





Sustainable Transportation and Urban Sustainability

Ashwaq Fadhel Muhkaber Alomari^{1*} , Tahrir Taki Ali Almusawi¹ , Lina Kifah Kadhum¹ , Zainab Qahtan
Abd Alkhayat² 

¹ Architecture Engineering Department, College of Engineering, Mustansiriyah University, Baghdad, Iraq

² Sustainable Process Engineering Centre (SPEC), Department of Chemical Engineering, University of Malaya, Kuala Lumpur, Malaysia

*Email: ashwaqalomare@uomustansiriyah.edu.iq

Article Info		Abstract
Received	21/04/2024	<p>The twenty-first century is witnessing the phenomenon of the expansion of the urban fabric in large areas, accompanied by a lack of public transport services, dependence on cars, decrease in dependence on walking and cycling, and the loss of landscapes, which affected the quality of urban life, and the development has become a significant concern throughout the world. The objectives of the transport-related sustainability concept are to reduce emissions of gases and noise, reduce the consumption of natural resources, reduce levels of land exploitation, increase traffic safety, and enhance the ability to reach the required places. The research problem is represented in the knowledge gap related to explaining the role of transport in achieving urban sustainability, where the research assumes that achieving urban sustainability is through sustainable transport. Hence, the study aims to reach a theoretical framework that clarifies the indicators of sustainable transport that achieve urban sustainability. To test the hypothesis, the abstracted theoretical framework was applied to a model of an Arab city (Masdar City) and a model for a global city (Shanghai City) in China.</p>
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1. Introduction

The study of transport occupies a prominent role in society's economic, social, and cultural reconstruction. It facilitates the exploitation of the available natural and human resources, increasing production quantity and quality. Therefore, many studies have tried to set a definition for this sector. The concept of transportation can be defined as a service that was found to connect production centers and populated areas or consumption centers. Transport is also described as moving goods and commodities from their points of production or selling to their consumption points with the required quantity, specified time, and reasonable cost. Transport was also defined as the tool through which it is possible to expand the market and exploit human and material resources that were not previously used in the direction of increasing production, improving its quality, and contributing to the movement of goods and labor to places where they are more beneficial [1], [2].

Transport types could be determined according to the classifications below:

- Classification according to the field of operation: It includes three types:
 - Internal transport is within the scope of the state.
- External (international) transport is a transit between countries (outside the scope of one country).
- Urban transport, which is transportation within city borders, is what this research means [3].
- Classification according to the path: It includes three types:
 - Water transport (river and marine).
 - Land transport (roads, railways, tunnels, buses, vehicles, pipes ...).
 - Air and joint transport (airplanes, airports, sea airplanes) [3].
- Classification according to the driving force: It includes three types:
 - Muscular (bicycle, carriage) or animal (animal-drawn cart).
 - Natural forces include wind (sailing ships) and water currents in rivers.
 - Energy (fuel, electricity) [3].
- Classification according to the quality of service: It includes two types:
 - Specialized: to transport passengers only or goods only.

- Joint: transporting passengers and goods or air and land transport together [3].
- Classification according to the level of service: It includes two types:
 - Speed (normal and fast).
 - Regularity of service (permanent, on-call) [3].
- Classification according to the nature of the means of transport: It includes two types, namely, public transport and private transport. Specialists in urban transport planning are interested in this classification because public and private transport means are among the most influential elements in the transport process in general and urban transport, that is, transport within cities in particular [3].

The research problem is represented in the knowledge gap related to explaining the role of transport in achieving urban sustainability. The research assumes that achieving urban sustainability is through sustainable transport, so it aims to reach a theoretical framework that clarifies the indicators of sustainable transport that achieve urban sustainability.

