The Challenges of Smart Development in Future Iraqi Cities: Achieving Techno-Sustainability

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Abstract. Many of the technological concepts of contemporary cities have expanded within smart development frameworks. Baghdad represents a global challenge that requires comprehensive changes at all levels to become a sustainable smart city. This study highlights the most important challenges facing contemporary cities in general and Baghdad city in particular in respect to creating techno-sustainability. In doing so, future cities will provide citizens with various lifestyles according to multiple development possibilities. Extant research suggests that technological cities actively deploy the latest technologies in order to ensure the best quality of life and facilitate access to all economic, social, and environmental levels. This model of technologies can be applied to Baghdad in a manner commensurate with the city’s social reality. Using the inductive analytical method, this study compare theories of smart development with the most important local challenges, thereby identifying areas of focus for achieving techno-sustainability in an Iraqi city. This study concludes that smart governance and smart movement followed by a digital learning platform and community participation are among the most influential factors for techno-sustainability. In turn, these factors strengthen research capacity and measure the turning points in the pathways of Iraqi cities.

1. Introduction
Sustainability has become a primary consideration in current scientific research as a result of its significance to cities around the world. Indeed, sustainability offers new ways of living together and conserving our natural resources, thereby impacting quality and security of life [1]. Nonetheless, contemporary cities still face numerous challenges, from natural and manmade disasters to the misuse of energy resources and the poor urban living conditions. Cities are generally divided according to the degree to which they suffer crises and challenges. Traditional cities face significant challenges, and the transition requires active and careful planning.

Exploring how technology works within smart cities, this paper examines the challenges of shifting from a traditional to techno-sustainable city, specifically focusing on Baghdad, Iraq. While struggling to talk about its ancient history, Baghdad is attempting to rebuild itself and become a future city of tomorrow in Iraq. Accordingly, it is important that we identify the challenges that need to be solved for successful development. This study elucidates the main axes of smart technologies and sustainable development to clarify the link between the concept of sustainable development and emergence of technological cities. In doing so, this study reveals the reality of sustainable development in Iraqi cities and the main challenges facing the city of Baghdad in achieving techno-sustainable development.

2. Approach and Aims
Contemporary cities face numerous challenges, many of which require urgent consideration due to their potential consequences for human life. Technology has been advanced as an effective solution,
particularly insofar as it can facilitate sustainable development within the framework of emerging and rebuilt cities. However, in cities like Baghdad, which faces both new and historically rooted difficulties, there is a lack of knowledge regarding the actual challenges faced by the city and how these challenges—including that of sustainability—can be addressed through smart development programmes.

Using an inductive analytical approach, this study compares theories of smart development with the most significant local challenges facing Baghdad, thereby extracting several indicators of what is required to transform Baghdad into a smart city. This study aims to (1) identify the weaknesses and strengths of Baghdad that can be used to create mechanisms to drive and prepare for the transition toward smart technology, (2) indicate whether Baghdad is able to host a smart environment. This study is based on the premise that smart development is an essential approach to achieving sustainable development in cities. Accordingly, an integrated framework based on technology can be constructed to achieve smart development.

3. Literature Review

The global community is facing numerous challenges and difficulties. Many areas urgently require attention, including poverty, economic growth, and the provision of social services. These issues lead to rising costs—a common factor in all progressive steps advocated by the international community [2]. The concept of sustainable development has been promulgated as a means of minimizing the negative impact of these problems on the environment [3].

Scholars have proposed numerous ways in which to promote development processes, especially in developing countries undergoing rapid urbanization. Underdeveloped and developing countries also face crises resulting from increasingly severe environmental degradation. These issues have resulted in the call for development rather than rescue plans [4], as well as aid across national borders in the form of global initiatives, foreign aid, and non-government organisations (NGOs). This support has achieved many positive results in some areas, particularly in the tackling of poverty. It has also facilitated the socio-economic growth of economically fragmented cities through the monitoring of economic growth, education enrolment, and health outcomes [5].

Studies show that smart city initiatives are an effective means of overcoming the traditional constraints of urban development programmes [6]. Urban infrastructures require a set of systems regulating the exchange of information between systems and stakeholders. The services provided by these systems depends on digital technologies such as the Internet, cloud computing, and open data, as well as technological connectivity. This highlights the concept of administrative empowerment, which refers to the control of these systems through their integration with the city’s health, education, care, and service systems [6]. This management is characterized by the development of restrictions for the control of data and information, shaping the protection of citizens’ privacy within smart development programmes. Certainly, individual security and privacy are subjects of concern in the discussion of smart city dynamics. This section surveys the relevant literature regarding techno-sustainability and the challenges involved in smart city development.

