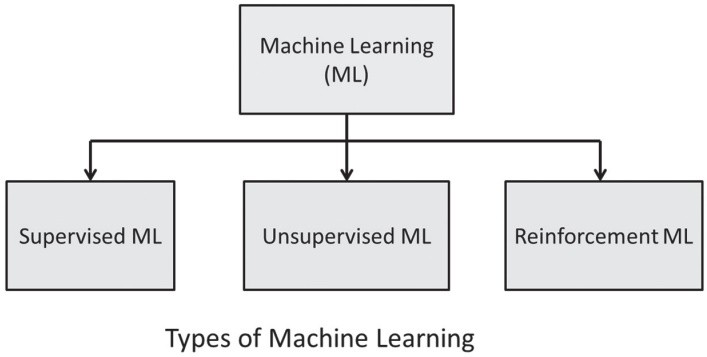

FIGURE 4.6 Types of machine learning [64].

There are some positive and negative of COVID-19 on education. Some of them are listed below [67].

4.1.5.3.1 Positive Impact of COVID-19 on Education [67]

i. Learning has become personalized and effective
ii. Enhanced the education quality from a future perspective
iii. It is better than conventional learning
iv. Saving time and money
v. No geophysical limitation to learning
vi. Conveyance free education
vii. Application of Learning Management Systems enhanced in education institute
viii. Progress in group debates and teamwork
ix. Request for MOOC and distance learning

4.1.5.3.2 Negative Impact of COVID-19 on Education [67]

i. Obstructed in the educational activity
ii. Lack of electricity power in rural areas
iii. Lack of study environment at home
iv. Lack of knowledge and technology application to parents
v. Parent's responsibility increased toward educating their wards
vi. Unprepared teachers/students for online education
vii. Students' brains are diverted toward entertainment on mobile and social networking
viii. No write up work is given
ix. Lack of nourishment due to school closure
x. Effective assessment of students are difficult
xi. Delay in fee payment
xii. Accessibility toward a digitized world
xiii. Recession effect on employment rate
xiv. Declination in employment opportunities globally

4.1.6 Smart Fitness

Routine physical activities have shown preventive treatment for non-communicable diseases such as cardiac disease, hypoglycemia, and chest cancer. It also prevents from putting on excessive weight, and enhances psychological level and health. Apart from benefits for health from physical activities, societies are more active in making an extra return on investment (ROI) involving declination in the utility of conventional energy sources, fresh air, and secured road. Outcomes of the above-mentioned ROI are interrelated in fulfilling the SDGs of 2030 Agenda. WHO action plan has promoted physical training globally [68], and requested countries to update a new framework of efficient and achievable policy to enhance physical training. Policies for upgrading walking, running, cycling, games, and sport contribute an important role in achieving SDGs of 2030 Agenda. Policies framework on physical training has many benefits in social, cultural, and economic developments, contributing to fulfill many goals of SD such as SD Goal 3 (good health and well-being), as well as other goals

including SD Goal 2 (ending all forms of malnutrition); SD Goal 4 (quality education); SD Goal 5 (gender equality); SD Goal 8 (decent work and economic growth), SD Goal 9 (industry, innovation, and infrastructure); SD Goal 10 (reduced inequalities); SD Goal 11 (sustainable cities and communities); SD Goal 12 (responsible production and consumption); SD Goal 13 (climate action); SD Goal 15 (life on land); SD Goal 16 (peace, justice, and strong institutions), and SD Goal 17 (partnerships) [68].