2. Sustainability

Sustainability is usually defined as the reduction of the use of natural resources, but this definition is a limitation of the term. Instead, the meaning extends to a more expansive expression of achieving a suitable human environment that cannot continue without integration with ecosystems and the natural environment. The most important thing when defining sustainability is the context to which the definition is directed, and it is more important than choosing and refining words. Sustainability is not about integrating environmental, social, and economic issues or "about" improving the quality of life. Still, it is about preserving something and providing it with the causes of life and continuity. Therefore, to understand the idea of sustainability, it is necessary to define the goal that we seek to work on "... improving the quality of human life within the available resources in the ecosystem," as stated in the International Union for the Protection of Nature and Natural Resources for sustainability [4]. For some people, sustainability may seem to be an approach to nostalgia and a pure, simple lifestyle, while the opposite is true. Sustainability is a call to adopt a new way of thinking and dealing more responsibly with the surrounding environment. However, this does not mean that there is a specific method to be achieved because each society or environment has spatial and civilization privacy and has needs and requirements stemming from this privacy and the available capabilities. So, sustainability means consciously dealing with the environment and natural resources, not just a ready formula or recipe for survival. Sustainability is defined as a concept that stems from a human theory calling for concern for the future of mankind and then preserving the environment that gives continuity to humanity to achieve environmental, social, and economic sustainability and thus enhance life in a way that allows others to meet their needs in the present and future [5].

It is also known as dealing with natural self-systems (ecological) and technological systems with the peculiarity of the place in creating an urban fabric or building adapted to the surrounding environment. The main idea of sustainability is based on maintaining balance and re-balancing, as it is an approach that aims to balance the economic and environmental impacts now and in the future. Sustainability requires a balance between environmental factors and social and economic considerations, and this matter is achieved in many applications, including architecture [4]. Transportation is one of the biggest environmental problems in the city, and sustainability reduces both mobility and passivity of traffic. Sustainable urban form or sustainable city encourages walking, cycling, public transportation, and efficiency in cohesion that promotes social interaction and rapid access to various services and reduces costs [6].

It is the transportation of services and people with economic, environmental, and social costs that are not harmful to the environment, as well as affordability and achievement of a balance between the needs of mobility and safety with the needs of access and the quality of the environment. Renewable energy sources support sustainable transport and do not emit greenhouse gases. It reduces land use, ensures fair accessibility to the community, and promotes a good and healthy environment to improve the quality of life for all at affordable costs. This promotes a vibrant community and a strong economy, includes measures aimed at reducing the need for mobility, and provides conducive conditions for the efficiency of energy, environment, and forms of urban transport. The design of land use has a major role in achieving these goals [7]. Sustainable transportation is a concept that can have less impact on the environment, including activities with no mechanical model, such as walking, cycling, and transportation, alongside all eco-friendly transits, such as car sharing. The aim is to ensure basic mobility and access without affecting the quality of life for future generations, and a safe, healthy, cost-effective environment also helps reduce pollution, according to the American Institute of Transportation [8].

Another definition of sustainable transportation is that it is a concept that fulfills and provides efficient and convenient mobility to achieve social, environmental, and economic goals for present generations in a way that benefits all [9],[10]. Transportation has significant economic, social, and environmental impacts, which are essential sustainability factors. Sustainability is a paradigm shift in transportation planning. In terms of assessing transportation, it is shifted to include people's ability to obtain the necessary goods and services that affect the impacts, which include land use, mobility, and delivery services; for example, congestion can be reduced through improved land use and accessibility or telecommunications, in addition to accommodating more vehicle traffic [11].

3. Priorities of Transportation Methods Adopted in Cities

The general directions for sustainability call for a trend to encourage pedestrian movement. By prioritizing pedestrians, bicycle use, and public transport, we can increase accessibility

to services without relying on private transportation. This reduces congestion, pollution, and energy consumption, as shown in Fig. 1.



Figure 1. Designing pedestrian and environmentally friendly transport means sustainable housing.[11].