3.1. Sustainable Development

The concept of urban sustainable development has been linked to the development of the reality and future vision of the city, as well as the preservation of the rights and securities of each generation. While scholars note the need to preserve the city’s assets in terms of the basic elements of life has long been considered in urban development [7], contemporary development advances the importance of increasing basic needs while mitigating negative socio-environmental impacts. Certainly, the need to consider basic needs and knock-on effects has been promulgated by the United Nations since 1951. While attention once focused on rural communities, the rapid growth of cities—and their problems—has led to a shift in development focus, with emphasis on the need to construct cities through development systems and programmes. The development of the urban environment and the transition to better socio-economic level depends on the participation of society [8]. It is in this regard that the adoption of sustainable development principles is significant, as urban support plays a role in the construction and transition of sustainable cities [9].
3.2. Technology and Smart Cities

Advanced urban areas emerge through the linking of development programmes and technology, impacting the city. Accordingly, different types of cities have emerged depending on what and how technology is used in their infrastructure, including smart, digital, electronic, and virtual cities (Figure 1). These cities differ according to the use of technological control, resulting in varying functional advantages [10]. These cities rely on communications technology and security services, as well as relative stability and peace.

Some argue that traditional cities should follow targeted development programmes in order to advance their construction process and transition into smart cities because smart cities have a basic development base linked to socio-economic development, enhance the quality of life, and achieve sustainability goals [11]. Indeed, these smart city goals coincide with those set by the UN’s future development plan for cities 2030, which reinforce the need for global co-operation in preserving the earth [5].

3.3. Development Axes of Techno-sustainable Cities

The process of building a technological city characterized by sustainability is not without challenges. Development axes are required to create a techno-sustainable city [12]. These axes are linked to what is available to and the reality of the government. As Figure 2 shows, the linkage of this administration with other areas—such as the economy, environment, and society—reflect how the government can dictate the role of each of these areas in the organization of the techno-sustainable city. Therefore, the administration should be able to identify the main points of the axes that contribute to the construction of these basic areas of the city [3].
In this regard, it is clear that the main axes of building a techno-sustainable city are as follows. First, it is necessary to analyse the current status of the city. Second, a basic, strong, and appropriate information base supported by digital management should be constructed in order to create a smart governance platform and sustainable intelligence urban planning. Reaching these goals depends on the interdependence and integration of these axes.

### 3.4. Smart City Development Strategies and Programmes

Many cities are in the process of transitioning from traditional cities to smart cities through targeted strategies. These strategies govern the changes necessary to become a sustainable city while enhancing the quality and efficiency of techno-urban structures through information or digital technology [13]. This requires two prerequisites [14]. First, it is necessary to build knowledge networks between cities and regions that have experienced the same conditions and development progress. These networks can be created and strengthened through knowledge exchange, including interaction between universities, institutions, and NGOs. Second, it is necessary to develop international co-operation via new models and interventions, giving relevant international elements a greater stake in the outcome.

Scholars have identified basic or general strategies able to accommodate for the challenges facing cities in the global south. These include strategies and tools to raise the social level, slum empowerment strategies, strategies and techniques to promote primary resource access (food, energy, water), protection and value strategies for tangible and intangible heritage, renewal and support strategies, and comprehensive governance strategies [15]. Meanwhile, numerous models can be used as a source of workable information in order to avoid the negative effects of the transition process, including the reduction of costs incurred [16].

![Basic smart city development programmes](image)

**Figure 3.** Basic smart city development programmes.

The concept of smart development can be understood as a set of development programmes that adopt smart digital technologies or advanced technology in order to ensure the effective application of these development programmes while ensuring community participation and the protection of rights. These programmes may vary depending on the needs and context of the city or region itself, generating various approaches and outcomes. The efficiency of smart development programmes and their compatibility with the local community, as well as the acceptance of these smart development goals by urban residents, are integral to the creation of a smart city. These aspects are related to urban infrastructure, including transportation, healthcare, education, and energy [17]. Smart development aims to improve these services and facilitating the management of the city by integrating services into a primary network with various branches as follows [18]:

1. **Smart governance:** the interdependence between the government and the people, ease of communication, and transparency in the receipt of information; direct participation.
2. **Smart economy:** entrepreneurial projects, employment and investment opportunities, services and rapid communication; remote control.
3. **Intelligent transport:** intelligent and efficient transport, intelligent road networks equipped with high technologies and services; pluralism.
4. **Smart environment:** sustainability, rationalize energy consumption and provision, the management and protection of the environment.
5. Smart society: empowerment of technology, digital society, smart care, and the spread of knowledge and experience to rural areas.

