

Approach to Reduce the Urban Footprint through Environmental Planning Elements for Cities (Berlin City and Singapore)

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Abstract: The urban footprint is a distinctive measure of the extent of achieving environmental sustainability accurately in cities, it reveals deficiencies and positives within cities that affect the value of the footprint and given that urban planning is in control of the way people conduct their activities inside cities. Environmental planning for cities is the key to reducing the environmental footprint and thus achieving sustainability within cities. So, the research shows two cities, Berlin and Singapore, which differ in the value of the urban footprint of their two, and the city planning methods for them, in order to reach mitigation measures that raise the urban footprint in each of them.

Keywords: Footprint; Urban; Ecological; Sustainability; Environmental; Cities: Berlin and Singapore

I. INTRODUCTION

With more than half of the world's population in cities and urban areas, all cities today are associated with climate change as a result of the growing demand for food, transportation, buildings and activities, which consume energy in unsustainable way, that have resulted in an increased Urban footprint, which is one of the greatest challenges nowadays. [1]

The rapid consumption of natural resources and the negative effects of carbon emissions from human settlements encourage the development of new methods and concepts of cities based on respect for nature and the reduction of environmental impact, based on a review of the way in which cities are planned to face these challenges, where City planning or urban form can affect the environmental status of the city through urban sustainability .

The Urban sustainability or urban dimension of sustainable development deals with the study of the relationship of urban planning of the urban development site with its potentials either for the site itself or for the environmental, natural, human and economic resources and the elements of site coordination. In addition to the quality of air and water and the degree of mutual influence between the city and the surrounding environment, thus, the urban concept of sustainable development is based on the following principles :

- Prediction of the magnitude of the adverse effects to which the surrounding environment will be affected.
- Non-exceeding the environmental standards for air, water, sewage and industrial wastes.
- Studying the relationship between natural resources, human activities and the possible environmental threats.
- Maintaining natural balance. [1]

Based on what has been achieved in the previous, the urban footprint is one of the best and most accurate tools for measuring the environmental and human activities' impact on the surrounding environment and therefore we need design and planning methods or indicators to control the urban impact of the surrounding environment and thereby reduce the value of the ecological urban footprint.

The urban footprint is one of the expressions of the amount of environmental impact by calculating the effect of man dealing with natural capital from the consumption of resources and the absorption of waste within a certain area represented by the city area. [2]

Cities are the container that embraces all human activities in different fields practiced by man, but they may be considered as one of the greatest human achievements on this planet. There is no doubt that they are the largest consumer of environmental resources on this planet. [3]

Cities play a vital role in the socio-economic development of countries. Urban efficiency allows sustainable urban settlements and strong economies to improve infrastructure, education, health, living conditions and poverty alleviation. One of the cities' biggest problems is environmental deterioration and inequality among communities that can be solved by correct planning and management.[1]

Environmental cities aim at alleviating poverty, improving climate conditions, improving waste collection efficiency, strengthening the capacity of local government and administration to establish a contemporary city catering to the needs of the population and providing a suitable life for them.

Therefore, it was necessary to find a way to measure the consumption of cities and urban communities of environmental resources through the urban footprint, which means one of the expressions of the amount of environmental impact by calculating the effect of man dealing with natural capital from the consumption of resources and the absorption of waste within a certain area represented by the city area. [2]

Different cities' Ecological Footprint Values are largely driven by socio-economic factors, such as available income, infrastructure, and cultural habits, Therefore, the factors affecting the urban footprint can be limited to the following Fig. 1.:

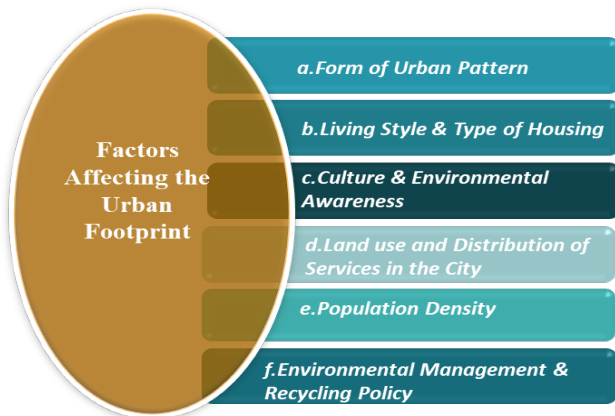


Fig. 1: Factors affecting on the Urban Footprint.[6]

