T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

THE ROLE OF SUSTAINABLE DEVELOPMENT IN THE SMART CITIES

MASTER THESIS

Ali Taha YASEEN

Engineering Management Department

Engineering Management Master in English Program

AUGUST 2022

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İSTANBUL GEDİK ÜNİVERSİTESİ
LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

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I dedicate this work to my parents first and to everyone who help in its accomplishment…

PREFACE

Many have dreamed of establishing a city where the citizens have everything they need. For example, "Utopia"—a book by Sir Thomas More—which represents an imaginary city focusing on equality in economics, government, and justice. And we should not forget Plato's work "The Republic", where citizens and visitors of the ideal city receive the best services without passing through complications, routine or bad treatment.

In the 21st century, the Scandinavian nation was classified as the happiest countries in the world and was sometimes described as modern utopias.

So, it may be reasonable for many countries to establish cities whose main goal is the welfare of their citizens by using the latest technologies like ICT and IoT.

A smart city consists of six solid factors, which are: smart government, smart people, smart environment, smart transport, smart living and smart economy. And if one of these factors is omitted, we cannot call it a smart city.

Smart cities are not a luxury, but rather a necessary shift and response to a number of crises such as environmental crises, resource depletion, and an increasing number of people living in cities.

August 2022   Ali Taha YASEEN

ABBREVIATIONS

ICT	: Information and communication Technology
IoT	: Internet of Things
UNEP:	: UN Environmental Program
IT	: Information Technology
ITU	: International Telecommunication Union
iOS	: Iphone Operating System
Siri	: Speech Interpretation And Recognition
NGO	: Non-Governmental Organizations
EEA	: European Environmental Agency
ICLEI	: International Council for Local Environmental Initiatives
GHG	: Green House Gases
UNDESA	: UN Department of Economic and Social Affairs
PRT	: Personal Rapid Transit
CIDA	: Canadian International Development Agency
CSO	: Central Statistical Organization (IRAQ)
MOE	: Ministry OF Education (IRAQ)
IIED	: International Institute for Environment and Development
WHO	: World Health Organization
UMP	: The Urban Management Program
MEIP	: Metropolitan Environmental Improvement Program

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ABSTRACT

As a result of industrialisation, more employment possibilities, and other causes, urbanization is on the rise around the globe. Increasing numbers of people are moving from rural areas to urban areas, which could lead to deteriorating physical infrastructure, inadequate social and health services, insufficient security systems, unpredictable human interrelationships, and higher levels of competition and complexity; and, thus, the significance of commissioning smart, sustainable city projects around the world would have a balancing effect.

In order to ensure sustainable growth in cities, researchers must find a way to utilize smart city technologies while also having a clear urban policy in place. They must also find ways to implement appropriate planning mechanisms that allow cities to meet increasing demand while also having a comprehensive strategy that ensures integrated urban planning.

The importance of sustainable urban development can today only be understood as an endeavor that strikes a balance not just between the present and the future, but also between the present and the past.

A city consist of bridges, streets, schools, hospitals, police stations, airport, bus stations, municipality, houses, and different government facilities all these and more are all working to serve one purpose, the welfare of people living in the city. Adding smart to assets and facilities mentioned above leads to smart bridge, smart street, smart house etc. and hence resulting in a smart city. So the citizen is the pushing force behind making smart cities, and all work to make the life of people easier away from complications and routine in all life parts using sensors, ICT, IoT, and all the required apps and programs which enables both the government and citizens to control ending up with saving time, saving efforts, preventing crimes, overcoming many health issues and most important aspect is saving the environment by lowering consumption and depletion of natural resources.

Keywords: *Smart Cities, Sustainability, Sustainable urban development, ICT, IoT*

AKILLI ŞEHİRLERDE SÜRDÜRÜLEBİLİR KALKINMANIN ROLÜ

ÖZET

Sanayileşme, daha fazla istihdam olanakları ve diğer nedenlerin bir sonucu olarak, kentleşme dünya çapında artıyor. Artan sayıda insan kırsal alanlardan kentsel alanlara taşınıyor, bu da fiziksel altyapının bozulmasına, yetersiz sosyal ve sağlık hizmetlerine, yetersiz güvenlik sistemlerine, öngörülemeyen insan ilişkilerine ve daha yüksek rekabet ve karmaşıklık seviyelerine yol açabilir; ve bu nedenle, dünya çapında akıllı, sürdürülebilir şehir projelerinin devreye alınmasının önemi dengeleyici bir etkiye sahip olacaktır.

Şehirlerde sürdürülebilir büyümeyi sağlamak için, araştırmacıların akıllı şehir teknolojilerinden yararlanmanın bir yolunu bulması ve aynı zamanda net bir şehir politikası oluşturması gerekiyor. Ayrıca, şehirlerin artan talebi karşılamasına olanak tanıyan uygun planlama mekanizmalarını uygulamanın ve aynı zamanda entegre şehir planlamasını sağlayan kapsamlı bir stratejiye sahip olmanın yollarını bulmaları gerekir.

Sürdürülebilir kentsel gelişimin önemi günümüzde ancak bugün ile gelecek arasında değil, bugün ile geçmiş arasında da denge kuran bir çaba olarak anlaşılabilmektedir.

Köprüler, caddeler, okullar, hastaneler, karakollar, hava alanı, otogarlar, belediye, evler ve farklı devlet tesislerinden oluşan bir şehir, tüm bunlar ve daha fazlası tek bir amaca, şehirde yaşayan insanların refahına hizmet etmek için çalışıyor. Yukarıda belirtilen varlık ve tesislere akıllı eklenmesi, akıllı köprü, akıllı sokak, akıllı ev vb. ve dolayısıyla akıllı bir şehir ile sonuçlanır. Dolayısıyla vatandaş, akıllı şehirler yapmanın arkasındaki itici güçtür ve her şey, sensörler, ICT, IoT ve hem hükümetin hem de devleti mümkün kılan tüm gerekli uygulama ve programları kullanarak, hayatın tüm bölümlerindeki karmaşıklıklardan ve rutinden uzaklaşarak insanların hayatını kolaylaştırmak için çalışır. zamandan tasarruf, çaba tasarrufu, suç önleme, birçok sağlık sorununun üstesinden gelme ile vatandaşların kontrol altına alınması ve en önemlisi doğal kaynakların tüketimini ve tükenmesini azaltarak çevreyi korumaktır.

Anahtar Kelimeler: *Akıllı Şehirler, Sürdürülebilirlik, Sürdürülebilir kentsel gelişim, BİT, IoT*

1. INTRODUCTION

1.1 Study Topic

Around 66 percent of the world's population is expected to live in cities by 2050, up from the current 54 percent (UNEP, 2018). As a result, the world's metropolitan population may grow by 2.4 billion. As a consequence, there will definitely be a considerable growth of current urban settings, as well as a demand to construct new cities. Cities occupy only 2% of the planet's land area yet use more than 75% of the world's raw materials. According to the United Nations Environment Program UNEP (2018), Cities' material consumption is expected to rise from 40 billion tons in 2010 to 90 billion tons by 2050, an increase of more than tenfold. Some of these resources are primary energy, raw materials, fossil fuels, water, and food (UNEP, 2012). A city's ability to expand, competes, and provides a quality of life for its residents would suffer as a consequence. Waste management, resource shortages, air pollution, and traffic congestion, all of which damage human health, have been exacerbated by rapid urbanization (NRDC, 2012). To address these issues, the smart city idea has emerged. It is a "smart city" that seeks to become more sustainable, efficient, equitable, and livable. Smart cities are defined in several ways in the literature, and many of these definitions are in conflict. The word "smart city" is increasingly being used in a broad variety of contexts, from the definition of what constitutes a "smart city" to how it's defined, what resources are required, and what the city's ambitions, purposes, and scope are.

Communication and information technologies of the late 20th century and early 21st century have led to a new sort of society that is increasingly reliant on digital information and technology. Instead of using traditional methods, virtualization is being used (Abdel Fattah, 2009). As a result of this societal growth, new words for technologically-based cities, such as digital, electronic, virtual, cognitive, and intelligent cities, have been coined to describe them. Smart Cities enable communities to expand their skills at a range of aspects, and the birth of this sort of civilization was linked to changes in the construction of cities. The technology

components of Smart Cities have wide-ranging applications in a variety of fields, covering services, industry, the environment, and the economy, and perform a vital task in solving urban issues. As these issues become more prevalent, researchers are looking at the role of Smart City applications in finding solutions (Zarzis, et all., 2011)

However, only a small number of nations have sought to link their scientific research and technological agendas to development goals and built specific projects to implement them. Nations that combine their technical strategies and growth strategies in order to create centers of information control and technologies, which will contribute in the world's economy and will also secure their sustainability for generations, will be referred to as "Global Cities" (Tareq, 2012).

1.2 Important Definitions

1.2.1 Information and communications technology (ICT)

Along this thesis, ICT is used all the time because without (ICT) we can't establish smart city.

Information and communications technology, which is an extension of the term IT, places an emphasis on the significance of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, in addition to the essential enterprise software, middleware, storage, and audiovisual components.

Audiovisual and telephone networks may be linked to computer networks by a single cabling or connection system, which is denoted as ICT. As a result of these advantages, it is economically advantageous to combine the telephone and computer networks into a single infrastructure. All forms of communication, from radio and television to mobile phones and computers, are covered by ICT, as are the numerous video conferencing and distance learning are only two examples of the tools and services available as a result of them. In addition to digital and analog technology, ICT includes all forms of communication that may carry data.

ICT is a wide-ranging topic, and ideas are always changing. Every product that may be used to digitize and transfer data falls under this broad definition of "electronic data storage and retrieval" (e.g., PC including smartphones, TV, email, or robots).

Information age skills framework is one of the frameworks used to define and manage competencies in the information technology (IT) fields of today (Murray, 2011; Ozdamli, and Ozdal, 2015), How the ITU helps build smart cities figure (1.1):

1. Internet of things (IoT): smart cities will be powered by millions of connected devices and objects. ITU enables the coordinated development of interoperable IoT technologies.

2. Big Data: big data fuels smart city innovation. ITU brings diverse stackholders together to define the specific capabilities required to manage massive and complex data streams.

3. 5G: smart city services will require 5G systems as critical infrastructure to handle the demands of big data in real time ITU standard is essential for 5G development.

4. Technical standards: ITU provides globally harmonized technical standards that encourage and protect key ICT infrastructure investments for smart cities.

5. Spectrum allocation: wireless communications are critical to smart cities. The globally harmonized ITU radio regulations ensure interference free wireless communications.

Figure 1.1: Information and Communication Technology (ICT)

Source: Del Rio et.al., 2019)

1.2.2 Internet of things (IoT)

The phrase "Internet of Things" (IoT) is used to denote a network of things (or sets of things) that may interconnect and exchange information over the Internet or other communication networks (Nilanjan et all., 2018). As a result, the phrase "internet of things" was put down as a loose term since appliances don't have to be linked to the open network in order to be regarded as part of the concept (Hendricks, 2015).
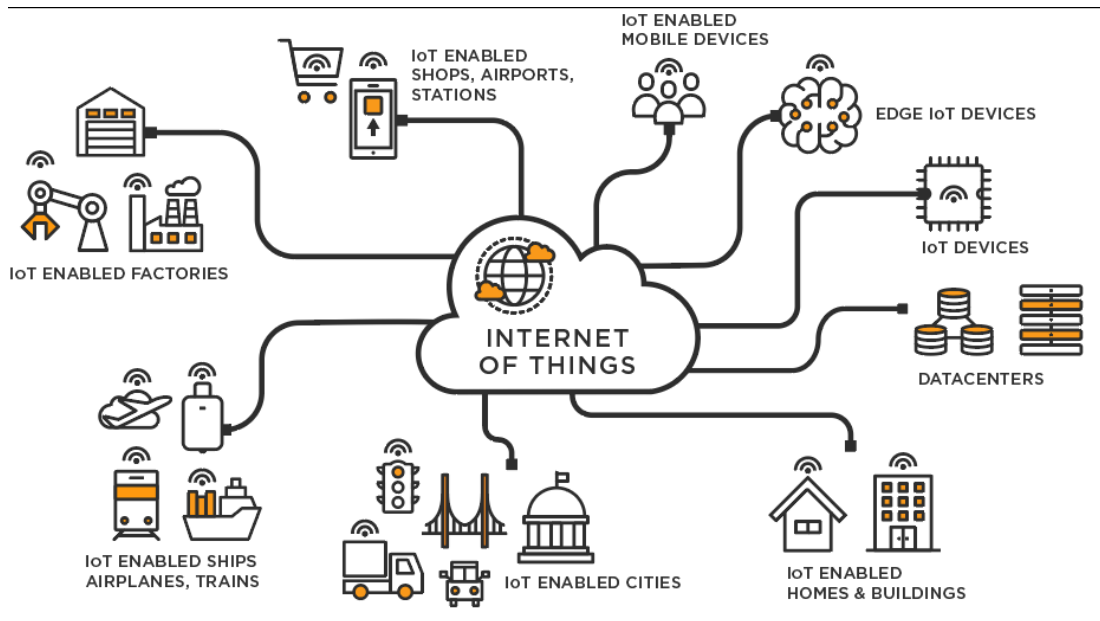
Figure 1.2: Internet of Things (IoT).

Source: (Internet of Things 2021)

Convergence of numerous technologies, such as cloud computing and affordable sensors and more sophisticated integrated devices, has resulted in the evolution of the industry (Hu, et all., 2022a). Internet of things (IoT) allows for conventional domains such as a network of wireless sensors and control systems as well as automated systems such as in homes and businesses). For consumers, IoT technology is best known for "smart home" products, such as illumination system, regulators and cameras that support one or more common ecosystems (such as smart phones and smart speakers) and can be organized utilizing smart speakers and smartphones that are part of that ecosystem. Medical facilities are also using the Internet of Things (IoT) (Hu, et all., 2022b).

IoT technology and devices are causing a lot of worry about privacy and security threats, which has resulted in a wide range of government and business initiatives to

address these concerns, like establishment of global and indigenous principles, references, and supervisory agendas (www1.nyc.gov, 2021).

1.2.2.1 Applications

Based on a platform or hubs guiding smart appliances and equipment, a smart or automated home might be constructed with Apple's Home Kit, producers can use iOS their household appliances and accessories using appliances such as the iPhone or Apple Watch. It is possible to utilize Siri and other iOS native applications for this purpose, as well. You may use the Apple Home app or Siri to control Lenovo Smart Home Essential devices without the requirement for a Wi-Fi bridge, such as Lenovo's Smart Home Essentials. It is possible to link a variety of smart home devices to a single smart home hub like Amazon Echo, Google Home or Apple HomePod, or Samsung Smart Things Hub. Home Assistant, Open HAB, and Domoticz are just a few of the open source ecosystems that are accessible (Greengard, 2015).