6. Smart place: correct investment of a site, promotion of tourism and heritage, as well as the integration of community traditions with smart development programmes.

As such, smart development comprises comprehensive and interrelated programmes intended to enhance efficiency and quality of life. The efficiency of these programmes is shaped by the appropriateness of their implementation, as well as community co-operation and participation. It is important to note that the state the primary role as it determines and controls these programmes through smart governance.

Table 1 presents the main axes impacting the development, implementation, and success of smart development programmes targeting urban challenges.

Table 1. Basic software for smart development process

| Types                        | Role                                           |
|------------------------------|------------------------------------------------|
| **Bodies/institutions**      | Supporting research orientation in the context of smart development |
| Scientific institutions      |                                               |
| NGOs                         |                                               |
| **Development programmes**   | Supporting smart development programmes       |
| Smart economic development programmes |                                             |
| Smart social development programmes |                                             |
| Smart governance development programmes |                                             |
| **Strategies**               | Long-term strategies and plans in the field of smart development |
| Empowerment strategy         |                                               |
| Reinforcement strategy       |                                               |
| Protection strategy          |                                               |
| Comprehensive governance strategy |                                           |
| Support strategy             |                                               |
| **Information**              | Digital governance management                 |
| Availability of information  |                                               |
| Confidentiality of the information |                                       |
| Information integrity        |                                               |
| **Levels**                   | Building a knowledge network                  |
| Local                        |                                               |
| International                |                                               |

3.5. The Mechanisms of Smart Development

While smart development appears to focus on the economy and the preservation of capacity, cost, and energy resources and other important things, the challenges involved in transforming traditional cities into smart cities depend on the needs, participation, and interaction of the city’s residents [19]. Many believe that smart development holds significant potential, thereby justifying the time, money, and effort required. This is certainly true insofar as these short-term costs are made up by long-term benefits, including reduced maintenance energy and costs [17]. Nonetheless, concerns regarding cost, time, and effort means that smart development programmes require mechanisms facilitating their implementation and management. Mechanisms include smart buildings, intelligent mobility systems, intelligent security services and smart safety, the smart lighting of public streets, intelligent waste recycling waste, as well as intelligent communication [17, 18].

As such, there is a wide variety of mechanisms to consider when deciding the process by which to of transition into a techno-sustainable city. Instituting these mechanisms presents a difficult challenge unless there is a basic plan that addresses the most important needs—one that accounts for the city’s specific social reality and degree of social support. However, the state plays an indispensable role in
controlling these technologies, programmes, and mechanisms, thus necessitating the presence of smart governance ensuring the appropriate integration of a smart environment, intelligent economy, and the smart city. Table 2 presents a breakdown of the dimensions of smart governance.

Table 2. Dimensions of smart governance

| Dimensions                                           | Smart mechanisms                                      |
|------------------------------------------------------|-------------------------------------------------------|
| Eco-environmental dimensions                         | Mechanism for the implementation of smart buildings in the city |
| Environmental, social, and economic dimensions       | Intelligent transport systems                         |
| Social dimensions                                    | Smart security and safety services                    |
| Eco-environmental dimensions                         | Smart lighting for public streets                     |
| Environmental, economic, and social dimensions       | Waste recycling                                      |
| Social dimensions                                    | Smart communication and sensor networks               |

The urban population plays an important role in determining the basic needs and available options. As noted, the degree to which a city’s residents accept the intention to become a smart city and the mechanisms required to do so shapes the success of the endeavour.

3.6. Global Challenges for Techno-sustainable Development

Techno-sustainable development has great potential for improving the situation of developing countries. After the introduction of the concept of modernity and technology within areas of a city, it is necessary to advance a complete framework to identify focal points to ensure smooth implementation [5]. This requires the existence of research capabilities in the context of the smart and techno-development of cities, including the support of research institutions. This framework should adopt the city’s original housing policy as a base, considering the context of the state and seeking the experiences of developed countries in developing reform. Smart governance should be adopted through smart environmental and economic dimensions. NGOs can be used to achieve a balance between public interests and sustainable development, as well as support smart city development initiatives. An integrated plan for developing cities on the basis of smart activation across all urban systems should then be developed. Given its developmental and sustainable importance, smart city initiatives should start from the top down, moving from the government to the citizens.