The restructuring of the transport system and the development of directed transport need prior planning studies and policies that take into account road planning, bus destinations, and their locations while linking pedestrian traffic with them and with local destinations starting from the city level to the local level with a study of regional interconnections, so it is preferable to increase short trips and reduce the long-distance trips, that is, building a hierarchy of day trips [12]. The methods of restructuring public transport systems can contribute to shaping the urban organization of cities importantly, and these methods have formed an important element in the efforts to restructure cities, as is the case in each of the cities of Curitiba in Brazil and Portland in the United States. The heavy rail systems constructed in major cities with high population density, usually as metro systems and established in central areas, are also important to support effective link operations between central regions and their important role in establishing links between central and remote areas. Besides, railway systems usually connect outer areas to city centers, while light bus systems provide good connections within central areas and between these areas, secondary sites, and suburban routes. They constitute potential points for implementing more focused development processes. Still, these operations will depend on how these services are used, in addition to their dependence on how these stations are organized and provided [13].

4. Principles Basic of Sustainable Transport

4.1. Secure Access

It is essential to have access to different services for social and economic benefits. This is important for the well-being of the society. Transportation is considered the basic service that should be provided for diverse communities, and different transportation options should be provided for all people. [14].

4.2. Achieving social justice

Transportation systems are an essential component of the national economy. They contribute to the advancement of society and develop well-being in general. It is important to provide accessible transportation. It should meet the needs of all people in different income groups in both rural and urban areas [14].

4.3. Integrated Transportation Planning

Integrated transportation planning could be achieved by ensuring the coordination process between all parties of the public and private sectors and stakeholders in planning, implementing, and operating transport systems. Decisions related to transportation should be integrated with the environment, health, energy, and land use in urban areas. In addition to making decisions related to the transportation process open and comprehensive, educating the public about the different choices of transportation and their inflation will encourage them in the decision-making process for the future needs of society. This addresses their occurrence and leads to many cost savings [8].

Integrated transport planning controls growth, reduces urban sprawl, and provides a more homogeneous distribution of land use in urban areas, which leads to a reduction in the demand for transportation, especially for private car trips, by making the beginning and end of the trip confined to the same area, through planning transportation systems that achieve efficiency in the use of land and other natural resources and designing transportation systems that have pedestrian and bicycle paths in urban areas, in addition to providing alternatives to private cars for attractive and safe public transport, in addition to integrating transportation modes, whether for travelers or goods to increase the efficiency of the movement of goods, in addition to providing a wide range of transportation options, preserving historical and archaeological sites, reducing noise and sound pollution when planning, designing and building transport networks. It is important to prioritize environmental considerations in the planning process to reduce environmental pollution, reduce the impact of means of transportation on the environment, and ensure compliance with the conditions for preserving biological diversity [14].

4.4. Health and Safety

Safety conditions must be met for the public health of the public transportation system in terms of physical and mental aspects. This also leads to a general improvement in the quality of life within society [14].

4.5. Environmental Quality

Human activities contribute to the destruction or consumption of natural resources at rates that exceed the ability of nature to regenerate or replace them. It also increases pressure on the environment and its limited capacity to absorb waste. In this area, efforts must be made towards developing transport systems that adhere to environmental considerations, such as ensuring that the rate of the use of renewable resources does not exceed their renewal rates, the use of renewable resources within the minimum limit, and the prevention of pollution, as transportation needs must be met without generating emissions that threaten public health, global climate, biodiversity and the integrity of basic ecological processes, and waste reduction by reducing emissions, residues and surface pollutants (fresh and saltwater and groundwater) especially related to air transport, in

addition to limiting the waste generated from changing means of transport, vehicles and ships that have ended or stopped working and replacing them with a new generation and the infrastructure related to them, by reducing the processes of change, reuse or recycling and ensure the existence of emerging management is important for the transportation system. It responds effectively to accidents that result in environmental crises, such as oil spilled at sea from super tanks. It is also essential to reduce fuel consumption and emissions through efficient management. The ongoing exploration of scientific research development to find alternative innovative technologies is necessary to enhance efficient transportation to protect the environment and encourage the use of renewable energy sources. [14]. Table 1 shows the theoretical framework for sustainable transport indicators.