The acceptance of ICT inside the medical sector has driven the idea of electronic health, i.e. e-health, leading toward cost saving and increased efficiency. Devices for e-health are smartphones which had opened the door to mobile-health. Health devices connected to IoT have enhanced the advantages of monitoring facilities globally [69]. Governments in local areas are spending the revenue in establishing ICT-based techno-infrastructure for intelligence and advancing social responsibilities regarding health and care in a sustainable environment. Because of it possibilities for smart cities are endless and many companies such as IBM, INTEL is taking leading initiatives in this sector. These companies have discovered the areas where smart cities play a vital role in community security, green energy, education, social welfare, business development, and Medicare [70]. Smart cities based on ICT technologies provide real-time information about weather conditions, congestion in traffic, environment contamination, antigen concentration, and many more. With the proper utility of healthcare information's, community people can utilize Medicare applications and facilities with awareness. The motive of this study is to generate the idea of smart fitness as the result of interaction between health and smart cities. ICT-based technologies have gained charm toward medical science.

4.1.6.1 e-Healthcare

Commitment for helping and supporting open biomedical problems is due to IoT-based sensor devices and computers. Such devices are electronic health (e-health) [71]. Gunther Eysenbach in 2001 has defined e-health as given below:

> e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state of mind, a way of thinking, an attitude, and a commitment to networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

e-Health not only specifies electrons-health, but many "e's" combine to portray e-health. Some of the "e's" in e-health are mentioned [71] as easily applicable, efficiency, enhanced quality improvement, empowerment of patients, evidence, education and encouragement, enabling, and equality ethics.

Easily applicable: Removing medical fee. Free medical policies focus to decline financial hindrances while obtaining medical services. Free Medicare policies have acquired fame in the last decades. Everyone can apply for free health care. Medicare policies in terms of financial benefits and services are combined.

Efficiency: Efficiency is an important parameter in e-health. High efficiency can be achieved by reducing the medical cost, useless diagnoses, and regular communication between healthcare centers and patients.

Enhanced quality improvement: With the reduction of medical fees and utility of medical policies have enhanced the quality of healthcare services among the community people.

Empowerment of patient: Patient empowerment is termed from the process where the patient acquires better control in taking decisions and actions related to health. Four basic elements of patient empowerment are given as understanding the role of the patient, patient awareness toward knowledge, and engagement of Medicare service provider, patient abilities to gain benefits, and accepting environment to perform the task.

Education and encouragement: Physicians and surgeons should have a thorough knowledge of the medical subject and should know how to maintain better relations with patients. Strong bonding will encourage the patient to share their personal as well as health and financial problems.

Enabling dual-sided communication and transferring information in a quality manner in between patient and Medicare provider.

Equality should be maintained between rich and poor patients. There shouldn't be any gender biasing in handling the patients.

Ethics should be maintained while providing services to online, informed, and private patients.

4.1.7 Smart Ecosystem

The main focus of smart city is based on the environmental impact of the city. Certainly, the important issue is related with the utility of green and clean energy. Thus, saving energy or an alternative source of energy is very must for transport system. Therefore, energy management is one of the best ways for invest and return. Another approach for smart ecosystem in smart cities is IoT. It is based on sensoring large information data. Some of these sensors are environmental pollution sensors, traffic congestion sensors, audio sensors, humidity and weather forecasting sensors, and video capturing cameras aligned all over the city. These sensors will provide information containing problems in the city. However, these problems are resolved by an impressive management system which is challenging itself. Thus, resolving critical issues at the cost of developing a techno-infrastructure. One more important approach of smart ecosystem in smart city is the ability of community people to take part in regular problems of the city. Participation of community people in digital mechanism, sensoring the real-time activities and associative fund management are some of the potentials deployed to make better city management. Now we can say that the city is the data-controlled service provider for social community people along with government and private companies and organizations, data-driven smart ecosystem for smart city [71] is shown in Figure 4.7.