The extant literature also indicates the need for a modern e-learning platform (digitization) that can guide citizens to learn about and participate in the urban planning of their cities. This is particularly important for enhancing community participation and support, which, as noted, play a vital role in achieving smart development in developing countries. It also serves to activate the concept of community belonging in an integrated work program. As emphasised throughout this study, implementing smart development requires a smart governance programme and community participation (Figure 4). This combination may be missing from developing cities, especially Baghdad, thus hindering techno-sustainable development.

![Figure 4. The axis of smart governance in society.](image-url)
4. The Techno-Sustainable Development of Baghdad

4.1. The Sustainable Development in Iraqi Cities

Iraq needs to prepare development programmes to advance its socio-economic and environmental potential. Despite the large-scale technological development in countries around the world today and the benefit of such development programmes, Iraq’s cities have much to do to achieve sustainable development. This seems particularly incongruous given the Iraq’s wealth and rich supply of resources—including oil—that would benefit from sustainable development [20]. As noted, there are two axes in the process of implementing sustainable development in third world cities. The first axis comprises the new initiatives and construction, while the second concerns the social, economic, and urban reform. Techno-sustainable development sees this second axis achieve reform through the use of smart technologies [21]. These basic axes of development typically have an overlapping modular structure, thereby guiding urban development based on sustainability goals [13].

Custom units and elements can be used to achieve development. Accordingly, Iraq can assess the appropriateness of these units for local conditions and identify which urban areas to target [9]. Organising sustainable development programmes according to patterns of associated elements is an easier way of achieving development goals, although it can be more labour intensive and requires a comprehensive vision that considers all levels or components of the programmes [22]. Arguably, given its resources and ability to customise sustainable development, Iraq should be at the forefront of sustainable development initiatives. With a complex history, the country faces significant challenges in its sustainable development goals.

4.2. The Challenges of Sustainable Development in Iraq

Today, Iraq is one of the most important countries seeking radical solutions to the problems and challenges that have worsened over time, including population growth, the spread of urban slums and informal housing, poor economic development, pollution, traffic congestion and pollution, and the exploitation of primary resources [23, 24]. These issues have been exacerbated by a lack of planning strategies, a dependence on foreign imports, and the destruction wrought by wars [24]. That Baghdad is Iraq’s capital heightens these challenges to achieving sustainability goals [24]. However, as Figures 5 and 6 show, these obstacles have many solutions.
Environmental pollution resulting from the failure to achieve sustainability goals

- Define law(s) and controls supporting sustainability goals in order to preserve the environment
- Activating the role of governance and urban management
- Activating the supervisory role and exploiting existing primary resources
- Supporting economic development and investment promotion programmes
- Integrate informal housing and the number of inhabitants within the area
- Lack of strategic planning for current and future years
- Failure to exploit existing primary resources and rely on external support for funding
- Weak economic sector, resulting in unemployment
- The emergence of slums and the spread of informal housing
- Environmental pollution resulting from the failure to achieve sustainability goals

**Figure 5.** The challenges of developing smart cities in Iraq.

**Table 2.** Basic solutions to particular challenges.

| Economy          | Society                  | Environment          | Judgment                        |
|------------------|--------------------------|----------------------|---------------------------------|
| Unemployment     | Population growth        | Energy waste         | Lack of strategic planning      |
| Poverty          | Lack of community control| Lack of sustainable mobility | High crime rates                |
| Absence of investment projects | Suspension of innovation support | High traffic | There is no basic database |
| Deterioration of the economy |                          |                      |                                 |
| Innovation and investment support | Knowledge | Sustainable development | Community participation |

Baghdad’s development process comprises three components. First, the process of becoming a technosustainable city requires the presence of a number of axes in Baghdad (Figure 7). These can be divided into three basic areas: namely, smart governance, smart community, and smart power. In regard to smart governance, a general planning department responsible for managing the emerging smart city is required to facilitate the transition. Smart community refers to the development of community culture
that enhances cultural and urban awareness. Smart power refers to the preparation of an appropriate smart city environment under the comprehensive concept of smart energy, which is linked to the smart economy and the availability of intelligent transport [25]. In this respect, smart development must be achieved holistically in order to make Baghdad a smart city. As such, there must be clear plans and specific strategies organised according to a scheduled of targets and milestones, each completed before moving on to the next.