Table 1. Theoretical framework for sustainable transport indicators

Main terms	Basic indicators	Secondary indicators
The ease of access.	Secure access Alternatives	<ul style="list-style-type: none"> • Ensure access to people, goods, and services. • Variety of transportation options
Achieving social justice.	Life Quality Justice	<ul style="list-style-type: none"> • Improving the quality of life • Achieving justice between different social classes
Integrated transport planning.	Sectors The integrity Future forecasting Urban development Road design Transport means Acoustic pollution Environmental pollution	<ul style="list-style-type: none"> • Coordination between all parties of the public and private sectors • Integration of transport-related decisions with the environment, health, energy, and land use • Future forecasts of expected social or environmental impacts • Concentrate growth and reduce urban sprawl. • Designing pedestrian and bicycle roads and safe public transportation • Integration of modes of transport, whether for travelers or goods • Reducing noise and acoustic pollution • Reducing environmental pollution and reducing the impact of transportation on the environment
Health and Safety	Public health Social welfare Health Quality	<ul style="list-style-type: none"> • Not harmful to public health (physical and mental) • It brings social welfare and safety to all people. • Improving the quality of life in the community
The environmental quality	Resources use Preventing pollution Wastes Emergency management Fuel consumption Scientific development	<ul style="list-style-type: none"> • Ensure that the rate of utilization of renewable resources • Filling transportation needs without generating emissions • Waste reduction • Ensure the existence of emergency management within the components of transport systems. • Reducing fossil fuel consumption and emission • Keeping pace with the development and scientific research • Expenditure of sustainable transportation systems
The economic efficiency	Transport costs Total costs Job opportunities	<ul style="list-style-type: none"> • Achieving the standard of equality and fairness in • Providing employment opportunities

4.6. Economic Feasibility

The expenditures of sustainable transportation systems must be cost-effective. Transportation decision-makers must create a system for calculating the total and integrated costs so that it reflects the social, economic, and environmental reality of the total costs, including the long-term costs, to achieve the standard of equality and fairness in payment by the users of transportation means compared to the total costs. The economic impacts, jobs, and benefits of reconfiguring transportation systems must also be considered [14]. Table 2 shows the

theoretical framework for indicators of sustainable transport that achieve urban sustainability. To make transportation more environmentally, socially, and economically sustainable, the following urban transport strategies must be followed [15]:

- Managing the existing road infrastructure to improve traffic flow and slow speeds around densely populated areas.
- When evaluating new road projects, pay attention to the impact of traffic on non-motorized transport and the environment.

- Imposing fees on land developers to finance new roads, applying traffic congestion pricing, and charging the full costs of parking the cars in the car parks.
- Improving the ability of public transport to continue by giving buses a priority in residential areas, providing adequate financing, and improving operating efficiency through organized competition.
- Providing safe lanes and bicycle paths to protect pedestrians.
- Providing mass transit based on railways in large cities with high transportation demand wherever it can serve low-income users.

It was stated in the Global Report on Human Settlements, 2009, to achieve sustainable cities, the development of a sustainable

transportation system to reduce the harmful environmental impacts resulting from reliance on vehicles that run on traditional fuels, and that strategic urban plans related to infrastructure development processes can contribute to promoting the emergence of better forms of urban expansion that are concentrated around places of the spread of public transport facilities. In this context, it is imperative to highlight the importance of linking the most prominent investment projects in infrastructure and mega projects with strategic planning processes. Furthermore, any infrastructure plan represents an essential component of strategic urban plans. Moreover, the links between the fields of transport and land use are the most important within this framework, and they should take precedence. Other infrastructure facilities, including water and sanitation, can be followed [1].

Table 2. The theoretical framework for indicators of sustainable transport that achieve urban sustainability

