Towards Smart Sustainable Iraqi Cities: Problems and Potentials

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Abstract

The idea of smart sustainable cities is an emerging and interesting one as it represents a starting point for a new urban era. Today, we have an opportunity to consider the desired future for the sustainability of smart cities. There are many international governments (Singapore, EU countries, Brazil, etc.) and Arab governments (Qatar, Saudi Arabia, Oman, etc.) that have undertaken or are currently undertaking smart sustainable city projects to address the challenges of rapid urbanization and globalization. Conversely, there are many other Arab cities (Yemen, Syria, Libya, Lebanon, and others), including Iraq, that still suffer from a knowledge gap regarding information as a result of numerous restrictions and challenges at the city or country level.

This research paper examines the agenda of the 2030 scheme for Sustainable Development articulated by the United Nations and adopted by all the countries in the world, in order to ascertain how they may be implemented in Iraq. The research contributes to achieving access to smart sustainable societies by summarizing the most important constraints and challenges facing the process of transition towards smart sustainable cities in Iraq in particular. The study summarizes what kind of actions, a road map and a framework should be devised to achieve a transition towards smart sustainable Iraqi cities.

Keywords: sustainable cities, smart cities (SCs), smart sustainable cities (SSCs), Information and Communication Technology (ICT) ,road map, framework.

Introduction

Rapid urbanization affects the sustainability of cities and adds a range of challenges at the city level, including the expansion of poverty, social pressure, urban pollution, natural pollution, a lack of resources and energy, and indiscriminate land use, among other negative things. Cities need a sustainable business model capable of providing solutions that urban dwellers need, provided that these solutions are environmentally, socially, and economically viable and sustainable. In other words, these solutions must be self-sufficient and capable of enabling people to use the current resources while conserving also for the future generations. In fact, they should ensure that all the strata of the society have equitable access to the benefits and services without discrimination. To achieve this in response to the complexity of issues, the current debates in urban and academic settings are increasingly focusing on the role of sustainable (in conjunction with Information and Communication Technology (ICT) in urban planning and development in response to the immense challenges induced by environmental, economic, and social impacts through several city governments' smart sustainable cities "SSCs" projects.

The objectves of this paper are as follows.

1. To examine the concept of smart sustainable cities .
2. To articulate the concept of transformation.
3. To present the most important theory of transformations of cities.
4. To identify the most important challenges that cities face during transformation.
5. To contribute to achieve a transition towards smart sustainable cities in Iraq.

Research Methodology

This research employs mixed methods. It examines numerous thesis and research related to this topic and analyses selected studies that discuss the major current issues faced in Iraq. This is an explorative technique to identify the most important strategies and guidelines in order to plot a roadmap for a reliable development method towards smart sustainable cities in Iraq. It will thus accomplish the no. 11 of sustainability development goals ensuring that cities and human settlements are sustainable, comprehensive and resilient while facing the temporary challenges.

1. Research Findings

Before devising ways andmeans of creating smart sustainable cities in Iraq, it is necessary first to know the concepts of sustainable cities and smart cities. It is also necessary to understand transformations and the most important theories as well as the most important challenges that cities face when transforming. This will enable the possibility to reach the steps the researcher has taken to achieve transformation.

1.1 Cities

1.1.1 Sustainable City

According to Wheeler et al. (2010), in the late 1980s, the idea of sustainability was born out of the realization that the prevailing model of urban social and economic development is oblivious to:

1. Risks of environmental crises .
2. Social degradation.

The concept of sustainability has no legal or specific definition. It is difficult to define because of its multifaceted philosophical and normative nature, in addition to the complexity of the ecological, social, and economic systems in which the concept of sustainability arises. However, the definition of sustainable development, as formulated in the Brundtland report is "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs.. It contains two main concepts: ‘needs’, in particular the basic needs of the world's poor, and the second concept, ‘ability’ is intended to enable the environment to fulfill the present and future demands as a result of the constraints imposed by social and economic systems. (Oxford 1987: 41) (Bibri,S.E.,2018,P.101-106).

Sustainable cities in general focus on the natural environment, the built environment, the city's infrastructure (water, waste management, energy), and the city's metabolism (production, outcomes, and effects). In addition, it also deals with a range of factors influencing sustainability as follows.

1. built environment.
2. sustainable urban development.
3. Sustainable urban form (density, hoarding, diversity, mixed use of land, sustainable transport, greening, negative solar design) in pursuit of sustainability.

Environmental sustainability

This indicates an understanding of living within the ecosystem's absorptive capacity and meeting existing and future demands by making decisions and doing activities that restore the quality of the environment and preserve its ability to support human life and allow well living to all people in the long term . (Oxford 1987). (Bibri,S.E.,2018,P.101-106).