![Smart development axes for the city of Baghdad.](image)

**Second**, a number of programmes and initiatives are required to support the transition to technosustainability. This is particularly necessary given the scope of considerations in smart city development, which will require the shifting and reorganisation of institutional responsibilities. Table 3 illustrates the necessary changes in the transition of Baghdad into a smart city.

**Table 3.** Comparison between smart city development and development in Baghdad

| Development in Baghdad | Smart City Development |
|------------------------|------------------------|
| Institutions and organisations | Administrative development programmes | Smart governance | Digital management | Government development |
| Ministry of Culture, Community, Schools and Universities | Cultural awareness programmes | Protection of heritage | Promoting tourism | Preservation of identity | Spatial development |
| Ministry of Transport | Development programmes for transport planning, urban design, and industry | Smart fast transmission lines | Intelligent parking spaces | Intelligent transport networks | Pluralism |
| Ministry of Health | Environmental development programmes | Sustainability | Rationalisation of energy consumption | Environmental management and protection | Smart environment |
Third, the aforementioned considerations need to identify smart city mechanisms commensurate with the reality of the city. Plans and strategies need to consider the definition, application, and objectives of techno-sustainability in accordance with local conditions and the mechanisms required at various levels. This involves approaches towards construction, energy collection and output, mobility systems, and the provision of security and safety. In this regard, it is important to clarify the most important areas of the city in terms of waste recycling and infrastructure services, and the provision of the necessary amenities to all parts of the city. Table 4 identifies what Baghdad lacks in this regard, thereby revealing areas that require attention in order to achieve development goals [25].

| The reality of the city of Baghdad | Mechanisms of action |
|-----------------------------------|----------------------|
| Non-existent                      | The city of Baghdad needs programmes to rationalize energy consumption and preserve the environment. Smart buildings have a major role in achieving this. Work mechanism for the implementation of smart buildings. |
| Non-existent                      | Intelligent mass transport and intelligent transport networks. Work mechanism with intelligent mobility systems. |
| Existing                          | One of the most important mechanisms for maintaining security in the city and reducing the risks. Work mechanism with smart security and safety services. |
| Non-existent                      | A catalyst for reducing energy consumption and improving device sustainability. Work mechanism with smart lighting of public streets. |
| Non-existent                      | Keeping the city clean and minimizing any negative effects on the environment. Smart work mechanism for recycling waste. |
| Non-existent                      | Supporting social communication systems and providing communication services in public areas. Smart communicator and sensor work mechanism. |

As such, while every country is dealing with a variety of challenges, diagnosing the problem and its primary cause are vital to finding the right solution. While sectors like the housing, economic, and social sector are important, this study suggests that identifying the primary points from which the launch the development process is fundamental to the success of the smart city initiative.

5. Conclusions and Recommendations

The arguments of this study can be summarized as follows. First, the presence of technology in smart cities contributes to the creation of a solid information base, which serves as the starting point for the management of smart cities. Second, smart development programmes are essential to educating urban residents, the support of whom is integral to development goals. In this respect, it is important that these programmes consider all of the components of smart sustainable development. Third, smart governance is necessary for the effective management of developing cities and needs to follow a well-developed plan.

Baghdad faces diverse challenges relating to management, society, the environment, and the economy. Various mechanisms associated with smart cities can address these challenges, including smart energy for the sustainable management and use of energy resources. In this regard, intelligent sensor systems are considered one of the most important smart systems insofar as they can be used to reduce energy consumption, as well as enhance the safety and security of citizens. Intelligent transport also significantly impacts the achievement of smart sustainable development because of its socio-
economic and environmental effects. Most importantly, smart development must be commensurate with the local context in order to achieve balanced and effective transition to techno-sustainability.

Based on the examination of Baghdad, this study makes the following recommendations to city planners and policymakers. First, research institutions should be encouraged to explore techno-sustainable development in order to expand current knowledge and enhance societal awareness of this type of development. In this respect, it is necessary to support research in the field of techno-sustainable development in the language of the target area, as well as enhance community awareness of this type of development. Second, it is necessary to implement governance legislation and standards for the city of Baghdad within the techno-sustainable development platform. In this regard, a design standard guideline for the city of Baghdad needs to be identified and used to guide the development process. It is also necessary to establish a smart construction platform and support the transition to a green economy supporting in order to manage this development. This will require the direct supervision of specialists and both governmental and non-governmental institutions.

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