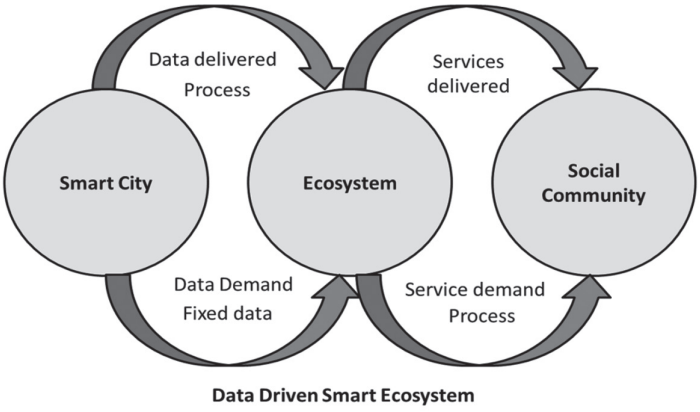

FIGURE 4.7 Data-driven smart ecosystem [71].

These services can be provided with the help of a subcontractor or by the organization making the ecosystem as the foundation with the aid of digital value-added services. This value-added digital system is added by ecosystem managing companies to achieve a different task, providing new processing information. This is how the ecosystem managing companies provide services to the community. The community people or we can say consumers also request the managing companies for adding new salient features for making services easy for smart city. These services are analyzed by some standards taken into account. An ISO standard for smart city is 37120:2014 [72] endorsed by the World Council on City Data [71], consisting of parameter considering the smart city. As big data is generated by the sensors of IoT, the ecosystem administrator further reuses these data for providing further advanced services. For new techno-services, new business models are searched. Some of the business model charge for their services. The reuse of public information has a great impact on the economy of our society. GDP which was 0.25% has increased up to 1.7% [73, 74] while fulfilling some of the market conditions. Undoubtedly, some significant technology will be adapted for smart cities to make better ecosystems.

Thus we can categorize a smart city based on knowledge and designing of a smart ecosystem, planning to implement day-to-day activities easily, and sharing the latest data for further innovations with the help and efforts of our society or community people along with the investments of shareholders. Factors influencing the sustainable and friendly ecosystem are quality of air, contamination in the environment, and improved sanitary system. A healthy ecosystem is categorized by the air quality index (AQI). AQI less than 50 is shown by green color; indicating good air quality with no risk to all people [75]. AQI in the range of 51 to 100 is shown by yellow color; indicating moderate air quality with risk for sensitive persons [75]. AQI in the range of 101 to 150 is shown by orange color, indicating health problems to a sensitive group of people and less effective to the general public [75]. AQI in the range

of 151 to 200 is shown by red color; indicating unhealthy air quality and can cause serious health problems [75]. AQI in the range of 201 to 300 is shown by purple color; indicating poor air quality with alarming health alert [75]. AQI greater than 300 is shown by maroon color; indicating hazardous air quality with health problems alarming to all people [75].

4.1.8 Smart Live-Style

Nowadays, smart city is a trend globally with the progress in ICT. Many countries have passed the proposal for smart city development with the least consideration toward the joyful life of the human. Joy-driven smart city (JDSC) is much better than developing a human-centralized smart city [76]. JDSC requires the investigation of multiple strategies. The strength and weaknesses of society should be on top priority for a smart city as shown in Figure 4.8 [76].

The idea of a smart city is acceptable only with the transformation toward social and economic development [77–79]. Taking initiative toward a smart city, knowledge, and landscape position are top priorities for revitalization for urban financial upgradation and maintaining competencies. However, it is seen that for developing a joyful smart city, minimal attention has been paid on the happiness of the community people. Healthy administrative management and equity will encourage the wisdom of justice and hope to contribute toward the happiness of the community people [80]. A meeting for the happiness and well-being of community people was held in support of UN high level and this report was published by John Helliwell in 2012 [81]. Happiness or well-being is based on emotions, sentiments, and life assessment on particular specifications. However, the basic requirement of the people for sustainability in the city must be available at each hook and corner of the city. Fulfillment of these basic needs enhances joy among everyone. As long as we are living in an enhanced innovative world, a question arises, how advanced