Economic sustainability

This refers to practices that support long-term economic growth without negatively impacting social, environmental and cultural aspects of the community . At the same time, many economists view economic sustainability dimension as a single system linking the environment and the economy, where economic sustainability requires identifying and implementing different strategies for optimizing the use of available resources and maintaining long-term consumption effectively and responsibly. It thereby aims to avoid deteriorating capital stocks while providing long-term economic and environmental benefits (Bibri,S.E.,2018,P.102).

Social sustainability

This includes equity, well-being, social justice, diversity and cultural promotion to the underprivileged and the disabled, and consequently meeting people's social and cultural needs in equitable ways. (Oxford 1987, P.42) (Bibri,S.E.,2018,P.102).

1.1.2 Smart Cities(SCs)

Smart city is one of the most important manifestations of the information revolution at the end of the twentieth century and the beginning of the twenty-first century. One of the most important reasons for the emergence of smart cities is the inadequacy of traditional methods and techniques in the creation and development of cities as well as the significant increase in the Earth's population. Smart city orientation is a new trend rising rapidly to achieve a modern lifestyle characterized by interdependence, multilateralism, transparency and sophisticated services. It is also driven by the desire of the communities and the officials governing the cities to reach the center stage in the list of global smart cities for their continuous development. It is based on the promotion of continued values of intelligence by attracting the global competencies and experiences of the creative layer and associated ideas to establish a new direction in city planning and design. It intends to provide creative and distinctive solutions to the existing urban problems (Al Nuaimi,2015;Neirotti, 2014;Bibri,2018) .

A smart city (Neirottip et al., 2014) is known as "a way to improve the quality of life of citizens and is increasingly important on the agenda of policymakers" (Aguilera G, et al., 2013,). It "is a very broad concept, encompassing not only physical infrastructure but also human and social factors, known as "a well-functioning city that looks forward to the economy, people, governance, transportation, environment, and intelligence-based living with intelligent citizens""(Chourabi, 2012:2294).

A smart city consists of some layers displayed serially. It is represented by aspects such as the physical natural layer, infrastructure layer, human layer, governance layer, digital infrastructure layer and inclusive technology layer. All of these layers overlap with each other and are interconnected in the sense that each layer overlaps and intersects with all the other layers down to the last layer that connects again to the first layer (Kirwan, C. G., & Zhiyong, F. ,2020:18).

These are as follows.

1. Natural layer: It means Nature which is at the base and is the abundant land with its ecosystems, wood and various minerals as well as various fuels.

2. The urban infrastructure layer[(1)] : which includes all the urban systems, services, and city infrastructure (fixed field / difficult field).
3. The human layer: it includes the behavior, patterns, language, culture, and beliefs of human beings (Soft field).
4. The governance layer: this includes institutions, organizations, associations, and political and socio-economic councils.
5. The digital infrastructure layer[(2)]: this includes ICTs, the Internet and the 21st century technologies.
6. The layer of the overall technological dimension)[(3)] :this integrates and converges seamlessly with the layer of Nature (the first layer). It is worth noting that this layer appears only after the other five layers have evolved.

Smart city since its emergence to now has relied on two approaches: First, the smart city's technology-oriented approach to information and communications was introduced by technology companies such as Cisco, which mainly used technologies to achieve the smart city concept (Hasler, Chenal and Soutter, 2017). Smart city was described by Angelidou (2014) as "a goal of efficiency for difficult infrastructure, including transport, energy, and resources". An example of such cities is the Masdar City in Abu Dhabi and Songdo in Seoul, South Korea, and Rio de Janeiro in Brazil. Many researchers have criticized the idea of this orientation of total reliance on advanced technologies, sensors, and computers without the active participation of the local citizens of the city.

Smart city is oriented by people and have appeared in response to all the challenges of towards ICT because it is necessary to engage people in the concept of smart cities. They are the main players who can participate and determine the success or failure of a smart city project (Hasler et al. 2017).

Borruso and Balletto (2022) divided the urban shifts towards smart cities into the following.

1. **Greenfield's plan**: The creation of a new smart city (technological infrastructure design and reliance on new materials and energy production) and the participation is from top to down central government support such as the Neom City in Saudi Arabia, the e-Masder in the United Arab Emirates and Songdo in South Korea.
2. **Brownfield**: An old urban design with few possibilities for new digital infrastructure. Participation is often from the bottom up with the support of the local smart communities or from the top down in advanced industrial countries, such as London in the United Kingdom, Amsterdam in the Netherlands and Copenhagen in Denmark.
3. **Brownfield plan**: Create new neighborhoods within a traditional city or redevelop an old neighborhood within a traditional city. Participation is often from bottom-up supported by the local smart communities or from top-down in advanced industrialized countries such as Milan, Italy.