1.2.2.2 Elder care

A smart home's most important use is to aid the elderly and people with disabilities. For people having impairments, a variety of assisting technologies is used in these household setups. Users with visual and mobility disabilities may benefit from voice control, while those with cochlear implants can benefit from alarm systems that can be linked directly to their devices. Medical emergencies such as collapses and seizures may also be detected by sensors installed in a patient's body; these devices may be outfitted with other safety measures. Using intelligent household devices in this way may provide homeowners more freedom and improve their quality of life (Demiris, 2008).

The phrase "Enterprise IoT" denotes technologies that are utilized in the workplace and in commercial environments. The Internet of Things (EIoT) have 9.1 billion devices in 2019 (Aburukba, et all., 2016).

1.2.2.3 Transportation

Incorporating diverse modes of transportation's communication, control, and information processing would be made easier with the help of the Internet of Things. In transportation, the Internet of Things (IoT) may be employed (i.e. the vehicle, the

infrastructure, and the driver or user). All of the above are achieved by the active interaction between different elements of a transportation system such as intelligent traffic control, intelligent parking, electronic toll collection, logistics and fleet management, vehicle control and safety, and road assistance (Khizir, et all., 2018).

There are three basic components of vehicles communicating with one other, vehicles communicating with the infrastructure around them, and vehicles communicating with pedestrians. in vehicular communications systems, known as V2X (vehicle-to-everything communication). Using V2X is the initial phase toward connected and self-driving vehicles (Xie, et all., 2017).

1.2.2.4 Building and home automation

A wide range of mechanical, electrical, and electronic systems may be monitored and controlled using IoT devices in home automation and building automation systems (such as those found in public and private buildings, industrial plants, and academic institutions, or residential)... Literature is focusing on three primary aspects in this context: Internet of Things (IOT) and building energy management systems are being integrated to produce "smart buildings" that are both energy efficient and IOT-driven (Haase, et all., 2016). Real-time monitoring of energy use and user behavior may be an option for lowering consumption. Built-environment integration and its potential future uses with the utilization of smart devices (Haase, et all., 2016).

1.2.2.5 Infrastructure applications

Sustainable urban and countryside infrastructures, such as bridges, railway lines, and wind farms, may be monitored and regulated using the Internet of Things (IoT). The Internet of Things infrastructure may be utilized to monitor any incidents or alterations in structural parameters that might threaten safety or elevate hazard. To save costs, cut employee expenses, enhance the quality of workday, remove paperwork, and increase productivity, construction companies may benefit from the Internet of Things (IoT). You'll be able to save time and money using Real-Time Data Analytics. When it comes to scheduling repairs and routine maintenance, it may be used to coordinate duties between service providers and facility users in an effort to save time and money. It is also possible to employ IoT devices to track and control critical structures like bridges so that vessels can go into and out of ports. A reduction in operational expenses and a rise in incident response efficiency are just a

few of the benefits that IoT devices may bring to infrastructure management and emergency response. The Internet of Things (IoT) may have a positive influence on garbage management as well (Gubbi, et all., 2013).

1.2.2.6 Implementation on a global level

Several significant IoT installations are being intended or are already in progress, in order to improve city and system management. Songdo, South Korea's first smart city, is being built in phases; as of the end of June 2018, the city's commercial core had been completed in around 70% of its total. For most municipal infrastructures, no human intervention is anticipated (Poon, 2018).

Projects in Santander, Spain, are now underway for an additional application. A hybrid of two strategies has been used in this utilization. Almost 18,000 individuals in this city of 180,000 have downloaded the city's smartphone app. The app's 10,000 sensors provide functions including parking search, environmental monitoring, and a digital city agenda (Rico, 2014).

Guangzhou Knowledge City and San Jose's efforts to enhance air quality and minimize noise pollution as well as promote transportation efficiency are examples of large-scale deployments that are now taking place in the United States as well as in Asia.

With their RPMA (Random Phase Multiple Access) technology, San Diego-based company Ingenu has created a public internet for low-bandwidth data transmissions that uses the same unlicensed 2.4 gigahertz spectrum as Wi-Fi. With cities like San Diego and Dallas included, Ingenu's "Machine Network" reaches more than a third of America's population in the US. Sigfox was the first company in the United States to begin construction of an Ultra Narrowband wireless broadband network in 2014. Declaring plans to deploy 4000 base stations across 30 US cities in December 2016, it surpassed other IoT network providers to become America's largest At the same time, Cisco is working on projects to make cities smarter. Five kilometers from Vijaywada in India, Cisco has started deploying smart Wi-Fi technology, smart safety and security, smart lighting and parking technologies, intelligent mass public transit, intelligent bus stops, intelligent kiosks, and remote expert for government services (REGS) (Ujaley, 2018).

To keep track of all of the city's watercraft and connect them together, New York Waterways completed a major deployment throughout the city. Chicago-based fluidmeshed networks, a business designing wireless networks for essential applications, planned and built the network. The NYWW network now covers the Hudson, East, and Upper New York Bays. The wireless network installed by NY Waterway has made it easier for the company to monitor its fleet and passengers. There will be more applications in the future for security, energy and fleet management, public Wi-Fi, paperless ticketing, and more (STE Security, 2021).

1.2.2.7 Energy management

Most energy-consumption appliances currently have an Internet connection that allows them to interact with utility companies not just to achieve equilibrium in energy production but as well to improve power usage in total. These devices may be controlled remotely by the user, or through a cloud-based interface, and can perform duties such as arrangement and monitoring (e.g., turning on and off heating appliances, stoves, and lighting fixtures at a distance etc.). Utility-side IoT applications, such as the smart grid, collect and act on data linked to energy and power in order to increase the effectiveness of electricity generation and supply. With the use of AMI-connected equipment, electric utilities are able to operate transformers and other distribution automation devices, as well as gather data from their customers' smart meters (Parello, et all., 2014).

1.2.2.8 Monitoring the environment

When it comes to environmental monitoring, sensors from the Internet of Things are often used to keep tabs on things like air and water quality, weather, soil conditions, and even animal activity and the ecosystems in which they live. As Internet-connected devices with limited resources become more common, emergency services will be able to make better use of these systems, such as early alarm systems for earthquakes and tsunamis. Sensors utilized in this field may be portable and spread over a large area. IoT's standards are said to have a profound impact on wireless sensing (Hart and Martinez, 2015).

1.3 Purpose of Study

The main goal of this research is to learn more about how smart cities can be used to make cities more sustainable and environmentally friendly, taking Singapore as an example of this direction and trying to investigate set important points such as:

- Understanding the idea of smart cities, their features and mechanisms.
- Understanding the difference between smart, sustainable and green cities.
- Tools needed for smart city.
- Identifying the ideas and theories which construct sustainable cities.
- Studying particular international experience for the creation and conversion to smart cities.
- Taking Singapore and Masdar as examples of smart cities
- The connection between sustainability and smart cities.

1.4 Previous Studies

Dameri and Ricciardi, (2017) examined the parallels between smart cities and green cities, as well as how much overlap there is and how many interactions there are. An observational study of Genova Smart City is conducted after a thorough review of the worldwide literature on these two subjects. The locations that cross over are highlighted. There is a huge common overlap between a smart city and a green city, whose size is determined by the city's decisions and preferences regarding green goals that may be achieved via the use of smart technology, according to the analysis of the literature and an actual example. Natural resources, energy usage, and pollution are all impacted by this interplay. The city's smartness and greenness factors must consider the fact that not all smart activities have environmental influences, and not all green activities are also smart. As a result, an index like the reduction of CO_2 emissions must be translated in relation to the activities that produced it. When it comes to laws that are shared by smart cities and green cities, the synergies will vary per city (Rassia, 2017).

Sun M., Zhang J, (2019) stated that a Smart City upgrades the living of residents, particularly through utilizing information which further develops lodging or transportation, for instance. Unfortunate, there is as yet a need, particularly when considering security. In addition, it's difficult to follow where the Smart City

information comes from in light of the fact that the sources (for example sensors) are circulated over a wide reach (Sun, 2019).

Osman (2018) defined the Smart City as an arrangement of frameworks since it contains various stages that share data together. Such stages (Costa D. G, 2020) are in everyday an assortment of installed and smart frameworks and could diminish the expenses of Internet of Things uses a great deal later on. The principle angle in a Smart City is dedicated on the sensors, which give accommodating data of heat or the contamination in a town, to fill in as specific illustrations. These devices are at that point handled by various town divisions. In this way, a sensor that detects a flame is immediately linked to the Firefighting Department. A wide range of conditions might then be identified by different sensors (Costa and de Oliveira, 2020).

2. SMART CITY AND SUSTAINABILITY

2.1 General

A city is more than simply a geographical location; it is also a place where people live and work. However, cities have seen significant social, cultural, and economic transformations as a result of the globalization process. Historic cities, in particular, where the past and present are intertwined and witness to the past, and where people participate throughout the city's area and locations that have been significantly impacted by these transition processes.

Population expansion and fast urbanization have an impact on them. The rising need for additional houses and the legal or informal formation of new residential zones will alter the features of cities, particularly the conventional residential environment. The significance of sustainable urban development must now be viewed as an activity that balances not just the present and future, but also the past. Sustainable cities, on the other hand, are not a new concept. Historical towns and metropolises around the globe had the ability to build and maintain a constant balance between internal, social, and economic activity, as well as exterior, natural, and agricultural environments.

The majority of empirical work on ecological or sustainable cities focuses on concepts and criteria for attaining a balance of ecological, economic, and social goals in urban settings. On the other hand, sustainable cities cannot perceive merely these three networks of linkages. The physical environment and spatial interactions are inextricably linked to this well-known triangle network, and both are clearly crucial.

2.2 Smart City

As a rule, a Smart City leverages innovation to improve on the conditions of life in a city. The goal of city planners is to enhance the quality of life for everyone by exchanging an enormous amount of data regarding energy, waste and reusing, and so forth Innovation advancement doesn't stop, what prompts diminished expenses on calculation force and further to an alteration in the rate of movement how a city's data may be analyzed and organized (Rassia, et all., 2017).

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A Smart City upgrades the live of residents, mainly by utilizing information which further improves lodging or transportation, for instance. Unfortunate, there is as yet a need, particularly when considering safekeeping. In addition, it's difficult to follow where the Smart City information comes from in light of the fact that the sources (for example sensors) are circulated over a comprehensive reach (Sun and Zhang, 2019).

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2.3 Smart City Scopes

As the smart city description, no characterized models in regards to smart city drives exists, be that as it may, there are" gatherings of grouped measurement which are utilized as the most widely recognized ones in certain investigations, reports, hierarchical sites, and so on for various reason like as a method for estimation and principally for positioning urban areas and assessing urban communities' cleverness (Monfaredzadeh, and Berardi, 2015).

For instance, European Smart Cities which created four forms of brilliance evaluation based on these measurements made a scale for European medium-sized urban communities positioning to display challenging spaces of smartness between them (Giffinger, et all., 2015). These measurements (Figure 2.1) include six segments of smart economy, smart transportation, smart government, smart environment, smart living 'and' Smart citizens (ASCIMER, 2017).

- Smart individuals or human resources: connected to the degree of capability of people and community resources, adaptability, inventiveness, resilience, modernity, and support in open life. The presence of residents ready to take

an interest admirably in shrewd metropolitan life and to adjust to new arrangements giving inventive arrangements, development and variety to their networks is required.

- Smart versatility: Smart Mobility seeks after to offer the most proficient, perfect and impartial vehicle network for individuals, merchandise, and information, alluding to nearby and supra-neighborhood openness, accessibility of ICT, present day, maintainable, and safe vehicle frameworks.

- Smart economy: an angle connected to a feeling of advancement, innovation and entrepreneurship, the adaptability of the marketplace, reconciliation in the worldwide industry, and the capacity to change. Savvy administration: identifies with support in dynamic cycles, straightforwardness of administration frameworks, accessibility of public administrations and nature of political techniques.

- Smart climate: comprehended as far as engaging quality of normal circumstances, nonexistence of pollution, and maintainable management of properties.

- Smart Environment: utilizes information assortment from utility organizations, clients, and air, water, and other city assets to set up fundamental spaces of activity in metropolitan arranging and city foundation arranging just as to advise metropolitan administrations administrators to accomplish a more proficient and maintainable metropolitan climate while further developing the residents' personal satisfaction.

- Smart living: social and educational services, holiday places, social unions, and human well-being are all included in the definition of overall gratification. The savvy the board of offices, community places, and administrations utilizing ICT advancements to place the attention on further developing availability, on the adaptability of employments, and on drawing nearer to the resident's requirements.
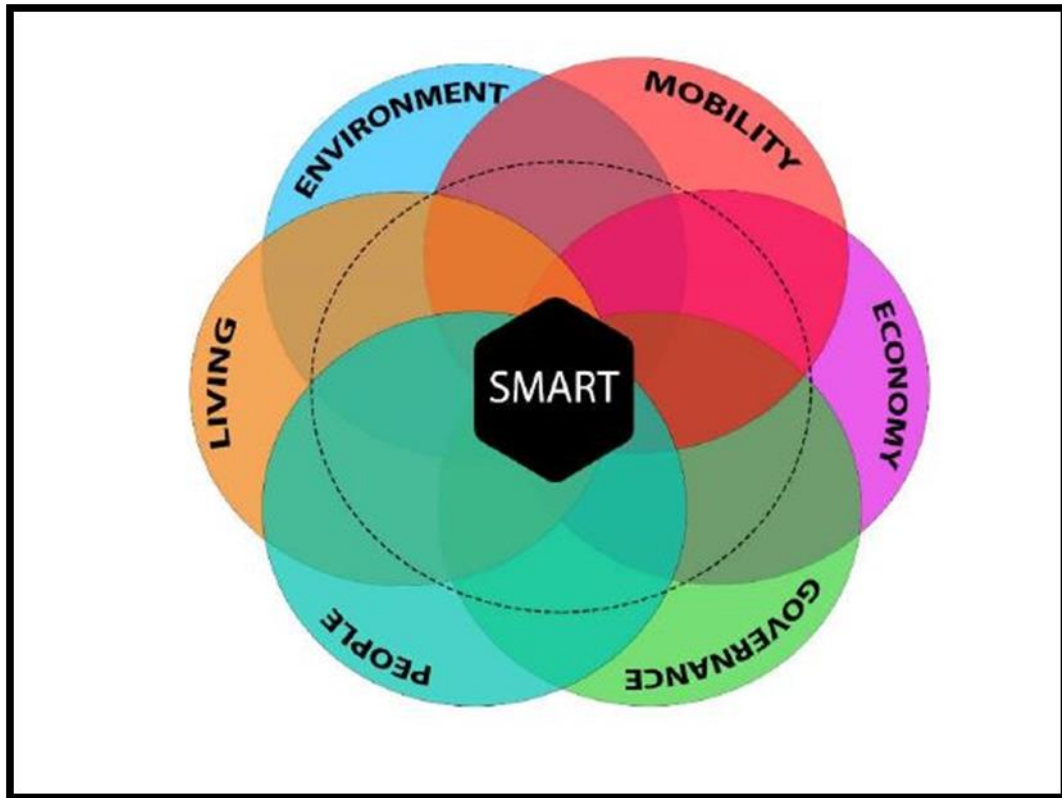
Figure 2.1: Smart city scopes.
Source: (ASCIMER, 2017).