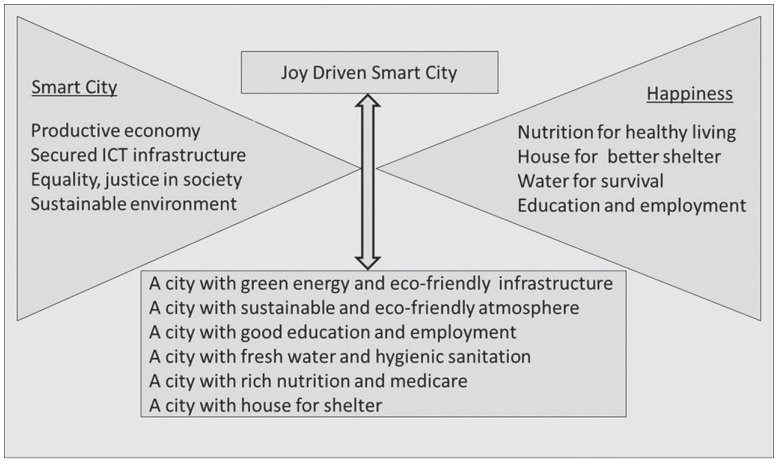

FIGURE 4.8 Joy-driven smart city [76].

innovation can create happiness in society? The motive of this chapter is to outline how we can focus the administrative activities in the city in this techno-world. These activities include tax function, transport sector, municipalities, law and order department, and many more as recorded in OCED better life index (BLI) [82]. The BLI involves income and wealth, household net financial wealth, job and earning, health status, and working and life [82]. Another evaluation for BLI throughout the nation is social progress index (SPI), based on three parameters depending on human need, i.e. house for shelter, better nutrition for improved health and development, water for survival. For human well-being foundation stones are education, health, atmospheric surroundings, communication and innovative technology. For growth and progress in career, a person requires right of freedom, individual rights, and integration. Above-mentioned features are the key source of human happiness and well-being. Factors furnishing toward a happy lifestyle are education, health, and security [76]. Technology awareness directs toward high education, transforming education toward learning, and assisting in achieving their goal [83]. Education in it is a path toward happiness, as it generates employment and enhances the financial status of the people [84]. Safety is also important for happy life. Safety atmosphere for people where offense and safety threats are handled properly, actions are taken immediately with the help of innovative technology corresponding to public safety function [85]. Safety itself is the center of attraction for city and maintaining happy life among each other in a beautiful and smart city [86]. Freedom leads toward a happy life.

4.1.9 Smart Finance

Smart city is categorized by its economy and capability to establish a business. This is the basic reason for the survival of city and people prefer to live as city is a conglomeration of business and finance [87]. In 2007, the economist declared that Homo sapiens are now "Homo urbanus" [88]. Figure 4.9, shows the change in the global

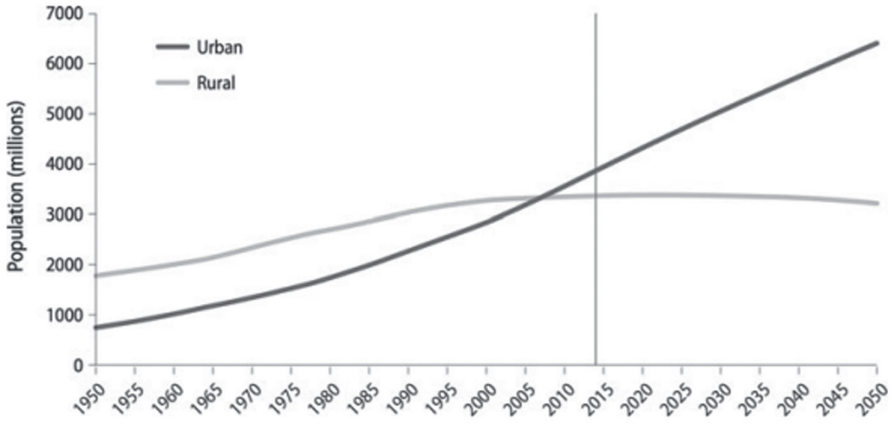

FIGURE 4.9 Change in global population in rural and urban from 1950 to 2050 (Source: United Nations) [89].