Main terms	Basic indicators	Secondary indicators	Urban sustainability		
			Environmental	Economic	Social
The ease of access.	Secure access	• Ensure access to people, goods, and services	•	•	•
	Alternatives	• Variety of transportation options	•	•	•
Achieving social justice.	Life Quality	• Improving the quality of life	•	•	•
	Justice	• Achieving justice between different social classes	•	•	•
Integrated transport planning.	Sectors	• Coordination between all parties of the public and private sectors	•	•	•
	The integrity	• Integration of transport-related decisions with the environment, health, energy, and land use in urban areas	•	•	•
	Future forecasting	• Future forecasts of expected social or environmental impacts	•	•	•
	Urban development	• Concentrate growth and reduce urban sprawl.	•	•	•
	Road design	• Designing pedestrian and bicycle roads and safe public transportation	•	•	•
	Transport means	• Integration of modes of transport, whether for travelers or goods,	•	•	•
	Acoustic pollution	• Reducing noise and acoustic pollution	•	•	•
	Environmental pollution	• Reducing environmental pollution	•	•	•
	Public health	• Not harmful to public health (physical and mental)	•	•	•
	Social welfare	• It brings social welfare and safety to all people.	•	•	•
Health and Safety	Health Quality	• Improving the quality of life in the community	•	•	•
	Resources use	• Ensure that the rate of utilization of renewable resources does not exceed their renewal rates.	•	•	•
	Preventing pollution	• Filling transportation needs without generating	•	•	•
	Wastes	• Waste reduction	•	•	•
	Emergency management	• Ensure the existence of emergency management.	•	•	•
	Fuel consumption	• Reducing fossil fuel consumption and emissions	•	•	•
	Scientific development	• Keeping pace with the development and scientific research	•	•	•
	Transport costs	• Expenditure of sustainable transportation systems is cost-effective	•	•	•
	Total costs	• Achieving the standard of equality and fairness in payment	•	•	•
	Job opportunities	• Providing employment opportunities	•	•	•
The environmental quality					
The economic efficiency					

5. Urban sustainability

The world witnessed the end of the twentieth century and the beginning of the twenty-first century when a global movement was made to make the city green. This movement, known in various ways as urban ecology, eco-cities, or sustainable cities, is looking for more in-depth and more satisfying answers to urban issues today than better technology can provide. It also reconciles the environmental, economic, and social aspects, thus creating a valid relationship between these three poles. It is characterized by being economically effective, socially equitable, and environmentally possible, as it respects natural resources and ecosystems, supports life on earth, and guarantees the economic aspect without forgetting the social goal, which is manifested in combating poverty, unemployment, inequality, and the search for justice [16]. Urban sustainability is one of the most essential pillars of developmental trends aiming to achieve sustainable development. Many areas that accommodate the concept of sustainability (in its comprehensive sense) appear within the urban environment with its physical content (represented by masses and spaces) and invisible (immaterial) content (represented by society and related considerations) [17]. Sustainability is considered, in its general framework, an environmental concept. It was transformed into a comprehensive development concept considering three main axes: the social axis (human), the economic axis, and the environmental axis. This concept means using energy and natural resources in the urban area and achieving a harmonious and compatible environment with nature that is concerned with the quality of human life within the ecosystem. Urban sustainability emphasizes balanced geographical distribution, distribution of other opportunities, economic and social development, and preservation of natural diversity while using sustainability in all its components as essential aspects for the continuation of human life, as shown in Fig 2, indicated four principles for achieving urban sustainability, namely [18]:

- Future: Focusing on humanitarian activities according to a future outlook.
- Justice: achieving environmental and social justice for the current and future generations.
- Participation: in making decisions.
- High density: Adopting high structural density.

The definition of urban sustainability indicates a need to work in several areas. The first is that cities work to reduce the environmental footprint (the ecological footprint) to be more successful in sustainable development. The second field focuses on the wise management of resources, significantly depleted ones, investment in human capital, and increasing economic production, which are the keys to wealth sustainability in urban areas. The third aspect calls for improving environmental health by reducing pollution and preserving resources.[18].



Figure 2. Urban sustainability indicators (Researchers)

6. Case studies

Global and Arab Experiences to Apply Sustainable Transport That Achieves Urban Sustainability