The urban footprint is a digital environmental indicator that is distinguished by accuracy to evaluate the environmental impact of cities. And to analyze the urban footprint of cities accurately, the environmental footprint of each sector in the city were measured separately. as shown in the following figure that shows elements of urban footprint following Fig.2.:

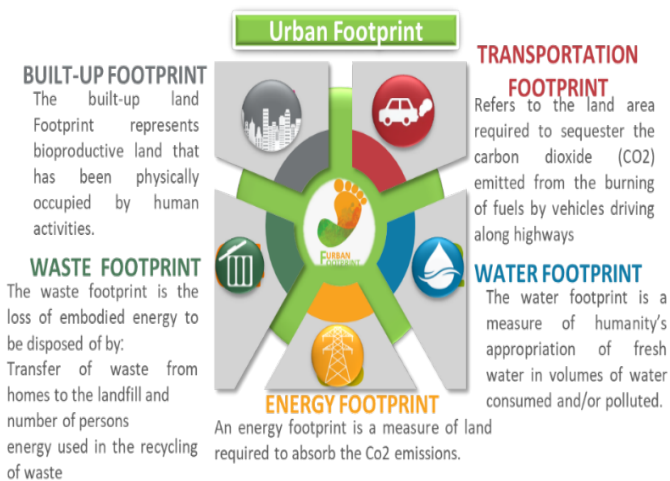


Fig. 2: Elements of Urban Footprint.[2]

The contributions of this manuscript can be summarized as follows:

- Identify the affecting Urban sectors on Urban Footprint of each cities.
- Comparison between the Urban Footprint of the urbanization sectors of the studied cities.
- Comparison between the Urban Characterizes for cities (Berlin city and Singapore).
- Access to Mitigations for reduce the urban footprint for case studies.

The rest of this paper will be discussed: In Sec.2, Urban components effects in urban footprint is discussed. In Sec.3, Urban footprint for case studies is presented. In Sec.4, Mitigations for reduce the urban footprint for case studies is discussed. finally, Conclusions are made in Sec.5.

II. URBAN COMPONENTS EFFECTS IN URBAN FOOTPRINT

Cities have always been unsustainable places that depend on many inputs such as food, water and energy and produce harmful outputs and because in the past the urban communities were small and therefore their inputs and outputs were small in addition to the fact that technological progress was not as it is now, the environmental Urban outcomes at this time were not a big problem as it is now[3].

Hence, many have defined the sustainable city which can be concluded in the following concept: A Sustainable city is: the city of proximity, the city of compactness and the city of adaptability. [3]

Based on this definition, the sustainable city must be characterized by the following:

Short and convergent distances, where all activities are in a close vicinity of the accommodation.

High density with low-rise buildings, as far as possible, according to the concept of "low rise high density".

Adapting to the continuing developments of society and changing social, economic and cultural needs so that the urban structure is adaptable to these changes and easily integrating these functions.

In this sense, the elements of the cities' planning and the elements of the urban form were analyzed through their impact on the environment and the extent to which they contributed to the value of the urban footprint of the cities as shown in Fig.3:

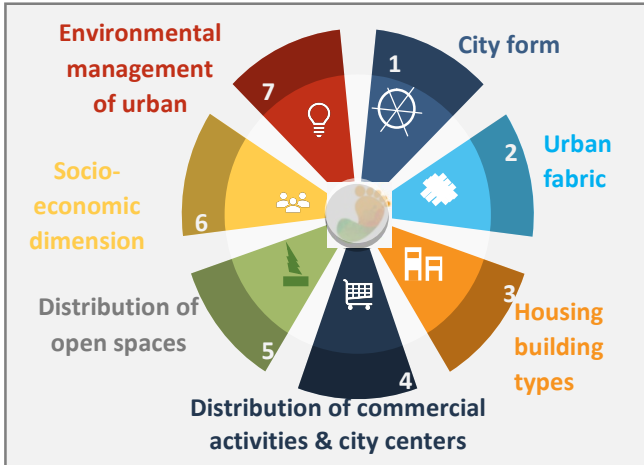


Fig.3. Urban components effect in Urban Footprint. [1]

Through the analysis the above-mentioned of the components of urban, it may be recommended to classify the effect of the patterns of each, knowledge of the least and most influential and ranking them in a hierarchy inserted from least to highest impact. Through analyzing the characteristics of each pattern of urban components, it was clarified that procedures for mitigation of urban footprint by addressing the methods of the design of each component and controlling the population and densities and distribution of services and activities, and the planning of housing patterns and how to control the behaviors of communities to move towards urban sustainability, as shown in Fig. 4. , so as to give insight into the safety or defect or corruption in The city's sustainability policy as a starting point for the arrival of the system to reduce the urban footprint of different cities through mitigation actions for planning decisions of the urban components.