Giffinger et al. (2007) have created a tool to assess the smart cities and have identified six key components that make up smart cities. They are, the smart economy, smart people, smart governance, smart transportation, smart environment, and smart life.

Urban Infrastructure Layer [(1)]: networks (roads, water, energy, telecommunications), resource and waste transport and the city's backbone.(Kirwan, C. G., & Zhiyong, F., 2020).

Digital Infrastructure Layer [(2)]: Includes all information technology, wireless and satellite devices and programs that transmit information all over the world. (Kirwan, C. G., & Zhiyong, F.,2020).

Inclusive Technology Layer[(3)]**:** It is intended to integrate technology with the natural environment so that technology is everywhere and invisible (utilizing nanotechnology). Sensors are placed everywhere in the city to monitor and control, and assess and analyze systems in urban areas with a view to improving the functions of city and the welfare of citizens. .(Kirwan, C. G., & Zhiyong, F., 2020).

Chourabi et al. (2012) have added more details and have also proposed eight components of a smart city. They are:

1. Administration and management.
2. Technology.
3. Control.
4. Policy .
5. People and communities.
6. Economy.
7. Built infrastructure.
8. Natural environment.

Factors for each component have also been identified. On the same basis but in a more flexible context, Camboim (2019) has introduced smart city more broadly, encompassing four main components rather than restricting the concept within it with specific components as suggested by the previous studies. Chourabi et al. (2012) and Giffinger et al. (2007) have indicated that all the components of a smart city created by the previous researchers and practitioners together had common advantages that could create four key components of a smart city concept.

They are: governance, urban environment, social, institutional and economic factors and technology. A set of factors to consider for each dimension to be taken into account when implementing a smart city also exist.

1.1.3 Smart Sustainable Cities (SCCs)

The intellectual challenge facing today's cities is about the notion that new technologies are being created not only to enable us to do new things and revolutionize them but also to study their implementation procedures and their effects on the city. For example, this may need to understand smart sustainable cities as a collection of smart applications and systems and their actual effect's role in promoting sustainability. Technology and society are simultaneously shaped by a mutual process, that is, the former evolves depending on the latter, thus affecting each other in the sense that we formulate technology later it will affect our lives. (Townsend,2015). This type of challenge needs to be overcome to create smart sustainable cities that will improve sustainability and, in turn, the quality of life of the inhabitants. Some specific definitions of a smart city consider sustainability an integral part of it, and therefore one might argue that a smart city is a smart sustainable city and that the word "sustainable" can be excluded without further ado. However, there are some reasons why it is necessary to retain the term "sustainability" (Hojer et al., 2015:9-10).

They include the following:

1. Some smart city concepts include "sustainability", which does not mean that all smart cities include this in a literary review of smart city concepts.
2. Since there is no baseline for sustainability in any of the individual smart city conceptions, defining sustainability or sustainable urban development is a challenge.
3. It is crucial to understand what sustainability is to know what needs to be done, and which purposes should be used. Thus, it is important to assess whether intelligence provides the intended results.
4. The definition of a "smart city" does not provide a hierarchy or priority in the order of importance for smart components or applications, effectively meaning that each of the following is valued equally: 'smart economy', 'smart transportation', 'smart environment', 'smart people', and 'smart living', etc.

Sustainable smart cities are a new technological urban phenomenon. Its term was published only in mid-2010 (Al-Nasrawi et al., 2015;Bibri and Krogstie, 2016a;Hojer et al,2015). It has emerged as a product of many global transformations, the most important of which are:

a. Globalization of environmental problems and sustainable development .
b. Urbanization and urban growth.
c-Sustainable urban development and sustainable cities.
d -Use ITC (Hojer et al.,2015).

The first attempts to define smart sustainable cities were made by the International Telecommunication Union (ITU) (ITU,2014). They defined it as "an innovative city that uses ICT and other means to improve quality of life, efficient operation of urban services, and competitiveness while ensuring that it meets the needs of the present and future generations about economic, social, and environmental aspects" (Hojer et al., 2015:14). It further says that "a smart sustainable city meets the needs of its current population without compromising the ability of the other people or future generations to meet their needs and therefore does not exceed local or global environmental constraints and is supported by ICT" (Bibri,S.E.,2018) to achieve the main dimensions of the smart sustainable city represented by the smart economy (competitive environment), smart environment (natural resources), smart governance (Shared), smart life (quality of life), smart transportation (transport and ICT) and smart society (human capital).

Ibrhim et al. (2016) show that each dimension has a set of factors that reflect the important aspects of this dimension. Al-Nasrawi et al. (2015) confirm that there is no systematic model of a smart sustainable city covering all the dimensions of a smart sustainable city that incudes one dimension instead of the other. Bibri and Krogstie (2017a) have discussed the advantages and differences in smart sustainable cities. Bibri (2021) discusses the benefits of a smart sustainable city in transport and traffic management, environmental control, health care, enhanced digital participation, security and public safety, improved accident and disaster management and others.