6.1. The experience of China City, shanghai (development of Shanghai, China)

Shanghai is the fifth largest city in the world and is a mesmerizing city bustling with life. With a population of about 13 million in 1990, it aspires to be a significant force in China's financial world and trade hub. For one reason or another, the city is rapidly moving towards following the European style and automating its nearly seven million bicycles. At the beginning of the twentieth century, several office complexes were established on the border of the wooded riverbank where the port wharf, which became the first disaster to befall the city, switched to mobility by cars. The rows of beautiful trees have been removed and replaced by riverside parking lots to make way for spectacular river views from the city. The Huangpu River is 1 km wide, and merchant ships travel to and fro of every shape and size. On this river is Pudong, a vast developed area covering thousands of hectares, part of which is the site of the new Lu Zia Sui, which reflects the heart of the old city and has an area of 1.5 square kilometers that was recently connected to the city by two of the world's longest bridges and a network of tunnels. Despite the urban culture enjoyed by the city, this project was attributed to the commercial and cultural diversity of the old city. In return, this new area for global office users is designed to be accessed by car. Traffic engineers have planned the massive, predicted traffic at peak hours by designing huge road networks and a corresponding network of bridges and underpasses.

The roads for this site are three times that of New York, with less than half the density of its buildings, where about a third of the site has been designated for buildings whose lands are

separated by a group of highways. As for Rogers and Co., the leading designers, they worked to prevent the creation of a neighborhood for the money separated from city life. In return, they encouraged the idea of Lu Zia Sui as a diversified commercial and residential neighborhood, improved with a network of open spaces and parks, and is accessed mainly by public transportation so that this area can be a cultural focus for all Pudong, which protects the region from the fluctuations of conditions and economic crises in the global office market, where areas designated for individual development go bankrupt (development in one location only). [18]. Besides, the designers aim to create sustainable communities and pleasant neighborhoods that consume half the planned energy and reduce their environmental impact. The size proportion between the city center and the entire urbanized area, population and development densities, mixed-use land, post-industrial public spaces, and the city's natural heritage. [19]. Environmental and transportation engineers have found that mixed-use activities and uses, and an emphasis on public transportation use, reduce the need for car trips and, thus, to the streets by about 60%. The designer expanded pedestrian road networks away from streets, bike paths, shopping areas, and wooded paths. The network of public spaces has also opened the way for cultural activities to open in the city. All this has been carefully woven with the public transport system to create a single interconnected network of public spaces and movement that starts from the door of the house and leads at the end by car parks, buses, or trams to stations and airports. The existence of a flexible chain of different modes of transportation, such as safe docks, high-speed trains, and air travel, greatly facilitates movement and transportation for the entire population. The central square is located in the heart of Lu Zia Sui, from which the boulevards spring and connect the concentric circular roads, as the outer road includes only pedestrian and bike roads, then trams and buses. The interior contains main car lanes, as shown in Fig. 3 and Fig. 4. The general objective is to determine the daily needs of society, including public transportation, through comfortable walking distances away from entering traffic. As shown in Fig.5, with an average of 80,000 people in each, six adjacent neighborhoods were concentrated around each of the main transportation switches connected to the leading public district network [19].

Each neighborhood has its distinct personality, and all are within a 10-minute walk from the central square, the river, and the nearby communities. Offices, places, commercial stores, and cultural centers congregate near the stations, while residential buildings gather around the square and beside the river, as well as hospitals, schools, and other buildings. The interconnectedness of the buildings has shaped streets and squares, with several separate streets and sites [19]. Work has also been made to change the heights of the buildings so that daylight gives life to the streets, squares, and wooded roads despite the high building density, as in Fig.6. The diversity and variation of the roofline increased the efficiency and perfection of the views, penetration of daylight into the buildings themselves, and reduced the need for energy and industrial lighting [19]. Table 3 shows the indicators test for the global project of Shanghai City.

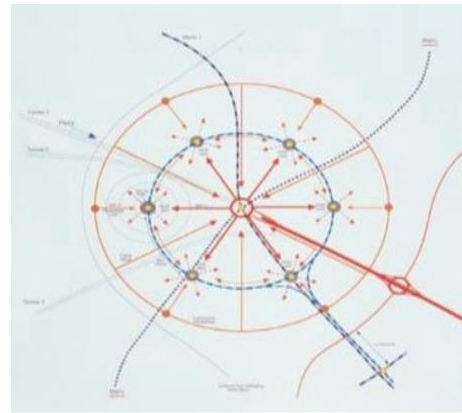


Figure 3. The central Lu Zia Sui Square [20]



Figure 4. The central square [20].