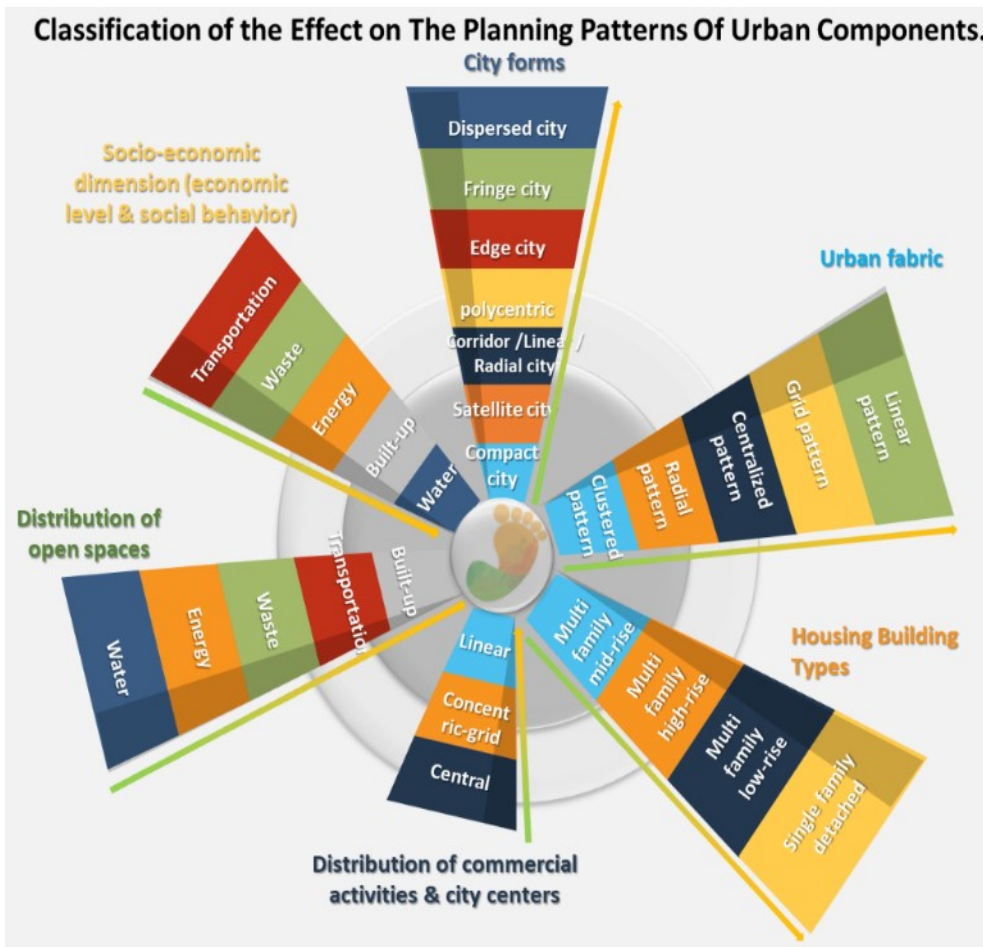


Fig.4. classification of the effect on the planning patterns of urban components. [1]

III. URBAN FOOTPRINT FOR CASE STUDIES

The study is conducted at the level of cities by applying the arithmetic equations for the urbanization of the previous

point, through application to several cities. This city are berlin city and Singapore.



Fig.5.City form for Berlin city. [8]

Berlin is Germany’s capital and the country’s most populous city, with some 4 million inhabitants within its city limits. The city’s economy is primarily based on services, encompassing various media and creative industries, tourism, life sciences and pharmaceuticals and conferences among other activities. [6] While Singapore is a prosperous city-state on the southern tip of Malaysia, with a population of about 5 million people. Its residents are on average the fourth wealthiest among the 22 cities in the Asian Green City Index, generating a GDP per person of 36,500 \$, US. Services account for about two-thirds of the city’s economic output, with industry making up just over a quarter. Singapore’s government faces challenges in maintaining the city’s economic success, however, including a lack of fossil fuel resources and a limited water supply. And Table 1. shows values of urban footprint elements for case studies.