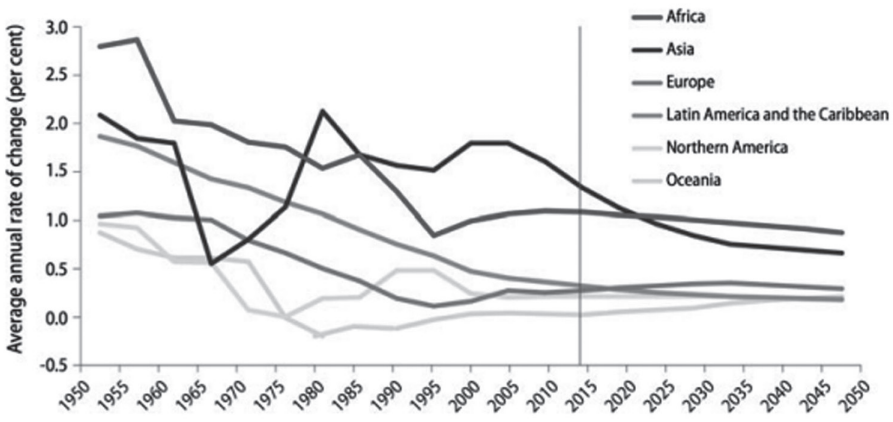

FIGURE 4.10 Transformation toward urbanization region wise from 1950 to 2050 (Source: United Nations) [90].

population of rural and urban from 1950 till 2050 [89]. With the increase in urban population growth, urbanization continued globally, especially with maximum growth performance in the region of Africa and Asia [88].

In 2000, Asia and Africa indicated 37.5% and 34.5% urbanization. In spite of low financial growth in Africa, population growth toward urbanization was nine times from 1950 to 2000 [89]. The statistical data record for the last 65 years shows urbanization in major regions of the world and till 2050 further regions will transform toward urbanization [89]. The percentage transformation toward urbanization region wise is shown in Figure 4.10 [90]. This was the key factor that the city was considered as the motor of the financial growth, fascinating competent and qualified professionals, and national and international investors and contributing toward financial growth nationally and internationally.

The financial layout for the sustainable urbanization evolution is directly associated with the issues of sustainable developments which are associated with 3P, i.e. People, Profit, and Planet [16]. People are related to society, profit to finance, and the planet to the environment [16].

Financial support is very important for entrepreneurs and small- and medium-scale industrial businesses. City enhances the commercial business by frequent interaction with the government and reducing hindrances in developing business. The economic growth in the city is very important for the welfare of the people. For this, the government is working on it and promoting business as its priority. Many cities provide online/internet commerce making it a center for trading platforms. Online trading has made life easier and also enhances the economic condition of the citizen making life happier. Public trust is also an important parameter for the support of finance and public health. Public trust is the biggest evidence for earning and growing economically, leading toward a happy and healthy place to live [81]. A trustworthy atmosphere brings joy and happiness among the citizen. Thus, we can say with pride that trustworthy and

corruptionless cities are the measuring parameters for the quality of the nation and the quality of the governance.

These days, there exists a global industrial revolution 4.0 [91]. This industrial revolution 4.0 is the latest paradigm toward industrial exposure and developments. It is based on automation and integrated digital technology and provides bigger information than a physical system [92]. This revolution directs toward enhancing internet potential, i.e. IoT. IoT's interconnect devices provide system automation and large information that can be accessed in real-time [93] as shown in Figure 4.10. The governance for a smart city is directly related to urban development giving rise to industrial revolution 4.0. With fast moving world, the cities are also growing but frequently the system of urban governance is unable to move parallel due to various problem. Some of these problems are high population, building construction compactness, traffic congestion, air pollution, and the environment. The metamorphosis of urban governance is directly proportional to smart city giving rise to new economy [94]. The utility of innovative technology is increased for developing, monitoring, and controlling the activities of the business, traffic, and change in weather conditions [91]. Now the era is known as the era of the digital economy (EDE).