The precarious development in city population and the subsequent growth in asset deployment will definitely make various complications for towns communities. This reality features the significance of moving standards in the manner urban communities work as far as manageability. For the reasons for the current investigation, build up a functioning meaning of maintainability.

Allen and Hoekstra, (1993) feature the significance of building up the measure on which a framework is being surveyed as far as maintainability. Accomplishing maintainability on a worldwide measure has need of distinctive kind of activities in comparison to a metropolitan measure. No particular best-settled definition as far as maintainability in the metropolitan scale all things considered there is a normally utilized arrangement of attributes of metropolitan supportability (Allen and Hoekstra, (1993).

These incorporate intergenerational value, intra-generational equity (social, geological, and administration value), preservation of the regular habitat, critical decrease of the utilization of non-inexhaustible assets, monetary essentialness and

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variety, self-governance in networks, resident prosperity, and delight of major human necessities (Maclaren, 1996).

It is a combination of the ecological, economic, and social aspects of maintainability: natural habitats and ordinary assets are preserved, and an energy-based economy is used to sustain the ecosystem. In terms of social value, local self-sufficiency, resident happiness, and meeting basic human needs, metropolitan areas are valued by monetary importance and how different they are (Lehtonen, 2004).

2.4 Outline of Urban Sustainability

The improvement of present day human culture has been described by mechanical advances that have prompted expanded creation and utilization, adding to enhancements in expectations for everyday comforts, wellbeing and prosperity. This, thus, has likewise advanced populace development. Improvements of this scale across industry and worldwide populace increment, have caused basic ecological issues, for example, air contamination and decreases in biodiversity, making extra pressing factors on restricted normal assets and expansions in deforestation and an unnatural weather change (Tietenberg and Lewis, 2016).

The quick extension of urban regions has set off some basic social and financial outcomes, especially in non-industrial nations. The most conspicuous of these are destitution, helpless lodging conditions, social changes, an absence of work and authoritative debasement. This is exacerbated by deficient social administrations including insufficient urban foundation and utilities, stuffing and an absence of public transportation (Barney, 2006), Resulting in expanding worldwide attention to the dangers to the planet and its occupants (Field, 2014).

Feasible advancement has arisen in light of the squeezing, complex and general difficulties concerning urban regions, addressing another way to deal with the plan and arranging of urban regions having been advanced in the course of the most recent couple of a very long time as a philosophy in numerous fields all throughout the planet (Muller and Bjorno, 2017).

It has now become acknowledged practice that pertinent specialists and arranging specialists should consider the rules and standards of urban supportability prior to settling on choices or undertaking/recovering any urban improvement project. In any

case, the execution of this methodology isn't simple as numerous ecological, social and monetary maintainability measurements should be tended to.

In the course of recent years, a wide scope of administrative, non-legislative (NGOs) and local area based associations have accepted feasible urban improvement as another worldview and considerable part of public strategy making (CIDA, 2012). Yield has changed and incorporates projects, files, structures and manageable urban communities' ideal models. For instance, the DPSIR system was created by the U.S. Climate Protection Agency in 1995, and afterward extended by the European Environmental Agency (EEA). This structure is utilized to survey and sort out complex ecological issues by depicting collaborations between society (human exercises) and the climate across numerous nations (Skondras and Karavitis, 2015).

The International Council for Local Environmental Initiatives (ICLEI) was set up in 1990 as one of the worldwide organizations for the local governments that have made a promise to reasonable turn of events. ICLEI gives preparing, specialized counsel and data administrations to share information, construct limit and backing nearby governments to carry out reasonable urban advancement at the neighborhood level (CIDA, 2012). Individuals from the World Sustainable Capitals (Middle East and North Africa) have set up Vision 2030. The Capitals have submitted, by working with worldwide urban communities, to arrive at a scope of reasonable urban objectives by 2030, through tending to ecological, monetary, social and social goals to make an economical future for urban areas (WGBC, 2013).

A few nations have given reasonable ideal models to the most economical urban improvements on the planet. These plan to work on the drawn out friendly, financial and environmental strength of urban areas, for example, Chongming eco-island in China (2006-2010), Masdar City in UAE (2006-2030), and Ottawa's Zibi project in Canada (Mersal, 2016).

Maintainable urban advancement should be one of the key destinations while improving or making urban networks. This requires discovering inventive methodologies and ideas, which can be carried out effectively to accomplish the standards of supportability.

2.5 Sustainable Urban Development

Internationally, feasible metropolitan improvement is perceived as a likely way forward to address urban difficulties by working in flexibility, defending the biological system and advancing the utilization of environmentally friendly power, with the objective to accomplish an advantageous connection between the climate, economy and society.

Ecological problems have been embraced as a need, covering high-energy utilization, the over misuse of regular assets, expanding GHG discharges, biodiversity decrease, and air contamination (Annex, 2012).

Yet, these should be tended to while overseeing financial difficulties, for example, those presented by high populace densities, urban development, helpless states of the lodging, neediness, expanding wrongdoing, wasteful social administrations and utilities, disintegrating framework the development business and joblessness (Cobbinah, et all., 2015).

Even though some creating economies, for example, China have gained huge headway in accomplishing the monetary component of manageable urban advancement through working on the nature of its resident's lives, the standards of reasonable urban improvement stay, as far as its pragmatic application, indistinct in various other agricultural nations (UNDESA , 2013).

Therefore, numerous worldwide arrangements, foundations and projects in the course of recent many years, have tried to create the idea of urban manageability a reality in agricultural nations by the exercises and projects of worldwide establishments. These include the United Nations Development Program (UNDP), the United Nations Environment Program (UNEP) and the United Nations Human Settlements Program (UNHABITAT) (Cobbinah, et all., 2015).

Linares, (2003) have recognized a few associations who have assumed a critical part in maintainability advancement in this, carrying out projects like The Urban Management Program (UMP), The Metropolitan Environmental Improvement Program (MEIP), and 'The Urban Management Program' (UMP) in Asia, Africa and South America. They have proposed new bearings relying upon worldwide experience, to handle and alleviate ecological urban difficulties and along these lines work on people groups' lives. These projects have focused on reinforcing the

capacity of nations to handle issues like urban land the board; the upkeep of urban foundation; the incorporation and improvement of water supply and disinfection administrations; contamination control and general assurance of the urban climate (Linares, 2003).

Satterthwaite (2003) covered drives for handling urban financial difficulties in Asia, South Africa and Latin America by rehashing fruitful arranging rehearses seen all throughout the planet for example by the World Health Organization (WHO) and International Institute for Environment and Development (IIED) (Satterthwaite, 2003). The greater part of these endeavors zeroed in on reinforcing public procedures and the limit of neighborhood chiefs to relieve urban difficulties like urban neediness, local area wellbeing, vagrant settlement, training and social prosperity (Vanclay, 2003).

Hardly any agricultural nations have experienced as much remarkable conditions and political precariousness because of progressive conflicts and global assents than Iraq. This has brought about extreme harm to the climate, the economy and society overall, for example, natural debasement and air contamination; wasteful framework; inadequate water supply frameworks; spontaneous changes in land use; brutality and financial frailty; an absence of essential conveniences and ecological products; gridlock and mishaps; and a crumbling in the neighborhood economy (MOE, 2013).

Notwithstanding the social and monetary weakening addressed by lodging shortages, absence of wellbeing in urban regions, joblessness, the shortfall of interest in maintainable turn of events and spread of casual repayments (CSO, 2013).

These difficulties address hindrances to the making of urban turns of events and the capacity to accept supportable practice. A down to earth understanding and significant exertion to accomplish manageable urban improvement for Iraqi urban areas might be viewed as an important, to relieve any adverse consequence, regardless of whether long or present moment, on human existence and the local area.

An accentuation on receiving practical urban advancement as a fundamental standard can assist with accomplishing key financial and urban ecological points, for example, upgrading the personal satisfaction of the residents; controlling urbanization; empowering lodging projects; further developing framework and transportation; the

advancement of public administrations and utilities; decreases in the overexploitation of normal assets; empowering the utilization of sustainable power in this manner supporting the nearby economy. This will likewise act to diminish by and large weights on the climate, ensure vegetation cover and lessen ecological contamination (CIDA, 2012).

2.6 Emerge of Sustainability

The socio-economic in urban areas is the aftereffect of social and monetary alteration caused by globalization and the transferal from modern advancement to data improvement (Egger, 2006).

Consequently, a solid need arose for reasonable urban communities. The notable Brundtland Report started a discussion in intuition around its center subjects on the climate, advancement, and administration. The report has prompted a scholarly reaction since its delivery in 1987 from assessments of the term 'supportability' to financial and value subjects and organizations, climate and involved urban matters too. The request for supportable advancement was a commonsense reaction to the difficulties of the era while the objectives of the report were broadly embraced (Sneddon et all., 2002). Subsequently, the idea of maintainability has been a vital piece of advancement work since the last part of the 1980s.

There is a long history of research on urban settlements that are both viable and livable, albeit the call for economical urban advancement showed up in the 1976 UN (Habitat, UN, 1976). An unmistakable definition was figured for supportable urban communities which ought to be an establishment for all urban areas: In order to be manageable, cities must fulfill the demands of their residents while without placing unnecessary strain on local or global resources and institutions (U.N., 2013).

Both the countries responsible for producing and those responsible for creating should be held accountable for this goal. UN has 17 Sustainable Development Goals since 2015, all of which are interconnected yet have their own specific goals to achieve. All of these SDGs must be achieved by 2030. Sustainable Cities and Communities is a goal that aims to achieve by 2030 and focuses mostly on affordable housing, access to practical transportation systems, and an increase in the degree of support and integration among residents toward a manageable city arrangement.

Additionally, it features the security of poor and weak occupants from various sicknesses (e.g., helpless water quality) and giving comprehensive and quality green public space for individuals. Nonetheless, as indicated by the (UN, 2013) these objectives "require working regional authorities capable both to guarantee that such advantages are acknowledged, and to receive a practical structure that energizes the city's development inside biological cutoff points."

In agricultural nations admittance to fundamental public administrations (e.g., water, sterilization, power and medical care) stays deficient. Because of overpopulation and serious relocation from country regions to enormous urban areas, challenge the institutional capacities with respect to further developing availability to framework and public administrations.

While urban-focused countries with high middle and upper-level salaries are now approaching basic public administrations, they will need to improve their proficiency in energy and water consumption, reduce waste generation, and further enhance their reusing frameworks to keep up with the times. Larger and wealthier cities, in particular, may have poorly managed asset structures, but their natural landscapes are also more impressive (U.N., 2013).

Besides, powerful urban administration is a condition for practical urban areas this requires staggered collaboration among nearby, public and worldwide networks and building up associations to assemble public and private assets.

Making strategy system for the supportable advancement of urban regions is one of the foundations just as fair authenticity, and partner conference is fundamental since approaches are the arrangement of thoughts or plans that are utilized as an establishment for dynamic in fields like governmental issues, arranging, and business. In the authoritative framework, the strategies' job is control of shift and show a course or approach for leaders (Solesbury, 2013).

European Union (EU) examines (Eurostat, 2016; 2017) and UN reports (2013) demonstrate the marvel of urban conundrum by underlining that urbanization gives new positions and freedoms to a huge number of individuals in both created and agricultural nations and has added to destitution annihilation endeavors around the world. Simultaneously, quick urbanization adds strain to the asset base and expands

the interest for different administrations and assets (Eurostat People in the EU, 2017; Eurostat, 2016).

Despite the fact that urban areas are frequently the spots of occupations and opportunity with admittance to quality schooling, medical care, a wide scope of administrations and furthermore development is concentrating there, numerous urban communities are described by high destitution, isolation, horror rate and high air and clamor contamination. By contrasting urban regions with the country, the work market is more powerful by giving adaptability which makes urban communities more alluring to organizations and individuals.

2.7 Need for Sustainable Cities

Urban areas have become the essential living space for people, and since 2007 the greater part of the World populace lives in urban regions, and studies gauge that this number will increment to 70% by 2050 (World Bank, 2018).

This pattern shows that individuals' ways of life are looking to progress according to financial exercises, social constructions, and their connection to nature because of the way that fundamentally individuals live and work in country regions. Urban communities are persistently confronting new difficulties in both created and non-industrial nations. These difficulties are intricate; subsequently a solitary arrangement can't be adequate to tackle these financial and ecological issues. Industrialization and free enterprise animated social and monetary cycles worldwide which created disparity in the conveyance of abundance. This imbalance made diverse urban regions where inhabitants don't have similar degree of availability to assets and administrations (Lipietz, 1995).

The expansion of the populace in urban areas likewise causes ecological corruption through the exceptional use of individual transportation and land use. This reality turned the scholarly world, choice and strategy producers to the requirement for more feasible urban areas, accordingly different ideas were grown like the zero-squander city, minimal city, eco-city, just city and among these the idea of keen city became one of the reactions to these complex urban difficulties (Albino et all., 2015).

Numerous current urban difficulties began in the mechanical city what began to develop in the nineteenth century when large scale manufacturing drove the best

approach to more coordinated private enterprise and later changed into Fordism. Verifiably, there has been an overall pattern of populace development from rustic to urban regions with an expanding number of individuals living in urban communities and towns which is regularly determined by the pursuit of work. The need in the mechanical city was availability, and accordingly, production lines focused close doors and purchasers, these manufacturing plants additionally requested countless labor force in this manner more, and more works moved to urbanized regions from the rustic pieces of the country. The urban design of the mechanical city was basically described by two things: above all else, plants ruled the urban view, while social isolation affected a division of neighborhoods (Pacione, 2009).