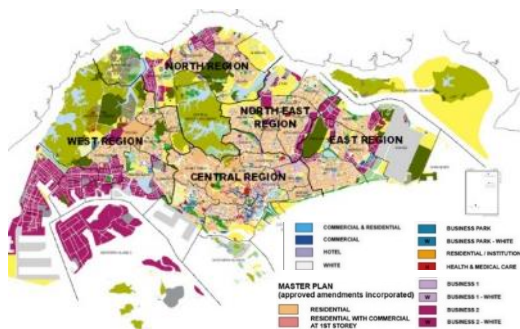


Fig.6. Singapore land uses. [9]

	city	berlin	Singapore
General data	Population	4120000	59300000
	Area	89.180 ha	71.99 ha
	GDP	21,561\$	\$36,5

Urban footprint elements	Transportation footprint	240.9	355.84
	Water footprint	13.4164	19.58
	Energy footprint	9.967	17.33
	Waste footprint	71.986	60.13
	Built-up footprint	3.4	13.1
	total urban footprint	339.67	465.952
	total urban footprint for capita	8.24	7.85

And The fig.7. shows the values of the urban footprint of the studied cities that Berlin city is the highest city while Singapore is the lowest, but in fact these values do not indicate the sustainability of the city but indicate the sustainability or impact of everyone’s ecological footprint in the city.

But if to see the impact of the real urban footprint at the city level, it find that the city of Singapore is the highest urban footprint at the level of urbanization followed by Berlin and in fact in the following order we find that this expression is more credible to express the impact of urban City and its various sectors On the environment and more reflective of the sustainability initiatives of each city. However, this difference in results indicates that the population in cities has an unquestionable impact on the value of the individual ecological footprint.

IV. MITIGATIONS FOR REDUCE THE URBAN FOOTPRINT FOR CASE STUDIES

According to the urban and ecological analysis of the case studies, as a result of those analyses, a model including some procedures to eliminate and control the urban footprint of these cities, based on their urban analysis, has been designed. The following table 2. shows the urban characteristics of the studied cities.

	Berlin	Singapore
population	4120000	59300000
Area	89.180 ha	71.990 ha
population density	108.956 person/ha	823.72 person/ha
structure density	1.347 ha	5.18 ha
City form	Radial	Compact
Fabric Pattern	clustered	grid
types of housing buildings	Multifamily low-rise	Multifamily high-rise
types of distribution of activities	Linear	Concentric grid
distribution of open spaces	Good (cover the city)	Mid (not cover the city)
GDP	21,561\$	\$36,500
efficiency of environmental management	good	good

Based on the previous table, a model including some procedures to eliminate and control the urban footprint of each city has been designed as stated in the following mitigations

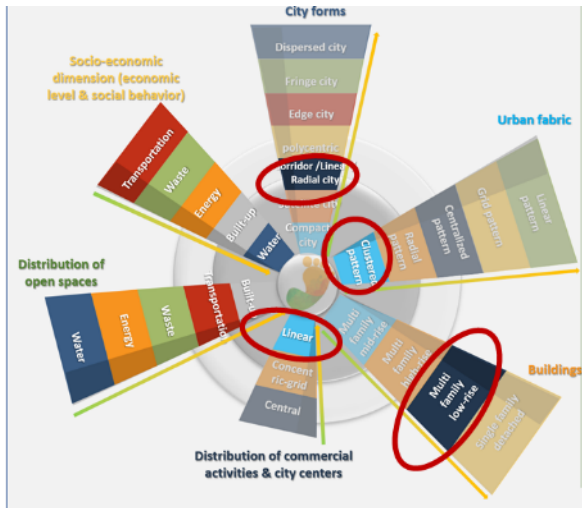


Fig.8. classification for urban characterizes for Berlin city.