Summary of the most important features of smart sustainable cities

1. Smart data focuses on applications to enhance the contribution to achieve sustainable development goals.
2. Promote urban performance, urban planning and urban systems and encourage collaboration between urban regions in response to environmental concerns, urban development, urban growth, and shifting social and economic requirements.
3. Monitor, watch, analyse, manage, control, and improve IT and advanced communications devices and applications to enhance a city's operational, planning and functional performance .
4. Improve participation by encouraging digital participation, equity, safety, transportation and accessibility.

This research thus comes up with a procedural definition of a smart sustainable city. According to this, it is a city that combines the strengths of a sustainable city and a smart city supported by the intensive use of advanced ICT for monitoring, watching, analysing, managing and controlling the systems and various urban areas of the city to enable that city to become more sustainable.

1.2 The concepts and definitions of transformation.

There is no agreement yet on what can and cannot be considered a transfomation (Asefeso, 2013). Daszko and Sheinberg define transformation as a "change to create something new unprecedented and this change cannot be expected in the past and leads to a change in the structure of the entire system function and/or shape" (2017:1). Geels and Kemp (2007) say that ransformation "is a continuous process (i.e., it is difficult to know when the transition process will end) and lead to changes in the direction of trajectories".

Tim (2003) explains that there can be structural transformations in cities if there is a rapid and emergency development that requires to come together with it in order to achieve better outcomes for the community and then stages of transition that will appear in the different configurations of the city.

1. Traditional Transition Phase: Represents the first stage of transition to the future in simple ways.
2. Rapid Transformation Phase: Quick strategies that must be implemented by time and place are considered the base for the start of development in the new configuration.
3. Dismantling phase: Represents the last stage when the formation is reformulated with a new system.

Katharina Hölscher (2021) discusses urban transformations in cities as a complex process through multiple dimensions such as social, institutional, cultural, political, economic, technological and environmental.

De Santis, et al. (2014) define the shift towards smart sustainable cities as a complex, multi-dimensional process that changes over time as all relevant stakeholders work to achieve more and better outcomes. This shift will affect many aspects and operations of a city, including government, transportation, energy, services, buildings and the environment.

1.2.1 The most important theories of becoming smart or smart sustainable cities

It is necessary to understand the most important theories that have explained the transformation of cities and how cities have been able to succeed.

1.2.1.1 Digital Transformation Theory

The digital transformation theory refers to the idea of transforming a city using the power of digital media, tools and techniques. Kankanhalli (2019) explains this by suggesting to have a main base for the introduction of modern technologies in a gradual manner to all components of the city up to and until a digital integration is achieved. Its transition phase includes the introduction of internet networks and rapid-response systems of artificial intelligence that could support this transformation. Most importantly, it requires the presence of citizens who can intelligently interact with the city. This transformation should take place while preserving the city's historical distinctiveness and characteristics that give it a cultural and social identity through which it differs from the other cities.

1.2.1.2 Development Transformation Framework Theory (SCTF) [(1)]

This theory requires the promotion of intelligent innovations through the use of a development transformation framework known as SCTF which is an integrated development program for physical and digital infrastructure planning and deploys smart solutions that help to accommodate problems and then solve them as easily as possible.

It has proposed a new concept of smart growth and has interpreted the process of urbanization in a new way based on digital networks, communication technology and information with the ability to monitor and control digital infrastructure (Kumar,2018:1-2)

1.2.1.3 Theory From the Invisible to the Visual System

The use of Internet and the digital and cloud networks are built from the outset based on hidden phenomena in cities. However, this theory explains the transformation of cities relying on these networks to regulate all their components as a shift from the invisible to the visual ones (Florida,2008:35).

[1]SCTF :The Smart Cities Transformation Framework.

1.2.1.4 The Theory of Smart Transformation:

This theory is interpreted even though transformation is a complex process. However, because of its association with technology, it will bring rapid changes while finding radical, smart solutions that are linked to sensors, artificial intelligence and advanced computing (Zhou,2018).

1.3 Challenges toward smart sustainable cities

The process of building a smart sustainable city comes along with difficult confrontations and challenges but it is not an impossible process. To transform cities, there must be aspects to building the new city. These aspects are linked to the actual state of the city such as its government, planning and executive administration, as well as its association with the environment, the economy and the community and to what the city aspects will be in the future (Boyer, 2013).

The implementation of smart sustainable city projects depends on the extent of political stability, the level of technological development and the availability of the city's financial and human resources. To know the most important challenges facing cities, one needs to know the most important global challenges and then the Arab challenges down to the local challenges.