The mass numbers of works were for the most part lived near their work environment in swarmed and unfortunate areas without essential foundation. These living regions were regularly coordinated by entrepreneurs and plant proprietors, hence the nearby governments didn't have the force or interest to control these regions, anyway this changed when distinctive work developments broad and began to dissent for work rights and better day to day environments at the turn of the nineteenth and twentieth hundreds of years, Later, extended democratic rights and residents' delegates began to work on work's neighborhoods by creating lodging and hard foundation (e.g., sewage framework, substantial street, public lighting and power in houses, and so on) in many industrialized nations (Pacione, 2009; Mommaas, 2004).

Be that as it may, the city was exceptionally contaminated because of the warming and power of private and non-private structures and plants which depended on coal or other dirtying assets. This type of the economy made the greater part of the present urban areas' urban constructions, and these urban communities were profoundly impractical socially, monetarily and naturally, and didn't change generally until the Second World War.

States and nearby governments animated and supported the period of prosperity after the Second World War which produced a huge improvement in the framework particularly in urban regions, and the new street frameworks focused on singular transportation. In this way, individuals who lived in the swarmed and contaminated urban areas were empowered to move in vicinity to the city, in the agglomeration due to the inescapable of vehicles. The never-ending suburbia caused ecological

debasement by including more grounds for the fabricated climate to the detriment of the common habitat (Nefs, 2006).

To have a superior comprehension of this post-war period and the overall outlook, we need to see that the overall considering individuals were that social and financial cycles and the climate were totally controllable by human activity (Lane, 2005).

Hence, this attitude unequivocally impacted fast urbanization and urban rebuilding which produced significant issues in the public eye and nature. This time was trailed by Post-Fordism which was described by specialization, the adaptability of work and in light of the improvement of correspondence, portability and mass market. The 'old economy' moved from mechanical creation to assistance and information based economy. The cycle of deindustrialization influenced the modern regions and harbors of huge urban areas from where a large portion of the creations were moved to different nations because of financial reasons, The high number of low gifted works lost their positions, so the joblessness rate quickly expanded in urban regions, while the country regions' economy couldn't give occupations because of mechanization (Jessop, 2005).

The alleged neoliberal state became kind of a specialist of the market instead of a controller, and for example began to privatize public claimed properties and to execute neoliberal urban strategies, thusly the private area transformed into the predominant main impetus, and private financial backers began to shape urban areas (Elwood, 2002).

Since the state required extra pay because of the downturn and didn't have the monetary asset to keep up with and remodel openly claimed properties, these properties were bought by private financial backers. The worth of specific areas near the downtown was expanded, where regularly inhabitants lived from the average workers or different hindered gatherings of people (e.g., jobless, ethnic minorities and so forth), in this manner these locale were the objectives of restoration programs and drawing in financial backers. This marvel is considered improvement that may actuate removal because of higher lodging costs which can push out the low-paid or neglected inhabitants and nearby organizations over the long run. The result of this wonders was a groundbreaking cycle from low-class to working class area (Atkinson, 2000).

In addition to that from a neoliberal perspective the worth of seriousness and the estimation of execution as an administrative apparatus turned out to be more far reaching and as often as possible used to look at urban communities and in the formation of different city rankings. There have been different city rankings with an emphasis on live ability, business engaging quality, advancement or smart, and so on The normalizing force of neoliberalism creates contest among urban areas through changing their disparities from the standard they expected in the picked rules to be the best practice.

This methodology, for example, can impact the distribution of monetary assets to advance the city's situation on various rankings, hence city chiefs can remove assets from more pertinent regions and picking arrangements what don't take care of the city's issues (Kornberger and Carter, 2010).

2.8 Sustainable Urban Challenges

Reasonable urban difficulties have become a squeezing worldwide issue for a considerable number of urban areas and urban regions all throughout the planet, which require reevaluation by governments (Mele, 2014). There is no question that changing urban arranging measures from unreasonable to manageable examples is testing. It's difficult urban structures, public administrations, framework, transportation, energy, water, and waste frameworks that must be changed, yet every one of the frameworks and guidelines identified with measure should be adjusted to mirror the economic plan.

The three normal urban difficulties will be talked about in this part; ecological, social, and monetary, their connections to one another and sway on one another completely investigated (Bjorno, 2017).

- Environmental

Ecological variables incorporate all components influencing environmental change and the regular habitat. It addresses the main test to feasible urban improvement meaning to decrease naturally harming exercises, for example, land use changes, the effect of the development business, energy utilization and related GHGs discharges, water use and accessibility, squander age and reusing, contamination, disinfection and foundation. These are for the most part factors which are probably going to turn

out to be considerably more testing in the short term (Clarke, and Ramalingam, 2012).

Various investigations have explored natural difficulties inside and out; (Tippett et al., 2007) uncovered a developing public mindfulness, about how to handle natural issues and the rise of numerous nearby activities that have had provincial and worldwide effects. Worldwide natural change can likewise influence neighborhood biological issues; for instance, perhaps the main concerns is the ecological effect of utilizing petroleum derivatives in urban regions just as the worldwide utilization of raw petroleum as an essential wellspring of energy (Tippett, et all., 2007).

(Campbell-Lendrum and Corvalán, 2007) brought up that urban areas make diverse ecological issues, identified with development industry examples of creation and utilization and contamination of air, water and waste. Numerous social issues are likewise brought about by the natural conditions, for example, traffic stuffing, lacking urban framework, wasteful public administrations and, biological catastrophes. Furthermore, an absence of clean water, the shortfall of satisfactory sterilization and amassing of waste can prompt infections or may cause demise, as in a portion of the underdeveloped nations (Tippett, et all., 2007; Campbell-Lendrum, and Corvalán, 2007).

In spite of the developing worry about different natural issues in the course of recent many years, environments across the world are declining, activity against environmental change still in its outset (Seto, and Shepherd, 2009).

- Social

Urban areas are developing, both in populace and topographical scattering. This has become the main social test and the principle determinant of ecological quality at nearby, provincial and worldwide levels. The assumption is that the overall urban populace will twofold to arrive at 3.5 billion by 2050 (UN, 2014).

A considerable extent of this bigger populace, particularly in non-industrial nations, will be living in casual settlements, experiencing issues identified with schooling and wellbeing, stuffing, deficiencies of water and other human necessities, these notwithstanding key urban issues including social interruption, the shortfall of urban arranging and lodging shortages (Molla, 2015).

Numerous new investigations have brought up that few urban areas, explicitly in non-industrial nations, have effectively been influenced by remarkable populace development and quick urbanization. These urban communities have been changed into wellsprings of negative ecological effects and drivers for the fast exhaustion of normal assets. The size of the test is with the end goal that a few creators have ventured to such an extreme as to mark these elements wild and flighty, presently and sooner rather than later (Molla, 2015).

- Economic

Monetary difficulties address one of the principle purposes behind fast, overall urbanization as individuals move to discover work and the expectation of a worked on way of life. The fast expansion in populace thickness, especially in agricultural nations, has made serious urban difficulties, like far reaching neediness, lacking lodging, compounding of financial inconsistencies, undesirable day to day environments working with the spread of illness and joblessness. This is particularly the situation when arranging endeavors are not powerful enough to manage the inflow of new occupants (Zurich, 2015).

The benefit of applying urban maintainability ways to deal with address natural financial difficulties is clear. Supportability looks to accomplish reasonableness and value in regards to the arrangement of fundamental public administrations like lodging, transportation and framework, which thusly works on the norm of human existence. This can likewise be a powerful method to handle the current global neediness emergency (Drexhage and Murphy, 2010).

It is significant, along these lines, to foster powerful approaches and answers for manageable urban improvement dependent on nearby needs which are frequently not quite the same as the worldwide ones. Moreover, these difficulties can frequently contrast from those found in created a nation which raises the significance of incorporating the perspectives on the nearby partners in all lifecycle phases of an urban improvement project.

As a general rule, key natural and financial difficulties affect individuals, where they live and on the spaces that drive monetary seriousness. Carrying out advancement can change the current and future existence of a local area and all things considered, is of huge worry for organizers, planners and strategy producers. It requires gathering

both quantitative and subjective data on the effects of urban turn of events, for example, coming about work open doors locally, interest for lodging, reasonableness, protection of culture and urban wellbeing and security. Thusly, it is fundamental that any proposed urban improvement be reliable with the nearby attributes of the local area (Gavaldà-Miralles and Choffnes, 2014).

2.9 Moving Cities towards Sustainability

Feasible urban areas have become an exceptionally wanted objective for future metropolitan turn of events. In any case, there are a few separating depictions of what precisely a maintainable city ought to resemble. As per the (Think-tank Sustainable Cities International, 2010), a city ought to embrace city-explicit economic improvement methodologies to cultivate development and headways inside framework and innovation, while likewise expanding effectiveness gains.

Bulkeley and Betsill (2005) address how unequivocally urban communities and neighborhood governments really can impact the difficulties of supportability. A few impediments are confronted while making a practical city, and the understanding and execution of maintainability are molded by the different types of administration, which challenges the customary differentiations between nearby, public and worldwide governmental issues (Bulkeley and Michele, 2005).

Urban areas can be viewed as engines used to move towards feasible turn of events, and the administration of these perplexing frameworks requires imaginative and refined arranging devices and ideas. Maybe than being free from each other, (Nam and Pardo, 2012) express that the current arranging devices and ideas are commonly associated and cross-over with one another. This can bring about huge disarray as far as definitions, which thusly confounds the application and utilization of such instruments and ideas (Nam et all. 2011).

Jabareen, (2006) distinguishes four sorts of maintainable metropolitan structures, and depicts how their plan ideas contribute towards manageability: neo-customary turn of events, the metropolitan control, the minimal city, and the eco-city (Jabareen, Yosef, 2006). Schatz, (2007) distinguishes the three sorts of advancements inside our undeniably urbanized territories just like the computerized city, the smart city, and the smart city (Schatz, 2007). Murray, et al (2011) recognize three answers for urban

areas moving towards maintainability: information urban areas, which center vigorously around training, long lasting learning and self-improvement; computerized urban communities or digital urban areas, driven principally by speculations from enormous data and interchanges innovation sellers expecting to empower tremendous interconnectedness; and eco-urban communities, which center around ecological manageability through the inescapable reception of sustainable assets. (Murray, et al ,2011) further express that an all-encompassing and fundamental coordination of these three city types brings about another metropolitan arranging approach, in particular, the brilliant city. Batagan, (2011) states that this fundamental methodology can address the manageability challenges in the metropolitan setting (Schatz, 2007; Murray et all., 2011; Silva et all., 2018).

2.10 Smart Cities and Sustainable Cities

Both smart urban areas and manageable urban areas give various advantages as far as supportability that ought to be consolidated and abused in the turn of events and execution of keen practical urban communities of things to come. (Bibri and Krogstie (2017a) sum up the principle benefits of keen urban communities and reasonable urban communities. Concerning urban communities, the benefits are outlined in association with the current necessities related with models of reasonable urban structures (Bibri and Krogstie 2017).

Urban supportability as a field of interdisciplinary examination and practice has basically centered on how to make an interpretation of maintainability into urban structures and related practices through a variety of planning and arranging ideas and standards overwhelmingly. However, urban examination and improvement approaches are changing with the ICT of the new flood of figures and their exploration plans. With this move, urban scientists are understanding that ideas and approaches created to help urban supportability as far as urban planning and arranging have become insufficient to comprehend urban issues and help the unique origination of maintainable urban communities driven by urbanization (Bibri and Krogstie 2017).

2.10.1 Advantages of smart cities

- Context-mindful and information driven applications for upgrading the commitment of the typologies and plan ideas of models of reasonable urban structure to the objectives of supportable turn of events.

- Sophisticated information driven techniques for assessing the reasonableness of these typologies and plan ideas with respect to their commitment to these objectives to prove or upgrade it.

- Data-driven strategies for looking at changed models of practical urban structure with respect to their commitment to those objectives.

- Advanced models for urban plan versatility, urban working proficiency, and urban arranging adaptability vital for reacting to urban development, ecological pressing factors, and changes in financial requirements.

- Advanced apparatuses and strategies for understanding a unique origination of models of reasonable urban structure as far as processual results of urbanization.

- Innovative models or structures for tiding up the digestion of models of economical urban structure to support their degrees of supportability.

- Context-mindful and information driven applications for incorporating and improving urban frameworks and working with cooperation and coordination among urban areas with regards to models of economical urban structure.

- Relating the typologies and plan ideas of models of supportable urban structure to their functional working and arranging through observing, robotization, control, the executives, and improvement empowered by ICT instruments.

- Exploring models of supportable urban structure as advancement labs utilizing urban insight capacities.

- Diversifying displaying approaches into building and totaling urban reproduction models to educate the future plan regarding models of maintainable urban structure dependent on estimating or forecast capacities.

- Improving support, value, decency, security, portability, availability, social legacy, and success.

- New methods of comprehension and resolving urban issues.

- Identification of a wide range of urban dangers, vulnerabilities, and perils in models of maintainable urban structure.

- Advancement of hard frameworks, advancements, and social and human resources.

- Better the executives and arranging of assets, frameworks, organizations, offices, and administrations.

- Increasing joint effort among financial and cultural entertainers and supporting inventive hierarchical and institutional models for propelling supportability Source (Bibri and Krogstie 2017a).

The reason for understanding urban issues and creating answers is the unique origination of practical urban areas driven by urbanization. The two benefit arrangements are aimed at providing experiences in comprehending the significance and significance of combining and bridging the qualities of both smart urban communities and economic urban areas into a coordinated, all-encompassing methodology into future brilliant, sustainable urban advancement exercises.

This can be cultivated by, as one recommended arrangement, contriving a common structure for tiding up existing models of supportable urban structure through incorporating their most economically solid typologies and plan ideas and standards with the most progressive arrangements being offered by smart urban areas considering ICT of the new rush of registering with regards to maintainability (Bibri and Krogstie 2017b).

2.10.2 Main advantages of sustainable cities

- Theoretically and for all intents and purposes grounded urban methodologies for accomplishing the necessary degree of supportability

- Approaches into applying the information on urban supportability and ecological innovations to the arranging and plan of urban areas

- Sustainable improvement systems for encouraging progression and advancement in urban foundations and their functional working, the executives, and arranging, just as in regular assets the board

- Established techniques for expanding energy productivity, reducing contamination and waste levels, and further developing human existence quality and prosperity

- Best practices of the execution of economically strong typologies and plan ideas

- Advanced information on models of feasible urban structure as far as various spatial levels:

- Regional level, urban level, city level, local area level, neighborhood level, and building level

- Different mixes of thickness, minimization, variety, blended land use, manageable vehicle, natural plan, and latent sun powered plan, with various degrees of execution of and commitment to supportability

- Successful acts of biological variety, green innovation, coordinated sustainable arrangements, and natural administration

- Practices of environmentally friendly power, zero-waste, and carbon-impartial areas and locale

- Environmental, social, institutional, and land use strategy instruments for overseeing urban spaces as far as various parts of manageability (Bibri and Krogstie 2017a).