4.1 Mitigation measures of urban footprint for berlin city[1]

- City form (radial city):

Mitigation measures are:

- Increasing the population density through the diversity of the joint residential buildings' patterns for reducing energy and construction materials.
- Increasing the structure density through the diversity of the joint residential buildings' patterns.
- Building cores for activities and services to totally cover the city and to be as a base to construct residential areas and to achieve the spatial distribution equity.
- Integrating the residential areas into services through applying the hierarchy services on the city's level to the neighborhood unit's level for reducing the access to services and for reducing depending on the central city.
- The diversity of the economic activities in the city and their integration with the residential areas.
- Supporting the city with infrastructure networks and perpendicular public transportation networks on the central networks in the city to have infrastructure networks that totally cover the city, support public transportation and reduce depending on private vehicles.
- Supporting the joint residential buildings' patterns for reducing energy and construction materials.
- Supporting the sustainable transportation systems and reducing the fossil fuel use and depending on the sustainable energy systems in transportation.
- Building more than one economic dimension away from the city center to reduce congestion.

- Urban Fabric (clustered pattern):

Mitigation measures are:

- Restructuring the services' distributions in the city to reduce the pressure on the city center and to overcome congestion.
- Promoting the joint housing patterns inside the city to be a reason for increasing the population and structure density with the urban pattern.
- Creating open spaces to increase the social connectedness among population.
- Spreading the open green areas into the residential areas for elevating the air quality.

- Housing Building Types (Multifamily low-rise)

Mitigation measures are:

- Achieving the ideal density on the city level.
- Supporting using the sustainable energy techniques and considering the designing basics to direct buildings to benefit from them and reduce the energy consumption in these buildings.
- Supporting constructing sustainable green infrastructure.
- Spreading the open green areas into the residential areas for elevating the air quality and achieving the ideal proportion per capita in the green areas.
- Using local construction materials with economic and ecological efficiency.
- Spreading the open green areas into the residential areas for elevating the air quality and achieving the ideal proportion per capita in the green areas.
- Making sure of the population's access to services and activities in the least distance as much as possible through the land uses' integration.

- Distribution of commercial activities (Linear)

Mitigation measures are:

- This pattern is in the distribution of services of the most flexibility and fairness in access to services it also enables the achievement of the progression of services commensurate with the needs of the population.

- Distribution of Open Spaces

- The hierarchy of the distribution of open spaces at the city level from the residential neighborhood to the city's territory .
- Combining open spaces with urban and residential blocks to reduce the distances of walking and improve air quality, based on the design basis for distributing open spaces based on different urban ranges.
- The use of sustainable irrigation methods that depend on recycling and reducing water wastage.
- Dependence on renewable energies in open-space energy consumption, especially solar energy.

- Reduce waste rates by activating sorting boxes and spreading behavioral awareness to deal with waste
- Waste recycling for open spaces.
- The sustainable design of building blocks in open spaces so as not to be a burden on the environment.

- *Socio-economic dimension (economic level & social behavior)*

Increasing the environmental awareness regarding the environment conservation importance and identifying consumption techniques and rationalization ways. As a result, the urban footprint decreases. This is achieved through awareness campaigns in schools and gatherings and through publicity means. The role of social participation should be activated in the awareness processes to consolidate the guiding consumption techniques to the environment with a less urban footprint.

4.2 Mitigation measures of urban footprint for Singapore [1]

City form (compact city):

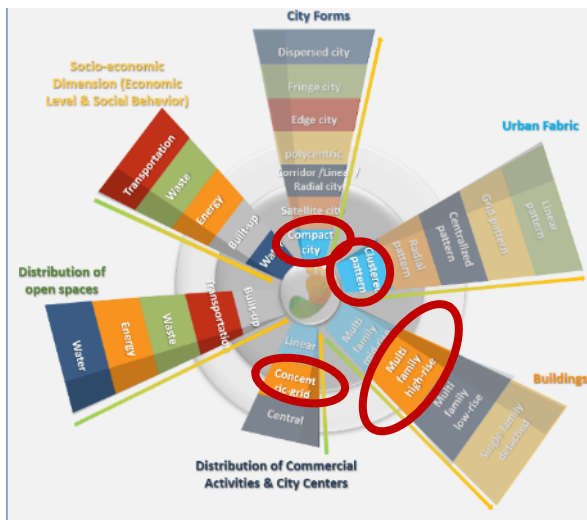


Fig.9. classification for urban characterizes for Singapore.

Mitigation measures are:

- Controlling the increasing population density through setting a standard for the population and urban density in the city. This can be achieved by controlling the inhabitants' 'number and the city size (block-structure areas and buildings' height) to overcome the congestion problem.
- The diversity of the economic activities in the city and their integration with the residential areas
- Supporting the green infrastructure networks for promoting the sustainable city.