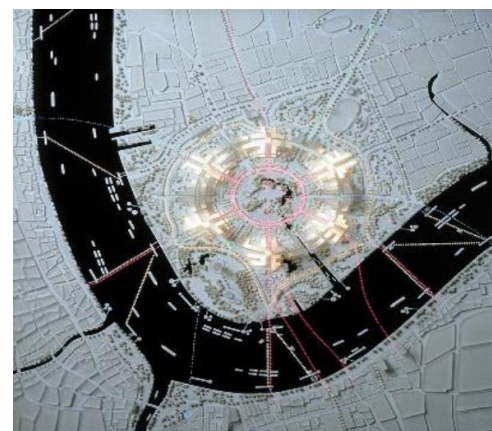


Figure 5. The concentration of six contiguous neighborhoods around each of the main transportation switches

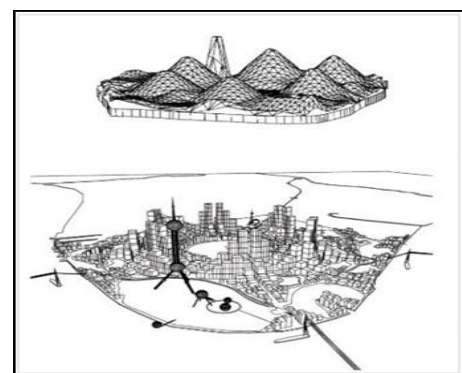


Figure 6. The adjacent neighborhoods and traffic in them

Table 3. Indicators test on the global project of Shanghai City

Indicators	Terms	Project description
The ease of access.	<ul style="list-style-type: none"> • Ensure access to people, goods, and services. • Variety of transportation options 	A flexible chain of different modes of transportation greatly facilitates movement transportation for all residents.
Achieving social justice.	<ul style="list-style-type: none"> • Improving the quality of life • Achieving justice between different social classes 	Each neighborhood has its distinct personality and is located within a 10-minute walk of each central square, river, and nearby neighborhoods.
The integrated planning of transport	<ul style="list-style-type: none"> • Coordination between all parties of the public and private sectors • Integration of transport-related decisions with the environment, health, energy, and land use in urban areas • Future forecasts of expected social or environmental impacts • Concentrate growth and reduce urban sprawl. • Designing pedestrian and bicycle roads and safe public transportation • Integration of modes of transport, whether for travelers or goods • Reducing noise and acoustic pollution • Reducing environmental pollution 	The central square is located in the heart, and the boulevards emanate from it, connecting the concentric circular roads, as the outer road includes pedestrian and bike roads only, the second trams and buses, and the interior main car lanes. The general goal is to determine the daily needs of society, including public transportation, through comfortable walking distances away from getting into traffic. Six adjacent neighborhoods, with an average of 80,000 people, were concentrated in each of them, around each of the main transportation switching places connected to the leading public network. River and nearby neighborhoods, offices, commercial areas, and cultural centers congregate near the stations, while residential buildings clustered around the square and by the river, in addition to hospitals, schools, and other buildings. The connection of buildings with each other formed streets and squares with several separate streets and sites. Work was also done to change the heights of buildings so that daylight gave life to the streets and squares.
Health and Safety	<ul style="list-style-type: none"> • Not harmful to public health (physical and mental) • It brings social welfare and safety to all people. • Improving the quality of life in the community 	Wooded roads, despite the high building density and the diversity and change of the roofline, increased the efficiency and perfection of views and penetration of daylight into the buildings themselves and reduced the need for energy and industrial lighting
Environment quality	<ul style="list-style-type: none"> • Ensure that the rate of utilization of renewable resources does not exceed their renewal rates. • Filling transportation needs without generating emissions that threaten public health and the global climate • Waste reduction • Ensure the existence of emergency management within the components of transport systems. • Reducing fossil fuel consumption and emissions • Keeping pace with the development and scientific research 	The network of public spaces has opened the way to the creation of cultural activities in the city. All of this has been carefully woven with the public transport system to create a single interconnected network of public spaces and movement that starts from the door of the house and leads, in the end, by car parks, buses, or trams to stations and airports.
The economic efficiency	<ul style="list-style-type: none"> • Expenditure of sustainable transportation systems is cost-effective. 	Encourage the idea of Lu Zia Sui as a diversified commercial and residential neighborhood, improved with a network of open spaces and positions, and is accessed mainly by public transportation so that this area can be a cultural focus for each Pudong, which protects the region from the fluctuations of conditions and economic crises Besides, designers aim to create sustainable communities and pleasant neighborhoods that consume half of the planned energy and reduce their impact on the environment.