1.3.1 The most important global challenge

The percentage of the world's population living in cities to the total population of the world is 55.72% in 2019. This shows that the global community faces many challenges and difficulties in various areas, which must be addressed quickly, such as tackling poverty, monitoring economic growth, preparing the community, and providing services (Boyer, 2013) in addition to controlling resources, crises, disasters, and environmental degradation, which has now reached the highest levels in these cities. To face the global challenges, it is necessary to develop many strategies for the following.

1-Social upgrading .
2-Empowerment of poor neighborhoods.
3-Enhancing food, energy, and water.
4-Provision of governments and interested people's participatory actions toward a smart sustainable city.
(Creutzig,2015;Bibri and Krogstie,2017a;Maywald, 2016;United Nations,2013).

1.3.2 The most important challenges for the Arab cities

The percentage of the population residing in Arab cities to the total population in the Arab region in 2019 was 59.2%. This is above the world average, making the Arab region exposed to many challenges and varying kinds of issues between cities. The most important of these are poverty, water scarcity, pollution, waste of resources and energy, economic problems, land reduction, high unemployment rates among the young people, gender inequality, armed conflicts, lack of digital skills (digital education), refugee influx, and weak digital infrastructure in some countries. In addition, there is a problem arising from the varying capacities of Arab countries to provide digital services and/or digital solutions and their adoption. To address these challenges in the Arab cities, it is necessary to find ways to develop the following strategies.

1. Expand the application of smart digital solutions as much as possible
2. Provide appropriate and timely health care services
3. Pay attention to the marginalized groups
4. Improve the education and health systems
5. Promote gender equality.

(Ibrahim et al., 2015)

1.3.3 Identifying the most important challenges facing Iraqi cities during transition

Iraq is one of the Arab countries that seeks to find radical solutions to many of the problems and challenges that have been exacerbated over the past decades by wars and economic crises, the consequences of which have been reflected in the city. To know the solutions, the research finds it necessary to know the main challenges under the aspects of the challenges mentioned earlier such as governance, environment, economy, and society (Al-Deen,2005;Dowisha,2008;El-Mooty,2017;Thabit,2019;Alsayed,2020;Hasan,2020; Mohsin,2020;Dawisha,2005;Mohammed,2020).

These are:

1. The security deterioration, especially after the 2003 war, both at the level of crimes and the level of terrorist acts caused by wars and armed conflicts.
2. Increased population growth along with the severe shortage of housing units and the exacerbation of citizens' needs for these units. This is aggravated by the consequent increase in the proportion of informal housing[(1)] and the spread of informal settlements (slums)[(2)] in the cities and especially Baghdad. The city being the capital attracts many displaced people **(**Fig. 1).
3. The main cause of environmental pollution is the emission of gases by internal combustion engines of vehicles on the streets of the cities and the frequent use of petrol-powered generators. The supply of electricity to the city by various means also contribute to a significant increase in pollution in addition to many other factors.
4. The prevalence of desertification caused by the lack of environmental awareness among the government and th ecitizens, the conversion of agricultural land to residential areas using inadequate irrigation systems and overgrazing.
5. Lack of utilization of primary resources due to the heavy reliance on external imports, especially in the field of construction and reconstruction.
6. The low level of the economic sector that has led to increased unemployment and weak economic developmenst.
7. The absence of an integrated planning system capable of addressing housing problems as well as the absence of planning strategies for the current or the next years. They have not been adhered to due to the emergency circumstances of the country.
8. Deterioration of Iraq's education sector, especially after the 2003 War, owing to corruption in the educational institutions, poor educational infrastructure and worsening student absences and school dropouts for economic reasons. All of these are reflected in the educational system.
9. The steady deterioration of the health sector in Iraq over the past four decades caused by wars, economic blockades, political instability and administrative and financial corruption. These have led to a significant deterioration of the level of health services.
10. The deterioration of Iraq's agricultural sector, particularly after the 2003 war, owing to external imports of food as well as scarcity of water.
11. The distortion of urban form, especially in Baghdad, caused by wars and the destruction and the absence of collective awareness among the architects and the intellectual elites.

[1]Informal housing: an unregulated residential area built mostly without a permit and may lack the most basic ingredients of decent life, such as pure drinking water, electricity and other basic living conditions (ar.wikipedia.org)
[2]Slums :Housing where regulations and construction laws are overrun (Kawther, k ,2015).

Fig. 1: Neglected palm trees in front of informal housing and slums of Iraqi cities
Source: author

2. Discussion

2.1 Motives for transforming the Iraqi cities into smart, sustainable cities.

The research considers it necessary to transform some cities in Iraq into smart sustainable cities using the Brownfield approach: urban design with few possibilities for new digital infrastructure or Brownfield approach: the creation of new neighborhoods within a traditional city or the redevelopment of an old neighborhood within a traditional city. The use of ICT alongside sustainable urban forms, sustainable urban developments, good resource management, energy, water and waste, metabolism. This is to enable the city's smart sustainable contribution to achieve the following.