2.10.3 Discrepancies between smart cities and sustainable cities

Regarding the frail or absence of association between savvy urban communities and manageable urban areas Bibri and Krogstie, (2017a) give a rundown of key errors between these two classes of urban communities with regards to manageability, as displayed in Table 2.3. This is planned to invigorate insightful investigation into the space of brilliant economical urban turn of events

- Sustainable urban communities emphasizing plan ideas and standards and disregarding savvy arrangements.

- Sustainable urban areas endeavoring basically for supportability objectives and savvy urban areas essentially for smart targets.

- Sustainability objectives and shrewdness targets are misconstrued regarding their cooperative energy and interconnection.

- Smart urban communities needed to consolidate the objectives of manageable turn of events and economical urban communities to tidy up their commitment to those objectives .

- Sustainable urban communities needed to use their educational scene and savvy urban areas their actual scene in accordance with the vision of maintainability.

- There is a misconception of the connection between the ideas of smart urban areas and supportable urban communities.

- There is a frail association between the ideas of savvy urban communities and ecological manageability.

- Smart city appraisal systems and ideas needed to be redeveloped and reclassified separately in manners that consolidate the natural markers and hypothetical builds of economical urban areas.

2.11 Challenges for smart cities

The reasonable execution of brilliant urban communities is tested all through plan, execution, and activity stages. Cost of plan and activity, heterogeneity among gadgets, tremendous information assortment and investigation, data security, and maintainability are a portion of the significant difficulties. (Figure 2.2) outlines not many principle worries in planning a practical brilliant city. Plan and upkeep cost is one of the significant difficulties for sensible brilliant city execution. Cost is arranged as configuration cost and functional expense. Configuration cost is the monetary capital for sending the smart city. Consequently, more modest the plan cost, higher the likelihood of true execution (Silva et all., 2018).
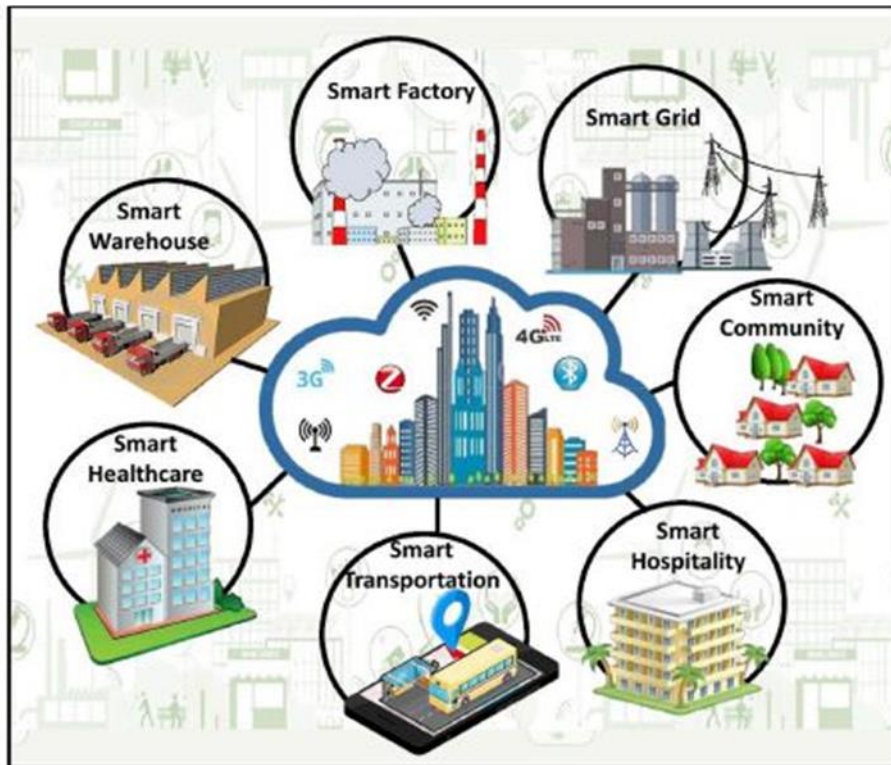
Figure 2.2: Generic Composition of Smart City Architecture

Source: (Silva, 2018)

Functional expenses cause because of day by day city activities and support undertakings. Negligible functional expenses are profoundly requested to guarantee the supportability of administration arrangement without extra monetary weight on civil. Be that as it may, the expense advancement all through the lifetime of a smart city is as yet a very difficult assignment. Heterogeneity is another critical worry of savvy city structures.

The recognition of the smart city concept is based on the ability to integrate this load of diverse items at the application layer. Heterogeneity's stage irregularities prevent coordination and communication across application layers. While working with extensive access might be boring and challenging, bright urban areas focus on planning and purchasing equipment and software that enables all of these diverse sub frameworks to function together. However high security brings about extra use on plan and support, foundation security and data security are profoundly implemented in smart urban areas. Innovative progressions make progressive changes in significant urban areas all throughout the planet. Urban areas adjusted innovation to further develop lives of occupants, guests, and organizations (Silva, 2018).

By and by, equal developments of innovation and malevolent dangers have caused an immense debate about getting smart urban communities and their tasks from potential assaults. An assault on a city the board system (CMS) that organizes heaps of undertakings gives a wide scope of choices to cause antagonistic impacts. For instance, a gas pipeline blast has been happened on June, 2010 in Johnson County, Texas because of disarrays about area and development progress comments on the CMS. Additionally, assault on Illinois water utility control framework in 2011, has annihilated a water siphon and removed water supply for 2200 inhabitants. Consequently, foundation security and data security are profoundly implemented in smart urban areas, despite the fact that high security causes extra consumption on plan and support. The metropolitan organization accumulates an assortment of information including profoundly delicate resident information, which is helpless for various security dangers for example side channels, cross-site prearranging, and information spillage

Subsequently, information security is another crucial element of any smart city structure. Truth be told, protection, trust, and information privacy accompany a cost. Residents speak with center smart city administrations through PCs PDAs, and other brilliant gadgets. Consequently, it is fundamental to oversee security issues for example listening in. In this manner, keeping up with these safety efforts to guarantee wellbeing of residents' information has become an exceptionally difficult and fundamental undertaking.

Ensuing to the constant information age from multitudinous gadgets, smart city information volumes will in general develop right away and dramatically. Consequently, move, store, review, and break down heft of information is fundamental for continuous and consistent activity of a clever city. Along these lines, brilliant urban areas long to find new domains and engaging procedures to manage its Big Data age and investigation. Protecting city climate and assets for people in the future by limiting carbon impression and productively using assets are key worries of current savvy urban communities. Accordingly, present day urban areas are zeroing in on environmentally friendly power sources to diminish the carbon impression, while guaranteeing the manageability of city activities and non-sustainable power sources. Attributable to the significance of energy usage, keeping up with maintainability, and decreasing carbon impression, Greater London Authority (GLA)

widely talked about on working on the proficiency of force organizations of London in brilliant freedoms for London report (ARUP, 2016).

Natural pollution and land filling have worsened the problem of executive carelessness in today's wealthy metropolitan settings. The ultimate goal of smart waste management is to make it easier to collect and separate garbage. For a successful waste management strategy, GLA (a corporation) claims that the lack of assets and the growth in the population must be addressed first. Disappointment the board is additionally a vital worry for any smart city advancement project. Disappointments can happen ensuing to catastrophic events for example floods, seismic tremors, twisters, and so on and framework disappointments like foundation breakdown and organization inaccessibility. Planning maintainability characterizes prompt recuperation procedures to conquer a disappointment and to return the city tasks to ordinary. In any case, distinguishing proof and execution of recuperation techniques and adaptation to non-critical failure procedures increment both plan cost and activity cost. The test is carrying out disappointment recuperation systems with insignificant impact to cost and functional proficiency (ARUP, 2016).

3. SMART CITIES DIMENSIONS

In 1950, 30 percent of the world's population resided in urban regions, according to the United Nations World Urbanization Prospects (United Nations, 2018). In 2018, the percentage increased to 55 percent, and by 2050, it is predicted to reach 68 percent. North (82%) and Latin (81%) Americas, as well as Europe, are now the world's most urbanized areas (74 percent). However, owing to economic recession and natural catastrophes, certain cities in Asia and Europe have had population declines in recent years; as a result, the low-income and lower-middle-income nations are predicted to have the most rapid urbanization in 2050 (UN, 2018).

Three sustainable pillars are strongly linked to urban growth: economic, social, and environmental advancements. However, in order to achieve a governance structure based on sustainable principles, maximizing economic opportunities, avoiding environmental harm, and favoring the emergency of a specific feeling of citizenship, smart city design should express these pillars. Because most cities are complex systems with complicated linkages between their many components and inhabitants, it is critical to create and implement dynamic mechanisms that take into account the population's development and requirements while also including them in decision-making processes (UN, 2018).

Intelligence, creativity, and web-based collaboration are more important in smart cities than embedded technology, sensors, and interactive media, according to the literature on smart cities (Batista, et al. 2012).

Despite the fact that there are different conceptual definitions associated with the smart city concept, it is widely accepted that their primary goal is to satisfy the expectations of a sustainable and economically developed city in which inhabitants participate in development processes (Batista, et al. 2012).

3.1 General Concepts

The notion of a "smart city" is significantly more expansive and difficult to define than the application of technology to a city, despite the fact that it has been around for a while.

It's widely acknowledged that a "smart city" is one that is able to adapt to changing conditions by gathering information from a range of sensors and using it to make judgments in a number of scenarios. With this project, the ultimate objective is to establish a collaborative and interoperable environment for the city to learn from (Fernandes, 2017).

The smart city structure is supported by a variety of pillars, and as a result, various writers have diverse ideas of what it means. "There is neither a single blueprint for framing a smart city nor a single-size-fits-all description of it. Smart city is defined as an "instrumented, networked and intelligent metropolis" in a company document from IBM (Harrison, et al. 2010).

- "Instrumented" refers to the capacity to collect and integrate real-time data from sensors, meters, personal gadgets, and other technologies;

Interconnectivity refers to how data from diverse municipal services may be integrated into a single platform, making it easier for them to communicate with one other.

Complex systems may be used to analyze, model, optimize, and visualize services in order to enhance operational choices.

While the phrase smart city is commonly used in urban planning as an ideological dimension, becoming smarter requires certain strategic approaches. To separate themselves from their competitors, governments and public agencies are adopting the concept of smartness at all levels by focusing on sustainable development, economic progress, and a higher quality of life for their population (Winters, 2011).

While ICT has traditionally been the primary focus of a "smart city," the definitions offered in Table 1 show that the notion has expanded to include the requirements of the community. People who live in these cities are often referred to be the major characters in the stories they write because of the influence they have on the world they live in.

A smart city's community must have a strong willingness to engage in and support the establishment of a smart city, according to Winters, (2011) (Winters, 2011).

Table 3.1: Definitions of a Smart City

Definition	Source
Cities are considered "smart" when they make sensible investments in human capital, social capital, conventional and contemporary transportation and communication infrastructure, as well as judicious use of natural resources.	Caragliu, del Bo and Nijkamp, 2011
If you want to live in a city that's ahead of the curve in every aspect of its residents' lives — from the economy to the people to government to transportation to the environment — you'll want a place like this. Searching for and identifying intelligent solutions that help contemporary cities improve the services they deliver to their residents is commonly regarded as "smart city."	Giffinger et al., 2007
Knowledge-intensive and innovative techniques aimed at improving the socio-economic, ecological, logistic, and competitive performance of cities are known as smart cities. In a smart city, human capital, infrastructural capital, social capital, and entrepreneurial capital all work together to provide a strong foundation for innovation and entrepreneurship.	Kourtit, Nijkamp and Arribas, 2012
A sustainable urban development policy is required if future smart cities are to have a high standard of living for all people, including the poor. […] A high quality of life, sustainable economic development, and participation in the management of natural resources are all characteristics of "smart" cities, which are defined as those that invest in human and social capital, as well as traditional and modern communications infrastructure (transportation and ICT). It's important that the aims of the smart city be aligned with the needs of its residents as well as the environment,"	Thuzar, 2011

Source: (Albino, et all. 2015)

3.2 European Smart City Index

For a smart city to succeed, the Vienna University of Technology's Center for Regional Science has established six pillars on which the concept must be built. Using an evaluation approach to score a city's "smartness", these components can be graphically illustrated in Figure (3.1) (Giffinger, R. et al. 2007).
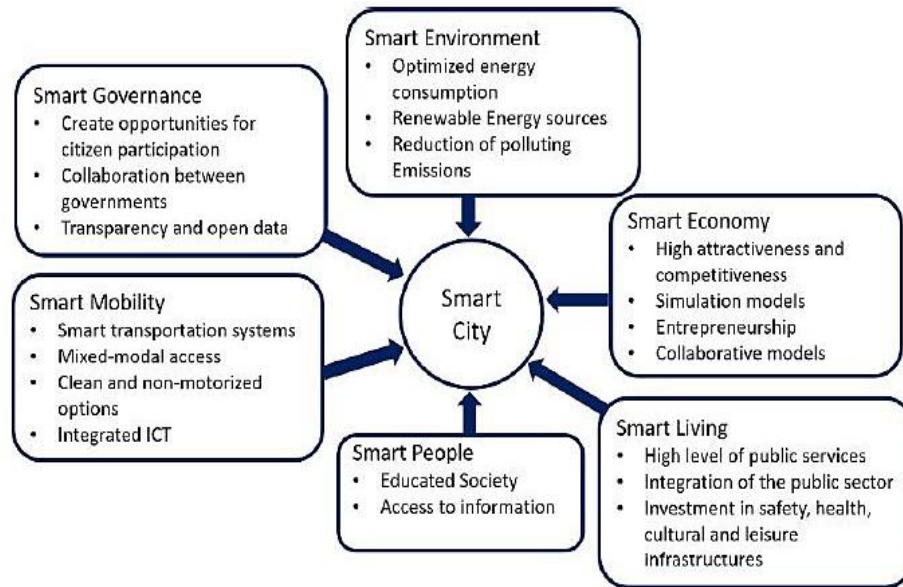
Figure 3.1: Smart City Components

Source: (Giffinger, 2018)

3.2.1 Smart economy

A city's social and political structure may be taken into account when designing a smart economy that makes use of ICT. It is important to focus on the creative and inventive potential of information and communications technology (ICT) skills, entrepreneurship, productivity, labor market adaptability, and international integration in order to achieve this aspect of a smart city. The utilization of collaborative simulation models and e-business and e-commerce practices are some of the major aims of a smart economy (Giffinger, R. et al. 2007).