- Supporting the sustainable transportation systems and reducing the fossil fuel use and depending on the sustainable energy systems in transportation.
- Increasing the green areas in the city and integrating them with the land uses in each residential area. This can be achieved through setting a maximum standard for having green areas and improving the air quality

- *Urban fabric (clustered pattern)*

Mitigation measures are:

- Restructuring the services' distributions in the city to reduce the pressure on the city center and to overcome congestion.
- Promoting the joint housing patterns inside the city to be a reason for increasing the population and structure density with the urban pattern.
- Creating open spaces to increase the social connectedness among population
- Spreading the open green areas into the residential areas for elevating the air quality.

- *Housing building types (Multi Family High-rise)*

Mitigation measures are:

- Achieving the ideal density on the city level.
- Supporting using the sustainable energy techniques and considering the designing basics to direct buildings to benefit from them and reduce the energy consumption in these buildings.
- Supporting constructing sustainable green infrastructure.
- Spreading the open green areas into the residential areas for elevating the air quality and achieving the ideal proportion per capita in the green areas.
- Using local construction materials with economic and ecological efficiency.
- Spreading the open green areas into the residential areas for elevating the air quality and achieving the ideal proportion per capita in the green areas.
- Making sure of the population's access to services and activities in the least distance as much as possible through the land uses' integration.

- *Distribution of Commercial Activities (Concentric-grid)*

Mitigation measures are:

- It is necessary to work longitudinal axis in vertical angles with each other in the form of barbed and when the growth of this pattern, the services grow to a scale commensurate with the region to achieve the required gradation of services based on the needs of the population to achieve justice in the distribution and access to services

- *Distribution of Open Spaces*

- The hierarchy of the distribution of open spaces at the city level from the residential neighborhood to the city's territory .
- Combining open spaces with urban and residential blocks to reduce the distances of walking and improve air quality, based on the design basis for distributing open spaces based on different urban ranges.
- The use of sustainable irrigation methods that depend on recycling and reducing water wastage
- Dependence on renewable energies in open-space energy consumption, especially solar energy
- Reduce waste rates by activating sorting boxes and spreading behavioral awareness to deal with waste
- Waste recycling for open spaces
- The sustainable design of building blocks in open spaces so as not to be a burden on the environment

- *Socio-economic dimension (economic level & social behavior)*

Increasing the environmental awareness regarding the environment conservation importance and identifying consumption techniques and rationalization ways. As a result, the urban footprint decreases. This is achieved through awareness campaigns in schools and gatherings and through publicity means. The role of social participation should be activated in the awareness processes to consolidate the guiding consumption techniques to the environment with a less urban footprint.

V. RESULTS AND CONCLUSION

The characteristics of a sustainable city as reached are: Compact city, clustered pattern, multifamily midrise, linear pattern of distribution commercial activities. By achieving the following points:

- Sustainable land use planning and integration with transport networks to cover the city.
- There must be strong environmental management and The public is accepted to share responsibility, This is done through cooperation between all government institutions and Consideration of long-term planning with continued follow-up .and the development of strict laws and legislation that criminalizes infringement of the environment.
- Raise the quality of life in the city by providing a healthy and safe environment to achieve a comfortable and dignified life that provides all the services needed by the population, and the development of marginalized social sectors, and create public spaces vibrant.
- Building a strong economic base in the city and investment in many sectors such as resources, infrastructure and services.
- Directing the city towards the green direction through improving air quality, replacing traditional fuel sources,

preserving green areas from urban sprawl and encouraging the use of bicycles and walking.

- Biodiversity conservation through measures against greenhouse gases, conservation of natural resources, study of energy demand and promotion of expanded use of renewable energies.
- Flexibility in the exploitation of resources and recycling and investment in the areas of waste is a national resource.
- Raise the environmental awareness of the city and raise the cultural and social level through raising the educational and knowledge level in the city.
- Supporting knowledge-based and smart technology-supported economic sectors by building a robust database, by supporting projects and innovations, introducing information systems on the road, developing technologies and adapting technology to help achieve sustainability and maintain environmental balance.
- Maintaining the identity of the city and deepen the belonging of the population.
- Benefit from technological advances in the sustainability of urban communities through intelligent transport systems, sustainable green infrastructure, building intelligence and sustainable urban spaces through the integration of urban intelligence and the sustainability of cities.

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