1. **Contributing to reduce the waste of resources and energy**
   This involves significantly reducing emissions of polluting gases by achieving sustainable urban developments and urban forms while using smart meters, smart buildings, smart environmental observations, improved accident management systems, risk assessments, disaster identification and reduced operating and maintenance costs due to advanced technological techniques.
2. **Enhancing security and reducing crimes and violence**
   This involves achieving sustainable urban forms and sustainable urban developments using surveillance cameras, mapping platforms, smart street lighting, and others that help cities predict terrorist acts and crimes before they occur.
3. **Enhancing traffic safety and reducing traffic congestion**
   This involves achieving sustainable urban forms and urban developments using surveillance cameras, applications and smart devices that collect instantaneous traffic data.
4. **Promote education, digital literacy and lifelong education**

This involves mobile or internet applications.

5. **Improving public health**
   This involves providing timely and appropriate healthcare services using intelligent healthcare workers through mobile and internet networks, applications, thermal imaging cameras and electronic helmets, etc.
6. **Achieving social justice and job creation**
   This involves sustainable urban developments and urban forms that promote urban integration and cultural diversity as well as the emergence of new professions and innovations in the field of informatics and information economics. It should also avoid all kinds of corruption from forgery and fraud. It is necessary to drive developments adopting the means of a smart economy by producing the right products according to the needs of the society through accurate data.
7. **Digital participation and the provision of services related to the city**
   This involves participation of citizens in operations such as monitoring, watching, planning and operation via the internet and mobile applications. Achievement of urban integration through social networking services is needed.
8. **Optimal use of land**
   This involves using some of the elements of urban forms such as mixed use of land, density, hoarding, diversity and sustainable transport, which contributes to enhanced access to services and facilities. It minimizes the travel time between the activities. It also involves the revitalization of life in numerous areas of the city.
9. **Promoting the local production of crops and agricultural**
   This involves operationalizing the concept of food production and consumption confined within the administrative limits of the city.
10. **Achieving the greening of the urban landscape**
    This involves greening as one of the elements of urban form that is sustainable and lessens the desertification in Iraq, while improving the urban image, increasing economic attractiveness and quality of life. It is also necessary to promote health benefits and contribute to meeting human needs to provide a sense of comfort, tranquility, meditation and enhanced social interaction.

3 . Measures for Smart Sustainable Cities In Iraq

3.1 For creating smart sustainable cities in Iraq, it is imperative to provide the following.

1. **Laws and government facilities to achieve security and safety**
   Smart sustainable environments need to provide a set of components, such as the government and community's will in terms of accepting participation in the leasing and ownership of land and providing guarantees to shareholders. It also needs reducing custom duties and electronic dealing and drafting intellectual property right laws. It is necessary to respond to the need for diversity of nationalities involved in design, planning, monitoring, and evaluation.
2. **Investing in geographical locations**
   Since many Iraqi cities are located adjoining the Tigris and Euphrates rivers and their tributaries, It is necessary to benefit from the advantages of the surface climate and water channels in lowering heat and thus limiting energy consumption. Is is necessary to explore the possibility of producing renewable energy fom sunlight, water movements, winds, and underground energy. Its geographical locations must be safeguarded and enhanced. Cities should also promote optimal land use in agriculture and achieve the metabolisms of the availability of water, good soil and human energies.

3. **Invest in the creative energies of Iraqi creators**
   Innovation epicenters and brainstorming centers can be created to generate creative ideas to find solutions to intractable problems and meet the challenges.
4. **Develop a clear road map to identify challenges**
   Developments must achieve key objectives toward the aspirations of Iraq's smart sustainable cities. The European Smart Cities Platform defined its road map to smart cities as "how to control the city's interconnected layers of digital infrastructure, technology, ecosystems, urban activities, and citizen-led innovations". The Smart city council of Washington (SCC) defines smart city readiness as the "bridge between ideas and procedures". Maysoun et al. (2016) notes that the roadmap for smart sustainable cities ensures the success of transformation to the maximum extent possible. The road map is the cornerstone of the transformation process and defines the stages, milestones and goals of transformation to achieve the vision of a smart sustainable city through a simplified outline showing the main steps.
5. **Develop a framework for the process of transitioning towards smart sustainable cities in Ira**q.
   Falconer and Mitchell (2012:9) define the framework as "the process that assists the city's key stakeholders and participants in understanding how cities operate, define city objectives and define the role of the city's stakeholders and ICTs. It is a step-by-step process to implement SSC". Chourabi, et al. (2012) define the framework as "that can be used to help the government create SSC" initiatives. Maysoun et al. (2016) explain that despite the differences in the names of different stages of the specific operational frameworks, the common denominator in the objectives of these phases is the importance of the planning phase of the city towards a smart sustainable city and that any practical framework is designed in a way that meets the requirements and characteristics of that city. Frameworks deal in different ways with the dimensions of the city. The framework provides a planning model that highlights and answers how to achieve the shift towards smart sustainable cities and provides tips to help the city leaders and stakeholders deliver and develop transition strategies towards smart sustainable cities.