Using a framework of restorative and regenerative economics in which everything may be a resource for something else, the circular economy can also be linked to a smart economy. This will lead to a sustainable economic system with no waste. Circular economy advocates repurposing things at every stage of their lifecycle, from manufacturing through disposal, in order to reduce waste and recycle products that would otherwise be discarded. There are various advantages to adopting a circular economy (Lankester, 2018).

Innovative technology can help improve the security of our resources and reduce our dependence on foreign imports.

Recycling garbage reduces greenhouse gas emissions, which is good for the environment. Keep materials in the loop to reduce the environmental effect of mining basic raw materials that are typically mined outside of Europe.

A platform for new ideas and business models to make greater value out of less natural resources is a third economic advantage.

4. Benefits to society – through promoting more environmentally friendly purchasing habits and expanding employment possibilities (EEA (European Economic Area), 2016).

As opposed to a linear economy, which relies on a five-step process of production, distribution, consumption, reuse/repair/recycle and recycling – the latter produces more waste that is not recycled or reused – a circular economy is built on five pillars: extraction of raw materials; production and distribution of goods; consumption; waste; and recycling (Figure 3.2) (Lankester, 2018).
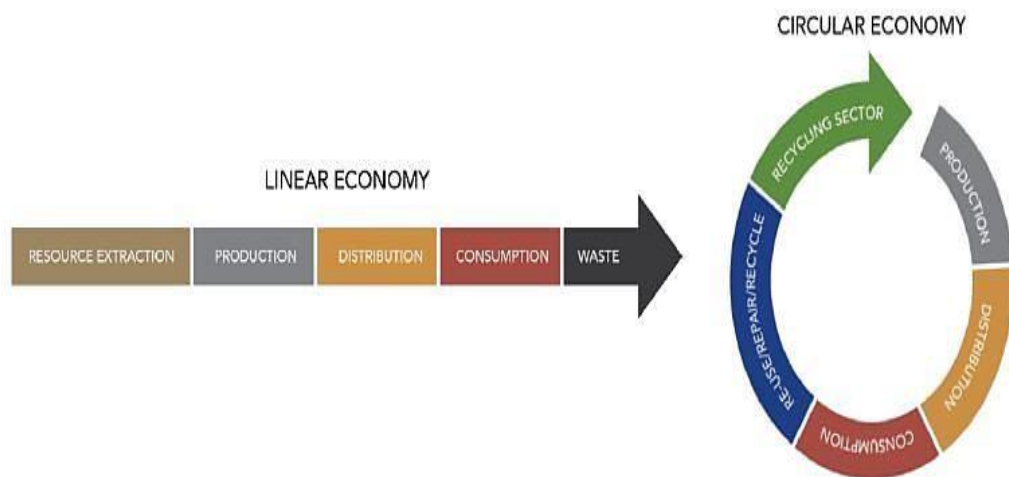
Figure 3.2: Differences Between Linear (Left) and Circular (Right) Economies
Source: (Sand & Birch, 2016)

3.2.2 Smart people

This is a foundational tenet for every city's growth and development. If the people of a smart city are informed about factors like mobility, health and safety, economics... the list goes on and on... they will be more likely to take part in and support the city's development and progress. So that a more open and creative society may emerge, they must acquire e-skills, lifelong learning, and understanding of human resource

management. One that encourages creative problem solving. Fernandes (2017) states that "Smart people," include many elements such as lifelong learning, ethnic and racial pluralism as well as the ability to adapt and participate in public discourse (Fernandes, 2017).

A "smart city" should be defined as the capacity of individuals with intelligence to come up with creative solutions for urban issues. Individual and collective knowledge offered by the government should be used to assist these solutions.

Albino et al. (2015) argue that brilliant people develop and profit from a smart city, portraying it as an acting magnet for creative individuals and employees that creates a positive feedback loop that makes them smarter and smarter.

Smart cities are those that have a culture of learning, adapting, and innovating, according to (Coe et al, 2001). To reap the rewards of technological advancement, people must be able to make use of it. In order for an educated society to thrive, it must have a constantly informed and eager population that is always learning about the city's requirements and performance (Coe, et all., 2001).

Co-creation and innovation may occur in the city thanks to the Lab Living concept, which allows citizens to directly participate in the design process of local urban solutions. These can then be scaled up to a bigger market. As a result, it is an experimental design in which the participants (citizens) are encouraged to work together as well as cooperate (Prandi, et al. 2013).

There are a number of open data resources available through the Lisboa Participa initiative, including a portal that allows any resident of Lisbon to voice their opinion on a variety of topics, such as municipal housing and collective facilities, hygiene and urban cleaning, street lighting and mobility as well as underground and above-ground improvements to the city's environment and green spaces. People may join and work with the Municipality, but they can also stay up to date on what's going on in Lisbon thanks to the program (CML, 2019).

3.2.3 Smart mobility

There are various issues that cities confront today, including their urban mobility (or immobility), which is symbolized by the existing chaotic traffic and the already inadequate public transit system (Chede, 2011). A recent study conducted by IBM in

20 countries found that traffic is a major source of dissatisfaction and stress for city residents, and that the time it takes to get from point A to point B within the same city is often a major cause of those feelings, resulting in significant losses in productivity and quality of life (Chede, 2011).

The United Nations predicts that by 2050, more than 70% of the world's population will be concentrated in metropolitan areas, resulting in an even greater strain on urban infrastructure already in overflow.

For the improvement of urban infrastructure and transportation systems in the digital and physical worlds, Chede (2011) believes that there is no longer room and time for protracted and large interventions, but rather, the articulation between the digital and physical worlds is needed. This is where the smart mobility component comes into play and makes a substantial contribution (Chede, 2011).

To achieve more efficient and effective mobility via the use of the ICT, smart mobility relies on the creation, enhancement and application of the ICT. Reducing emissions of greenhouse gases and easing traffic and parking congestion (which are common in large cities and metropoles) are two ways to improve mobility in a city. As a result, the city will have to rely on innovative transportation systems, including those that combine modes of mobility, as well as clean and non-motorized choices, all of which will be supported by an integrated information and communications technology (ICT) network (Chede, 2011).

A sustainable (smart) transportation system is cost-effective, runs equitably and effectively, provides a variety of transportation options, and promotes a competitive economy and balanced regional growth in a cost-effective manner. As a result, it seeks to reduce emissions and waste to levels that can be absorbed by the world utilizing renewable resources (European Union, 2009). Basic stages for implementing a smart transportation model are outlined in (Chede, 2011).

a. Develop a strategy that takes into account the potential use of cutting-edge technology that might alter the way the present transportation system is administered;

b. The transportation industry should have a "customer-centric strategy."

c. Promotion of public and private transportation (cars and bicycles) as a unit in an integrated mobility system;

d. Manage the entire transition in an intelligent and effective manner and avoid trying to develop everything at the same time.

There is no relationship between technology and urban infrastructure and transportation services in cities with smart mobility design as opposed to "regular" cities. Consequently, there is no space for improvement in automobiles or for more convenient (and wiser) access to public transit. Without non-motorized and renewable energy transportation, this city would be unlivable. As a result, it has become a city frozen in time.

An integrated mobility system with a mobile app integrating data and information from the use of buses, trains, bicycles, electric chargers, parking of shared automotive systems and other forms of transportation is already well established in certain regions of Portugal, such as MobiCascais (Ferreira, 2018).

3.2.4 Smart environment

Investing in renewable energy, monitoring pollution levels, developing green structures, and implementing green urban planning rules are all part of a smart environment agenda. Another important part of the smart environment agenda is lowering overall energy use. It is our primary mission to make our environment cleaner and greener. In order to attain this goal, smart buildings and energy, as well as the establishment of low-carbon neighborhoods, are needed.

At its core, a sustainable smart city uses digital technology to integrate urban processes and infrastructures to enhance resource efficiency, service distribution, and citizen involvement (Gabrys, 2014).

An eco-conscious city is vastly different from a conventional metropolis. Even while "normal" cities are considered as centers of economic development and innovation, they are also locations of high resource usage and greenhouse gas emissions, making them vital regions to adopt sustainable measures and create a more efficient city than ever before (Gabrys, 2014).

Computer-oriented programs and procedures may be used to increase a city's sustainability," says (Gabrys, 2014), presenting the CSC (Computer Sciences Corporation) project (under Cisco's CUD – Connected Urban Development initiative). To address climate change and resource limitations, the project employs

the smart city as a means of creating sustainable urban environments through intelligent digital designs (Gabrys, 2014).

The city of Évora in Portugal has a program called InovCity that uses smart meters to relay data on the amount of water and lighting use in individual buildings. Additionally, household appliances are programmed to operate on more convenient schedules, real-time consumption is managed to reduce expenses, and regular vs renewable energy generation is controlled. An additional case in point is the irrigation system control at Castelo Branco, which has reportedly reduced water use by over 20% since it was implemented (Gabrys, 2014).

3.2.5 Smart governance

It is necessary to have a government that is conscious and capable of operating at three separate levels: inside the city, with the federal government, and open to collaborating with other governments in various areas or nations. As a result, leaders must be able to coordinate the interplay of technology components with political and institutional factors, as well as with their population, in order to lead a city toward a smart city. In the words of Fernandos (2017), when a government fosters the removal of obstacles such as those caused by language, culture, education, or physical or mental disability, it is said to be engaging in "smart governance," according to Albino et al. (2015). Furthermore, the notion of smart governance is also related with the involvement of many stakeholders in decision-making processes and public service administration. E-governance, as an ICT-mediated government that is essential to bring smart city projects to residents and ensure openness in the decision and implementation processes, is also emphasized by the writers (Giffinger, et al., 2007; Fernandes, 2017).

As a result of smart governance, the concept of a "smart city" as a "citizen-centric and citizen-driven" city is reinforced. This includes political awareness, public and social services, and an efficient and transparent administration. It is feasible to create a more democratic, resilient, and hence appealing city by encouraging citizens to participate in civic life.

Since successful projects are the outcome of an alliance between business, education and government. Nam and Pardo, (2011) argue that stakeholders must be taken into account when designing a smart city. Clever governance and smart people are

inseparable concepts, thus they must be studied and developed jointly (Nam and Pardo, 2011).

Coimbra has an Internet of Things (IoT) system with a name like The Things Network that can be utilized by both people and stakeholders (government and public and private companies). This information is sent into a platform that analyzes the data in real time, enabling owners and developers to improve or rectify these features in the most effective way (Ferreira da Rocha, 2018).

3.2.6 Smart living

In the definition of "smart living," as given by (Lombardi, et al., 2012), it refers to the percentage of a community's land used for recreational activities, such as sports and leisure, as well as the total number of public libraries, book loans, and other media. Investment in intelligent technology is also required in order to improve the quality of life of the population, which will have an enormous impact on people's behavior and social habits, which will affect their contributions to the creation of a smart city (Fernandes, 2017). In other words, the quality of life of the city's residents is a consideration (Lombardi, et al. 2012; Fernandes, 2017).

This aspect is heavily reliant on the government's commitment to raising the quality and clarity of public services. Investments in cultural and recreational facilities, health conditions, individual security, housing quality, touristic appeal and utility networks are all part of smart living, as are investments in social cohesion. As part of this investment, the public sector will be gradually integrated to ensure that the projected high level of public service is maintained.

A Lisbon Urban Management director claims that this app will bring together all of the city's present services, from transit to adjacent cultural events. The goal is to bring together all of the "three hundred information systems" now in existence into a single system. It will link all of the municipality's internal systems and combine data from those systems with sensors placed across the city as part of the application's distribution strategy. Another potential use of this software is as a way for individuals and the local government alike to voice their thoughts. Using this app, the Lisbon municipality shows its desire to give inhabitants with access to numerous city services (Caetano, 2019.

3.3 Benefits and uses

Investments in smart cities have the potential to improve the quality of life and municipal services by streamlining and streamlining city processes. This will result in a city that is nimble enough to change and develop on its own will. This is accomplished by the installation of sensors around the city, which are linked to computer systems that can address urgent issues, build hypothetical urban situations, and provide creative reactions in response to those scenarios (Fernandes, 2017).

Security, water and waste efficiency, increased awareness of traffic and infrastructure challenges, and transportation are just a few of the advantages that smart cities and smart technologies have provided recently, according to GlobalSign's official blog (Low, 2018).

3.3.1 Security

When it comes to protecting its residents, one of the most essential things a city can do is to establish superior security systems by integrating Closed Circuit Television cameras. Face recognition technology is a significant advancement in security measures even if they aren't brand new. It will make it easier to identify suspects before a crime happens. Add-on features like as smoke alarms, air quality sensors, and door lock and unlock systems will be included with these cameras (Low, 2018).

3.3.2 Water and waste efficiency

There are several ways in which a dedicated infrastructure may be used to guarantee efficient and effective management of water and wastewater. GlobalSign (security and identity solutions) recommends the usage of smart water grids. To minimize over-allocation and guarantee that water reaches its destination; their plan incorporates water transportation monitoring. Using smart pumps and valves that are able to read environmental conditions and sensor signals and change their operations accordingly is another option. This drastically reduces the quantity of water and energy that is lost in each operation, while simultaneously increasing the overall efficiency of the process (Low, 2018).

3.3.3 Increase awareness to traffic/ infrastructure issues

One of the most well-known advantages of a smart city is the ability to monitor traffic patterns and congestion hotspots via sensors in automobiles. For example, sensors may be used to gather information on traffic patterns and identify an area that needs to be altered for the benefit of the public (Low, 2018).

Traffic lights and pedestrian signals, for example, may be monitored for wear and tear with smart technology, as can the impact of traffic on the surrounding environment (Low, 2018).

3.3.4 Transportation

Transporting products and services and people is almost what makes a city "move" as a city's capacity to deliver efficient and effective services to its population is critical. Inefficient transportation, a problem in many cities owing to increased traffic or hazardous pollutants, is a primary priority for the government (Low, 2018).

Mobile applications that provide estimates for trains, buses, and other public transportation alternatives are one approach to optimize travel, according to the corporate blog of GlobalSign (Low, 2018). You might make the difference between using a private vehicle or public transit by doing just one easy step. Another noteworthy development is the growing reliance on electric cars, which reduces pollution from motor vehicles into the atmosphere. A popular alternative to driving an electric car right now is to create "power strips" or big parts of the city equipped with charging stations for electric vehicles (Low, 2018).

Government-citizen interactions will be transformed by a multilayered active cooperation that replaces citizens' decision-making authority with their capacity to alter it.