The industrial revolution 4.0 also relates to the trend of increasing internet capacity or the IoT. Based on its terminology, IoT encompasses everything that can be connected from one device to another, with the connection between devices will create system automation, accessing information, analyzing data in real-time, and making actions in response [93]. The incorporation of four industrial technologies has transformed the conventional industry into an adaptable and redesigned smart industry [95]. Smart industry means smart production with innovative technologies such as IoT's AI and data management system. Smart production is related to digital production whose output can be defined as a digital economy. Industries based on ICT, enhance the manufacturing process, making the production cost very low, thus increasing the competition in the market and the growth of the economy. Thus digital marketing (DM) utilizes digital technology and internet facilities in developing business. DM increases the publicity of products and services through real-time data and information of the customer. It also generates sales channels for the products. Information regarding the products such as their cost and product specification is easier and faster, thus increasing the business value. All these are only possible with the digital economy.

4.1.10 Smart Governance

Smart governance is expressed as the examination of complete public areas and duties toward a smart city. Furthermore, it also explores how social and political governance structures can be changed to administer the smart city digitally. Smart governance is two phases of a coin, developing good relations between government-public, reinforcing government-private institutions and integrating all the societies under one umbrella [96]. ICT is now an essential part of our lifestyle. Life is unimaginable without internet facilities and digital technology. Today transport, safety and security, health and fitness, learning and communication are dependent on ICT. The

motive of smart governance is to develop a transparent system and strengthen social welfare. The salient feature of smart governance is the utility of ICT tools, the IoT, social media interactions and analysis, private and public cloud, education, employment, and entertainment.

4.1.10.1 Utility of Information and Communication Technology (ICT)

ICT is the base of smart governance. This technology enhances the collaboration level between government departments, government and private sectors and government and society, providing efficient services and sustainability. With the help of ICT, large real-time data and information can be stored giving absolute solutions to the problem. This technology also helps in upbringing the business under the same atmosphere and enhancing the economy of the nation. Good telecom channels such as FM radios, mobile telephones, and satellite communication for receiving and transmitting the information. Transport and travel, video and audio conferencing and security systems require Geographical Information System (GIS) [96].

4.1.10.2 Internet of Things

IoT is based on sensor devices connected to the internet. IoT-based sensory devices are used for monitoring military troops, transportation, drones for defense, temperature control systems, and many more [97]. As written by Bruce Sinclair: IoT is only a transformation toward internet developments. Businesses with IoT technology will lead to economic advancement. IoT-based e-governance ecosystem should guarantee the participation of all policymakers and shareholders as well as the government sector, private sector, technicians, academicians, and consumers.

4.1.10.3 Government and Private Cloud

The birth of the CC model has found a rich and bright base in a smart city in regard to storing large data and information for providing services [98, 99]. CC has gained attention over the past ten years, benefitting where large complex data has to be accessed with restricted resources and economy. The concept of the cloud could act to connect IoT with people on the internet via horizontal and vertical integration [100]. Connecting IoT with CC can be referred to as cloud of things (CoT). Cloud of things is the center for academician and industries globally. It provides services with little investment, awaited progress, high accessibility, excess defect-tolerance ability, endless expandability, and many more.

4.2 CONCLUSION

Developing a smart city with digital technology benefits people globally. It not only enhances the lifestyle but also guarantees sustainability. ICT-based technology provides the solution for big problems saving time, money, and energy. It is also helping in reducing green gas emissions and controlling transportation systems. As the market of smart cities with innovative technology is new for all, it needs a new framework and policymakers to build a new business model and find an easy way to implement sustainability.

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