3.2 Proposal for a general road map to a sustainable smart city in Iraq

This is a general proposal not applicable to a particular context or a city in Iraq and aims to transform some Iraqi cities into smart sustainable cities to help planners, policymakers, key stakeholders and decision-makers to understand the key aspects that need to be taken into account during the transition journey. Transformation process is a sophisticated process that yields multifaceted, long-lasting changes that improve the sustainability of the city and provide its residents with a good quality of life, through the use of ICT and SSC.

The stages of this proposal include defining the city's vision, strategies, and objectives, as well as identifying its stakeholders and citizen participants with the ability to verify the city's readiness and willingness to change by examining the current context of the city in terms of non-ICT (solid and soft) and ICT-based infrastructure. Systems and programs and the level of digital literacy and the assessment of all other urban areas of the present city thus face environmental, economic, social, and government challenges. All of this is done by monitoring and evaluating the transformation process, providing solutions and taking advantage of previous experiences to avoid repeating past errors and providing continuous improvements to improve transformation goals. It should improve maintenance of solutions and services implemented and provided, announce achievements to keep the SSC transformation process transparent to increase the support of citizens and stakeholders, and learn from the expertise. Finally, the evolution must be kept on track, produce further changes, and add many activities

to the city to ensure continuity of the transformation process to achieve transformation towards smart sustainable cities (Fig. 2).

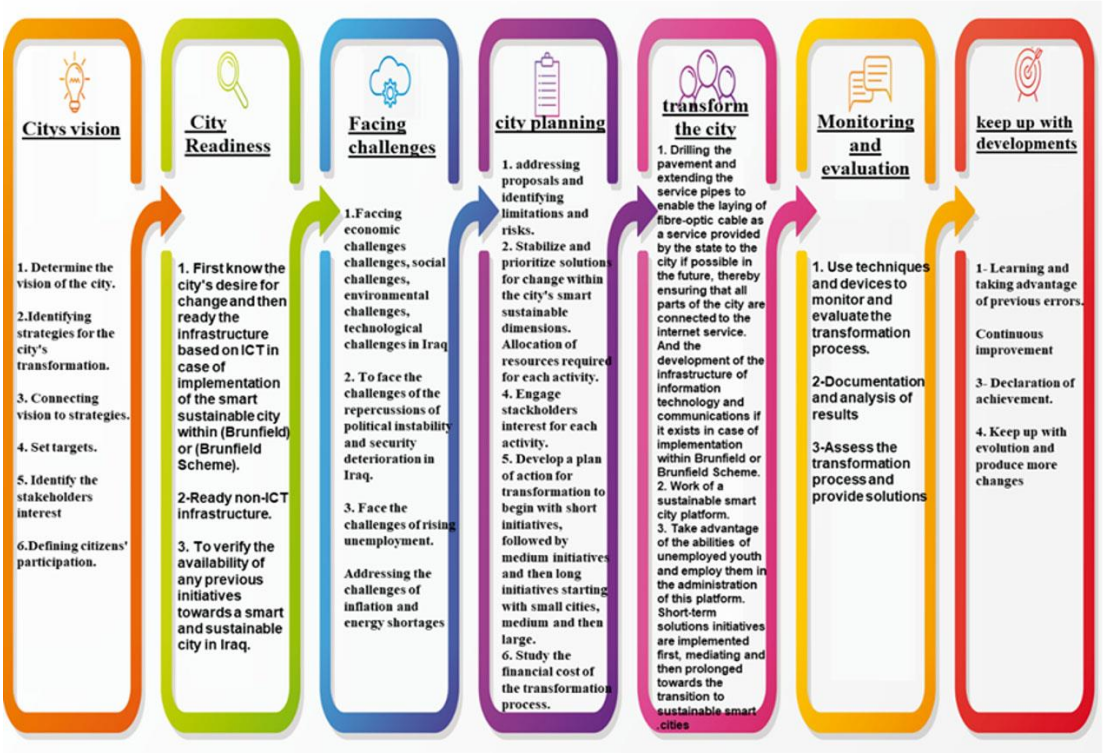

Fig. 2: General road map for the transformation towards smart and sustainable cities in Iraq
Source: Author

3.3 A general framework for the transition toward a smart and sustainable city in Iraq

This is a general proposal not applicable to a particular context or city in Iraq and is determined by the following stages.