Digital and web-based city plans of the future are predicted by Batista e Silva et al. (2012). Their design will focus on how to develop collective intelligence (various attitudes and dimensions) and how to use governance tools to study artificial intelligence and modeling. In order to stimulate urban innovation, this will promote a more participatory approach toward information. We must thus abandon the "conventional" structure of planning in favor of innovative methodologies such as

simulation and other technical approaches for expressing, assessing, and monitoring city plans (Batista et al. (2012).

3.4 Smart City Challenges

It's critical to solve current challenges in some areas even though smart city concepts are generally acknowledged and realistically applied in the actual world. Here, we'll take a look at some of the problems and exciting prospects for implementing smart cities in the real world. Extensive investigation into the latest smart city studies revealed the issues that needed to be addressed. In the same way, the prospects were discovered through current smart city research and hands-on experimentation (Batista et al. (2012).

3.4.1 Challenges for smart cities

At each level of the smart city process, the viability of its implementation is questioned. Some of the most important challenges are cost, design, operation, heterogeneity, data collection and analysis, security, and sustainability. An actual smart city is depicted in Figure 3.3, which includes some of the most significant issues.

Design and maintenance costs are major roadblocks to a viable smart city implementation. There are two basic categories of expenses: design costs and operational costs. The cost of designing a smart city is the amount of money that will be needed to accomplish the project. When design expenses are reduced, there is a greater likelihood of a product being used in the actual world. The city's day-to-day operations and upkeep necessitate expenses. Maintaining low operational costs is critical to municipal services' long-term sustainability. The long-term cost optimization of a smart city is still a key problem to be solved.

Architects of smart cities must address the issue of diversity. There are many different manufacturers of sensors, appliances, and other equipment that are utilized in smart cities. The realization of the smart city idea will be impossible without the capacity to integrate all of these diverse aspects at the application level. Platform incompatibilities impede application layer integration and interoperability as a result of heterogeneity (Silva, et all. 2018).

Smart cities strive to identify and procure hardware and software that supports the aggregation of heterogeneous subsystems in order to give universal access. Infrastructure and data security are top priorities for smart cities, despite the fact that doing so increases the costs of construction and maintenance.

Throughout the world, major cities have seen dramatic changes owing to technology advancements. Cities' embrace of new technology benefits everyone, including residents, visitors, and businesses alike. Many people are concerned about securing smart cities and their operations from cyber-attacks because of the fast development in both technology and hostile threats. An attack on a city management system (CMS), which acts as a center for many diverse operations, might have a variety of adverse results. An example from more recently is the Johnson County, Texas gas pipeline explosion in June 2010, which occurred because the location and progress claims for the CMS construction site were interpreted incorrectly (Silva, et all. 2018).

An attack on Illinois' water utility control system resulted in the loss of service to 2200 families in 2011. Even if increasing the cost of development and upkeep is a drawback for smart cities, infrastructure and data security are given top attention (Silva, et all. 2018).

Figure 3.3: Common Challenges for Practical Implementation of Smart Cities

Source: (Silva, et all. 2018).

Various security vulnerabilities, such as side channels, cross-site scripting, and data leakage, exist because the urban network collects a wide range of data, including highly sensitive citizen data (Garcia-Molina, 2011).

As a result, the protection of personal information is an essential component of any smart city design. To be honest, there's a price to pay for things like anonymity and privacy when it comes to data. Using laptops, smartphones, and other smart devices, citizens may access essential smart city services. Because of this, addressing privacy concerns such as eavesdropping is a top priority. In order to keep people' data safe, it has become increasingly difficult to maintain these security procedures.

Smart city data volumes tend to expand quickly and dramatically as a result of the constant data creation from a wide range of devices. Consequently, the ability to send, store, retrieve, and analyze large amounts of data is essential for the ongoing and flawless operation of an intelligent city.

As a result, smart cities are always searching for innovative and interesting ways to cope with the massive amounts of data they generate and analyze. Sustainable urban development and resource conservation are top priorities for today's smart cities, which are committed to reducing their carbon footprint and making the most of their available resources. In order to lower their carbon footprint while maintaining the sustainability of municipal operations and non-renewable energy, modern cities are turning to renewable energy sources.

Greater London Authority (GLA) emphasized the significance of energy use, sustainability, and decreasing carbon footprint in its report on smart opportunities for London (SOL) (ARUP, 2016).

Due to environmental degradation and land filling, waste management is a major concern in modern smart cities. Rapid collection and separation are the primary objectives of smart waste management (ARUP, 2016). According to the GLA, sustainable waste management techniques must handle resource constraints and population expansion.

A smart city development project's failure management is also a major worry. An infrastructure breakdown or a lack of access to the network can lead to failures after a natural disaster, such as a flood or an earthquake. Recovering quickly from an emergency situation is an important part of designing sustainability. To compensate

for these additional costs, recovery and fault tolerance methods must be developed and implemented. With the goal of minimizing operational and financial costs, the challenge would be to design fail-safe methods (Silva, et all. 2018).

3.5 Future Trends and Opportunities

A lot of money is being invested in smart technology and smart city initiatives at the moment. The Smart Nation plan unveiled by the Singaporean government in 2015 was one of the first. By 2025, the primary objective of this effort is to turn Singapore into the world's first truly intelligent city. An intelligent operating system for the whole city will be developed, allowing it to be operated like a computer's software.

There are plans to create a 3D virtual map of Singapore with layers of information on the city's buildings and geography. The technology is already being used in a small number of service test applications, including aged care facilities, health care facilities, and others. As a living laboratory for these intelligent initiatives, the Jurong Lake District is viewed as a national model (CML, 2019).

In the future, we'll need a strategy for increasing public engagement and transparency in the planning process, and this strategy should be more interactive, instructive, and self-explanatory in the context of intelligent cities.

For an intelligent city, it is recommended that a continuous assessment be used to monitor the plan's features and parameters in real-time so that changes may be made as they occur. An ability to analyze data and provide recommendations for improvement and adjustment over the course of the project's execution is what this system will be able to do (Batista, et al. 2012).

The urban organization assembles an assortment of information including profoundly touchy resident information, which are defenseless for various security dangers for example side channels, cross-site prearranging, and information spillage (Garcia-Molina, 2011).

Thus, information protection is another significant element of any brilliant city structure. Indeed, protection, trust, and information classification accompany a cost. Residents speak with center brilliant city administrations through PCs advanced cells, and other savvy gadgets. Consequently, it is fundamental to oversee protection issues for example listening in. Accordingly, keeping up with these safety efforts to

guarantee security of residents' information has become an exceptionally difficult and fundamental errand.

Resulting to the constant information age from endless gadgets, brilliant city information volumes will in general develop quickly and dramatically. Henceforth, move, store, review, and investigate main part of information is imperative for continuous and consistent activity of a keen city.

Thusly, brilliant urban areas long to find new domains and engaging methodologies to manage its Big Data age and examination. Protecting city climate and assets for people in the future by limiting carbon impression and effectively using assets are key worries of current keen urban areas. Along these lines, current urban communities are zeroing in on environmentally friendly power sources to decrease the carbon impression, while guaranteeing the supportability of city activities and non-sustainable power sources.

Attributable to the significance of energy use, keeping up with supportability, and decreasing carbon impression, Greater London Authority(GLA) widely talked about on working on the proficiency of force organizations of London in shrewd freedoms for London report (ARUP, 2016).

Squander the board is another basic issue in current brilliant urban areas because of natural contamination and land filling. The most extreme objective of shrewd waste administration is to assist assortment and detachment processes. GLA states shortage of assets and populace development are the fundamental issues to be tended to for effective waste administration methods (ARUP, 2016).

Disappointment the executives is additionally a critical worry for any brilliant city improvement project. Disappointments can happen ensuing to catastrophic events for example floods, quakes, cyclones, and so on and framework disappointments like foundation breakdown and organization inaccessibility. Planning maintainability characterizes prompt recuperation procedures to defeat a disappointment and to return the city tasks to ordinary. In any case, recognizable proof and execution of recuperation systems and adaptation to internal failure methodologies increment both plan cost and activity cost. The test is execute disappointment recuperation components with insignificant impact to cost and functional productivity (Silva, et all., 2018).

At present, there are now impressive interests in shrewd advancements and in brilliant city projects. One of the pioneer ones being the Smart Nation drive declared in 2015 by the public authority of Singapore. This drive has the primary objective of changing the city of Singapore in the principal shrewd city on the planet by 2025. The arrangement includes the advancement of an insightful functional framework for the entire city which will capable it to be controlled actually like a PC's product.

The Government of Singapore's goals include fostering a 3D virtual guide of the city formed by layers addressing the city's structures, territory and other data freely accessible. This moment there are now some minor assistance test applications utilizing the framework: old homes, medical care and others. The Jurong Lake District is considered as the living research facility for these canny activities determined to enhance all at a public level (Garcia-Molina, 2011).

Later an arrangement to advance public cooperation guaranteeing straightforwardness to the arranging cycle is required and with regards to smart urban areas this arrangement ought to be more intuitive, educational and plain as day.

As per (Batista e Silva et al., 2012) a wise arrangement for a clever city ought to be kept and kept up with by a continuous assessment, an assessment that exploits plan checking and, thusly, permits the change of its attributes and boundaries progressively. All in all, it will ready to deal with data to give input on arrangement enhancements and changes over the span of its execution (Batista, et al. 2012).

4. CASE STUDIES

4.1 Singapore Smart City

When we make a search on the internet about Singapore smart nation, you will find some core principle of smart city which is "94% of our government services are digital from end to end", this tells us that smart city begins with government services and all these services try to make life easier for citizens.

To properly understand smart city, we should look at figure 4.1 which illustrates how different things and human are connected by using internet, devices, built-in sensors and feed-back of people.
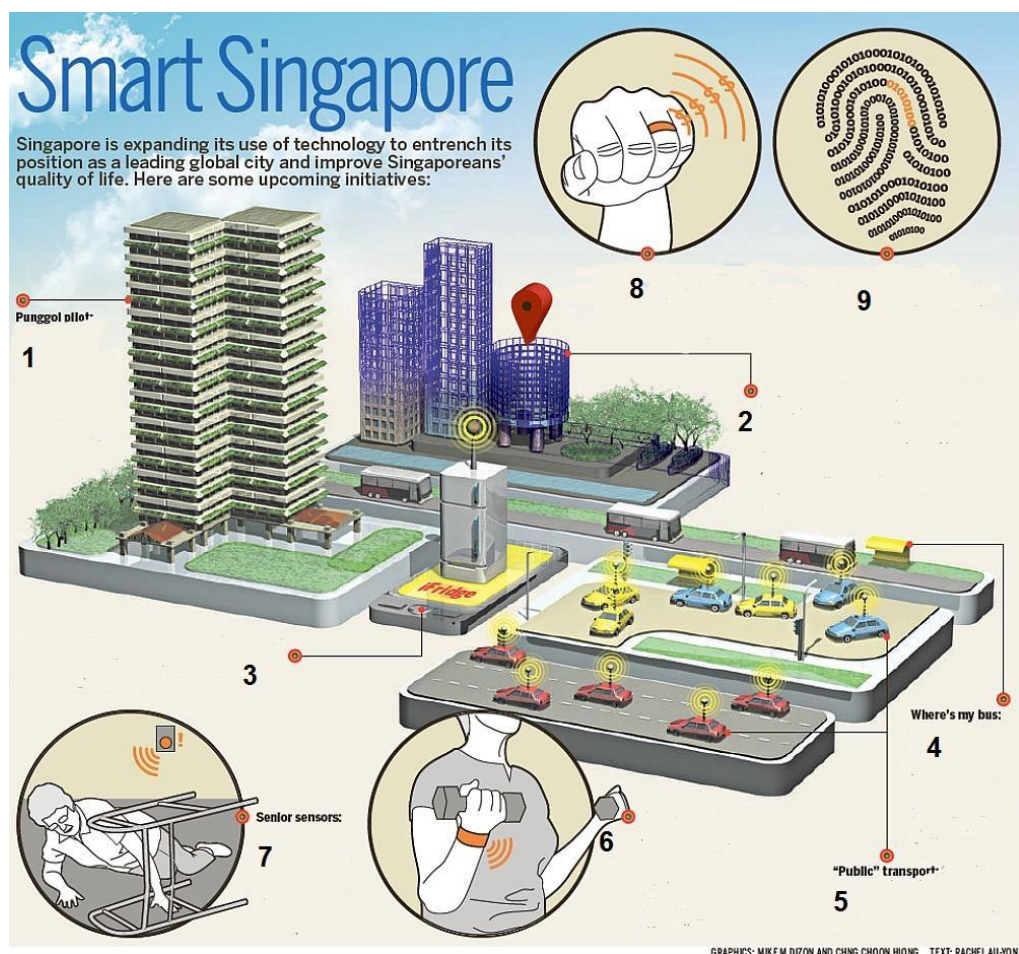

Figure 4.1: Smart Singapore

Source: Smart City Solutions

In order to become a premier global metropolis and enhance the quality of life for Singaporeans, Singapore is increasing its use of technology. The following are a few future projects:

1. A trial project in Pungol will incorporate energy-efficient measures such as motion sensor lighting in parking lots, which will be implemented as part of the first smart home project.

2. Virtual Singapore, a new 3D map project, will include data on Singapore's buildings, land, and environment. When it comes to solving challenges like identifying flood-prone regions, public data such as traffic patterns or popular retail spots may be used by government agencies and other groups.

3. Once the (Housing & Development Board) HDB identifies the digital infrastructure required for an automated home, smart phone control of domestic appliances may be achievable.

4. Use the "My transport app" to find out exactly when your bus will arrive and how busy it is.

5. For the first time, self-driving "public transportation" vehicles will be tested on public roads.

6. It is being tried in community hospitals to enable patients to undertake therapeutic activities at home while sensors linked to their limbs communicate data back.

7. In the future, sensors in old people's houses will identify any unusual behavior and transmit notifications to family members or other care specialist.

8. Eliminating the need for cash or credit cards by using an integrated chip in any of people's jewelry, including rings, watches, and ID cards.

9. There is an effort on to eliminate the need for individuals to re-enter their personal information for government transactions by developing a new digital platform (Smart Solutions, 2021).

Sustainability may be achieved in an urban context if social justice, environmental conservation, economic vitality, and quality of life are all met. Urban sustainability seems to be a recurring theme in smart city literature.

Smart city efforts are increasingly being recognized by governments throughout the world as a method of addressing denser, more diversified, and rising urban populations, as well as the possibilities and advantages connected with them. Singapore is unique in that it has been involved in so-called "smart city activities" from the 1980s. As a result, the Smart Nation model prioritizes people above four enablers: government, manpower, collaboration, and technology (Yap, et all. 2015).

Figure 4.2: Singapore City

Known as a tech-savvy city-state, Singapore is currently executing its ambition to become the world's first Smart Nation, based on the use of data and analytics to enhance the lives of its residents. Additionally, the country is engaged in a variety of additional programs that support its Smart Nation objective.