1. Vision phase: strategic planning .
2. City readiness phase: determining the city's susceptibility and willingness to change
3. Challenge phase: addressing challenges that run counter to the possibilities of change.
4. Design and planning phase: design, development and plans for the city services
5. Transition phase: implementation and testing of the city services.
6. Monitoring and evaluation phase: monitoring and evaluation of the city.
7. The stage of keeping pace with development: continued support and change to achieve better services for the city (Fig. 3).

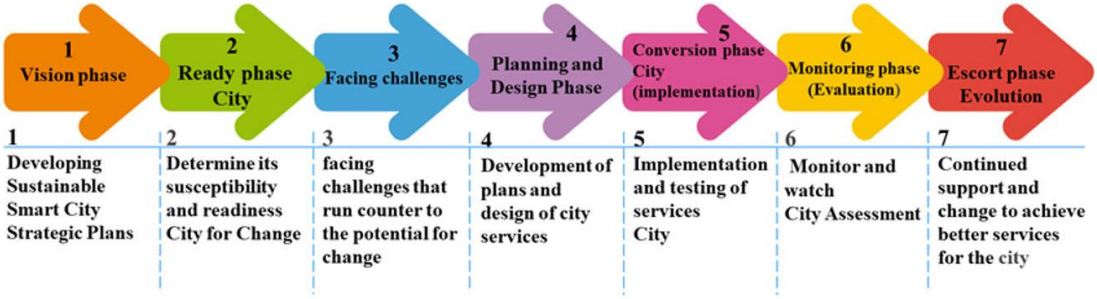

Fig. 3: General Framework for Transition to Sustainable Smart Cities in Iraq
Source: Author

4. Conclusions

The Smart sustainable city is a city that combines the city's strengths to be smart and sustainable supported by the intensive spread of advanced ICT and its use in various urban systems and areas to enable the city to become more sustainable. They contribute to address the challenges faced by Iraqi cities such as:

•The security deterioration
• Increasing population growth.

With the increase in the proportion of informal housing and the spread of informal settlements or slums in the cities and especially Baghdad there are complex issues such as:

• Environmental pollution and the spread of desertification
• Underutilization of Primary resources
• Energy waste
• Lower level of economic performance
• Absence of planning policy
• Deterioration of the educational sector
• Continuous decline in the health and the agricultural sector
• Deformation of urban form.

A smart sustainable city contributes to achieve the following.

• Reducing of waste resources and energy and reduces emissions of polluting gases.
• Enhance security and reduce crime and violence.
• Promote traffic safety and reduce traffic congestion.
• Promote education and eradicate digital illiteracy.
• Promote public health.
• Achieve social justice and provide employment opportunities.
• Digital participation and providing many services.
• Optimal use of land in the city.
• Promote the local production of crops and agricultural products.
• Achieving the greening of the urban landscape and reducing the phenomenon of desertification.

These can be achieved through:

• Legislate laws and provide government facilities as well as provide security and safety.
• Invest in geographical locations.
• Invest in the creative energies of Iraqi creators.
• Establish a clear road map for the process of transition towards smart sustainable cities in Iraq.
• Develop a framework for the process of transforming into smart sustainable cities in Iraq.

Given these findings, it is recommended:

1- to move towards smart and sustainable cities to meet the challenges of rapid urbanization and globalization, especially that the concept of smart and smart sustainable cities is no longer limited to the use of ICT, but also includes the view of society and its needs.

2- Take initiatives of sustainable smart cities starting from educational universities and research authorities that are responsible for seeking to discover knowledge in

urban data and to find innovative solutions to meet the challenge of urbanization and sustainability. The role of government officials is to stimulate innovation in these universities and research authorities.

3- to take advantage of the previous experiences of smart cities and smart sustainable cities, based on the need to engage many and effective actors in the development or establishment of smart and sustainable cities including government, public sector, private sector, Citizens, civil society communities, academia and expert advisers in the planning and development of the formation, organization and evaluation of these cities' projects.

4. To provide smart technologies and keep abreast of their development in the societies while strengthening the knowledge role of engineers, planners and technicians as they are the key to building innovative capacity in the urban environment by increasing their ability to deal with technologies in it is different fields.

5. To attract creators and owners of creative industries because it contributes to the promotion and development of ecosystems of knowledge that bring prosperity to the city.

6. ensure that Iraqi society defines its role in the information age driven by artificial intelligence because communication, intellectual openness, creativity and effective participation in public life are essential elements for the development of smart people. This is because smart people along with governance solutions is a successful key to achieve technical, social transformation.

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