Singapore is currently involved in the following activities:

1. Using the open access fiber networks of its dominant position;

2. Improving Street-level coverage by increasing the intelligent urban infrastructure

3. Developing a new heterogeneous network that spans both fixed and mobile infrastructure.

It is possible for Singapore's government and city service providers to swiftly address urban concerns and empower residents with data insights to enhance their lives using the city's current urban operating system.

Singapore's supreme smart city goal will be impacted by five important domains. Digital technology can have a "needle moving" effect in each of these crucial areas. The following are the most important areas:

- Transport.
- Home and environment.
- Productivity in the workplace
- The ability to age in good health; and
- Services provided by the government.

As a result of its relationship with (International Telecommunication Union) ITU, Singapore aims to spread its best practices and lessons gained in national (Information and Communication Technology) ICT planning. Urban planners and practitioners throughout the world will find these lessons and best practices based on the ITU's key performance indicators quite useful. One of the key goals of the smart nation program is to identify and investigate existing features and activities that might be used to further this goal (Bhati et all. 2016).

4.2 Masdar City

The Mubadala Development Company, one of the United Arab Emirates' emirates, is presently developing Abu Dhabi's Masdar City as a subsidiary business (Halligan, nd.). As a "Smart City," Masdar City stands out for its use of the Internet of Things (IoT) to improve quality of life and service delivery while also creating a more ecologically-balanced integrated urban development. Subsystems such as transportation; civic utilities; physical infrastructure; water management; waste management as well as other zero-carbon elements were further leveraged by the city to achieve its aims of an eco-friendly environment.

Of November 15, 2007, the United Arab Emirates (UAE) started construction on Masdar Metropolis, a "world's first zero-carbon" emission city that would serve as the UAE's frontier producer of renewable energy solutions for its environmental issues. Masdar, which translates to "source" in Arabic, invests in renewable energy

projects across the globe. It is owned by the Mubadala Investment Company of the United Arab Emirates (UAE), which uses Masdar Clean Energy to invest in projects overseas and Masdar Institute, a research university supported by the MIT Corporation, to create environmental solutions in the United Arab Emirates. In addition to being a worldwide commercial center, Masdar City serves as a testing ground for the company's technical solutions.

One unique initiative, the development of a solar thermal power plant, is ongoing to provide the majority of the city's energy demands with solar power. Masdar's mission extends beyond the creation of new technologies and infrastructures to include encouraging a transformation in the consumption patterns of its people. This project's goal is to reduce energy usage while preserving a contemporary lifestyle, as will be shown in a debate of neoliberal and environmental ideas (D'Eramo, 2021).

4.2.1 Architecture

Pedestrians and bicycles will appreciate Masdar's emphasis on creating a mixed-use development that is environmentally responsible (Masdar City, 2022).

Terracotta (porous fired clay) surfaces decorate the city walls of Masdar City. The city seems to be a cube from a distance. The roadway temperature is often 15 to 20 degrees Celsius (27 to 36 degrees Fahrenheit) lower than the surrounding desert. This discrepancy in temperature is a result of the unusual design of Masdar's buildings. Masdar's streets are kept cool by a 45-meter-high (148-foot) wind tower inspired by traditional Arab architecture. There is a cooling impact due to the site's elevation above the rest of the area. Streets and walkways are protected from the sun by a dense cluster of buildings.

Foster and Partners were tasked with the design of Masdar City. They began their study by visiting ancient places like Cairo and Muscat, where they were able to observe how people remained cool. Using shorter, narrower streets, Because of the wind turbulence at the end of these streets, cold air is flushed upward, making the roadway seem more comfortable (Masdar Institute, 2022).

The innovation park in Masdar City is built out of repurposed 40-foot shipping containers. With 40,000 inhabitants, the city's workforce is expected to exceed 50,000 people: students and academics; start-up businesses; investors; and governmental institutions (Nader, 2009).

4.2.2 Transport system

The original plan prohibited the use of vehicles since all transportation would be provided by means of public mass transit and personal rapid transit (PRT), with existing roads and railroads serving as backbones (PRTConsulting.com, 2021). Narrow, shaded streets at Masdar help channel cooler breezes throughout the city since cars aren't allowed, and Masdar's outer wall keeps off scorching desert winds. The PRT will be used to convey people, products and supplies. In October 2010, it was stated that the PRT will not spread beyond the trial scheme because of the expense of building the undercroft to separate the system from pedestrian traffic (Mitsubishi Heavy Industries, 2021). This was followed up by the deployment in 2011 of an electric car testing fleet consisting of 10 Mitsubishi i-MiEVs in an effort to investigate the feasibility of providing city residents with an alternative to PRT and FRT, both of which utilize fully automated electric vehicles (Masdarcity.ae., 2011). The PRTs will no longer be the primary mode of citywide public transportation under a new plan. Mass transportation in the city of Masdar will instead be provided by a combination of electric and alternative fuel vehicles. Most private automobiles will be confined to parking facilities outside of the city. The proposed and delayed light rail and metro line in Abu Dhabi will link Masdar City's central section with the broader metropolitan region (Masdarcity.ae., 2011).

As part of an ongoing experiment, seven NAVYA Autonom completely driverless shuttles have shuttled passengers between the parking lot and the city center. My City Centre Masdar Shopping Mall and IRENA's headquarters were scheduled to open in 2019 on a new road from the city's North Car Park to the city's North Car Park residential complex (Masdarcity.ae., 2021).

4.2.3 Siemens

Siemens has established a regional headquarters in Masdar City. The most energy-efficient structure in Abu Dhabi is this one. Sustainable and energy efficient materials and processes are used in the LEED Platinum construction (Leech, 2013). Compared to normal office buildings, it was intended to consume 45% less energy and 50% less water than the same structures (Leech, 2022). In 2012, the Mpim Architectural Review Future Projects Awards recognized the Siemens headquarters as the greatest office building in the world. A year later, the Middle East Architect

Awards recognized it both the finest and most sustainable office building in the region (Leech, 2022).

There is a "box inside a box" theme to the 12,000 m2 (130,000-square-foot) structure. An airtight, highly insulated inside façade keeps out the sun, while a lightweight aluminum shade system protects the building from the elements. Underground, the plaza is funnel-shaped. The design of this skyscraper allows the prevailing winds to be sucked beneath the structure. For free cooling in public areas of a building, the Venturi effect (the drop in flow pressure that occurs when fluids flow past constrictions) may be harnessed in the construction of the building. Additionally, sunshine is allowed to reach the building's core, eliminating the need for artificial lighting and thereby decreasing energy use (Leech, 2022; Siemens, 2022).

4.2.4 Renewable resources

The initial aim for the city was for it to run completely off the grid and be carbon neutral (Savodnik, 2011). Even after being connected to the public grid Savodnik, (2011)., the development's management concluded in 2016 that the city will never achieve net-zero carbon emissions (Goldenberg, 2016).

Lighting and water use in the city are controlled by movement sensors rather than switches or taps, resulting in a 51% reduction in both [138]. According to Masdar's principal architect, Gerard Evenden, the initial concept intended for rooftop solar panels to power the whole city. Then he added, "Nobody has ever contemplated doing a project of this scope before we began. Then you'll see that putting your solar array on the ground in the midst of the desert is a much better use of your resources. You don't have to go door-to-door to check on everyone's buildings one at a time; instead, you can have a guy come in every day to make sure everything is functioning well. Instead of placing them on every building in the city, this is a far better option" (Breaking Energy 2022).

Masdar has worked with other firms to develop coverings with holes smaller than sand particles to prevent it from clinging to its solar panels from blowing. Coatings that resist sand and microorganisms are also being developed by scientists at the Masdar Institute (Breaking Energy 2022); Prior, 2011; (Ammari, 2010).

The management of water has been arranged in a way that is also ecologically sound. It is planned to recycle and reuse waste water "as many times as feasible," and this greywater will be put to good use irrigating crops and other plants (Dilworth, 2007; Palca, 2008).

Palm wood, a sustainable hardwood replacement produced by Pacific Green from plantation coconut trees that no longer yield fruit, is utilized as external wood throughout the city. Entrance gates, screens, and doors made of palm wood are all examples of this material's use (Laylin, Tafline, 2011).

5. CONCLUSIONS

5.1 What Can We Do To Build A Smart City? The Answer To This Question Would Summarize All The Above Mentioned Sections

A smart city is not just a building or a project that costs a small amount of money. It requires a huge capital (to build a city with all its facilities), government involvement (to provide all the required services and provide safety in the daily transactions between citizens and safe exchange of peoples personal information etc.), educated citizens (who understands how to live in a smart city starting with how to deal with energy, waste, mobility and the most important is how to live in harmony with nature by reducing the activities that harm nature), also the availability of advanced technology represented by ICT and IoT.

Moreover, we need a suitable place (vast area), for example the line smart city in Saudia Arabia is about 170 KM length and 200 meters wide, employing active and passive design strategies and solutions to recycle water and waste.

Also, to build a smart city, we need to make use of others experiences like Singapore (see section 4.1 the last paragraph) and Masdar city which started with ideal goals of a smart city and ended with eliminating many items due to the fact that they do not have the ability to make it in the real time (for example "The initial aim for the city was for it to run completely off the grid and be carbon neutral. Even after being connected to the public grid, the development's management concluded in 2016 that the city will never achieve net-zero carbon emissions").

5.2 Summary

Evolution in all aspects of our life especially in information, technology and artificial intelligence theoretically lead humanity to better living, but on the other hand we have many problems associated with this massive development which for example; natural resources depletion, accelerated environmental crises due to pollution and

CO2 emissions. So, inorder to ensure our continuity on this planet, there are certain steps must be taken to avoid the coming black future.

One of these steps is establishing smart cities with the responsibility to integrate with sustainability because without coupling smart cities with sustainability, no change would be made and the humanity will eventually fail. For example, in Masdar smart city, we can see the coupling of smart technology represented by using smart transportation, sensors and energy efficiency, also using ICT and IoT in all aspects of the city coupled with LEED certified sustainable buildings such as Siemens company building and the use of active and passive building strategies.

One of the most important issues to focus on is to start teach ourselves to consume less and start to recycle and reuse things, stop depending on fossil fuels and start to harness renewable energies. In this way smart cities would flourish and do its real mission. As mentioned in section (4.2) "Masdar's purpose is not just inventing new technologies and infrastructures; it is also about facilitating a cultural shift in its citizens' consumption habits, neoliberal and environmental thought, lowering energy consumption to a minimum while maintaining a modern way of life", so, changing thoughts and bad habits of consumption and replace It with aware citizens is one of the main keys to establish a smart city.

There is a start for everything, and to start with a smart city we need smart planning which puts all the important issues in consideration especially environmental issues. As we see in MASDAR city, solar cells have been used as a source of energy. Also, they used passive design strategies to overcome the high temperature in summer by making the streets narrower and using a wind tower to capture cold air from upper layers and push it through the narrow passages in the city to lower the temperature from (45-50) degrees Celsius to (15-20) degrees Celsius. Buildings are clustered close together to create streets and walkways shielded from the sun. But on the other hand, the management of the city declared in 2016 the city will never achieve net zero carbon. We can learn from above that planning is very important and we should differentiate between dreams and reality.

5.2.1 Is it possible to build a smart city in Baghdad or Istanbul?

To build a smart city we need all the required items in section 5.1 and also we need the city to be safe. In Baghdad, with the present unstable political situation, it is not

applicable to establish a smart city. By keeping this problem aside, Baghdad has all the required items to do so. A wealthy city that could prepare the necessary capital and benefit from global expertise, also the sun is shining all the year so we can make use of the solar cells to provide clean energy.

Istanbul, on the other hand has all the necessary items to create a smart city with its importance as a well-developed city. The creation of such city would help to prove that Turkey could be among the leading countries in the world in the field of sustainability and smartness.

The advanced world is in a hectic competence to reach a clean and free of pollutants cities depending on renewable energies, recycling of materials and maintaining natural resources.

Table 5.1: Main points in Masdar and Singapore Smart Cities

Masdar City	Singapore City
On November 15, 2007, the United Arab Emirates (UAE) started construction of Masdar Smart city.	Singapore is unique in that it has been involved in so-called "smart city activities" from the 1980s.
use of the Internet of Things (IoT) to improve quality of life and service delivery while also creating a more ecologically-balanced integrated urban development	A new 3D map project will include data on Singapore's buildings, land, and environment. When it comes to solving challenges like identifying flood-prone regions, public data such as traffic patterns or popular retail spots may be used by government agencies and other groups.
Subsystems such as transportation; civic utilities; physical infrastructure; water management; waste management as well as other zero-carbon elements were further leveraged by the city to achieve its aims of an eco-friendly environment.	motion sensor lighting in parking lots
One unique initiative, the development of a solar thermal power plant, is ongoing to provide the majority of the city's energy demands with solar power	automated home, smart phone control of domestic appliances
Encouraging a transformation in the consumption patterns of its people. This project's goal is to reduce energy usage while preserving a contemporary lifestyle	Use the "My transport app" to find out exactly when your bus will arrive and how busy it is.

Table 5.1: (Cont.) Main points in Masdar and Singapore Smart Cities

Masdar City	Singapore City
Encouraging a transformation in the consumption patterns of its people. This project's goal is to reduce energy usage while preserving a contemporary lifestyle	Use the "My transport app" to find out exactly when your bus will arrive and how busy it is.
Masdar's streets are kept cool by a 45-meter-high (148-foot) wind tower inspired by traditional Arab architecture. There is a cooling impact due to the site's elevation above the rest of the area. Streets and walkways are protected from the sun by a dense cluster of buildings	self-driving "public transportation" vehicles will be tested on public roads.
Using shorter, narrower streets, Because of the wind turbulence at the end of these streets, cold air is flushed upward, making the roadway seem more comfortable	Enable patients to undertake therapeutic activities at home while sensors linked to their limbs communicate data back.
The innovation park in Masdar City is built out of repurposed 40-foot shipping containers	Sensors in old people's houses will identify any unusual behavior and transmit notifications to family members or other care specialist.
Combination of electric and alternative fuel vehicles. Most private automobiles will be confined to parking facilities outside of the city. The proposed and delayed light rail and metro line in Abu Dhabi will link Masdar City's central section with the broader metropolitan region.	Eliminating the need for cash or credit cards by using an integrated chip in any of people's jewelry, including rings, watches, and ID cards
Lighting and water use in the city are controlled by movement sensors rather than switches or taps, resulting in a 51% reduction in both	There is an effort on to eliminate the need for individuals to re-enter their personal information for government transactions by developing a new digital platform

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