6.2. Emirates Arab example: Masdar City, Abu Dhabi, in the United Arab

Masdar City is located in the heart of the desert, and this city was designed to be the most sustainable city by the architectural design firm LAVA; located near Abu Dhabi (17 kilometers to the south), which is completely dependent on renewable

energy. Emirati cities live in an environment free of carbon and waste, experiencing a new boom. It is directed towards focusing entirely on solar energy, with the solar power plant located in its center; in addition to the wind farms that supply it with energy, this city aims to be free of carbon emissions and is also an incubator for companies based on clean technology, starting

from water to trash, everything in the city is measured and monitored to become a source of information. The city is pedestrian-friendly as cars do not enter it. It is experimenting with a network of electric personal vehicles that run six meters under the city streets, as shown in Fig.7 [20].

In Masdar City, 30% of the area will be allocated for housing, 24% for the business and research area, 13% for commercial use, including light industries, 6% for the Masdar Institute for Science and Technology, 19% for services and transportation, and 8% for cultural events. Approximately 40,000 people are expected to live in this city, while nearly 50,000 others visit it every day who will go to work. Critics believe this city will become a new province for the rich and wonder if it is possible to establish cities similar to this city in other countries. The construction area is about 6 km², and the built area is about 50% of the total area. The population density is 140 people/hectare, and the average height of buildings is 4-6 floors; the maximum height is 40 meters. For the width of the streets, the central street was 25 meters, the maximum width of public roads was 14 meters, and the side streets were 8.5m. All economic and environmental aspects were addressed during the city's planning and urban engineering process, with a special focus on sustainability to achieve the city's goal of becoming one of the most sustainable cities in the world and a wonderful place to live and work. Fig.8 shows a public space in the city. The design should be considered, particularly facilitating energy generation where possible (such as the angle and shape of the roof) to reduce the consumption of electricity and water, and so on. We can define the city through the following salient features:

- Optimally oriented, the city and the road network were directed on a southeast-northwest axis to provide shadows on the road throughout the day, reducing the walls' acquisition of thermal glare and facilitating the flow of cold breezes around the city.



Figure 7. A perspective of the Masdar city, noting the direction of the city and the road network

- In a vibrant urban area, public spaces are considered to be of the same importance as buildings. Several methods have been followed to activate these spaces, and thus, the city has become a place where roads and squares facilitate interaction between residents and visitors.



Figure 8. The general space of the city

- In an integrated city, there are no separate areas for companies and culture; the university and traditional business elements are integrated into the heart of society, as are entertainment facilities so that residents and those traveling to the city can find their needs close to them. Fig.9 shows the city's mixed-use and diversity.



Figure 9. Mixed-use in the city

- Low buildings and high density are pivotal aspects of an urban society that does not consume much energy for various reasons, including using less energy in transportation (between and within buildings) and less heating/cooling loads.



Figure 10. Traveling on foot due to the short travel distances

- Walking travel is encouraged by close distances between buildings to provide shade and a pleasant environment on the streets, as shown in Fig.10. Masdar City is designed to provide a high-quality life with minimal negative impacts on the environment, which confirms that meeting the

requirements of environmentally friendly life is not difficult and can contribute to providing a commercially rewarding business model. Table 4 shows the test of indicators in Masdar City.

Table 4. Test of indicators on Masdar City

Indicators	Terms	Project description	Figure The
The ease of access.	<ul style="list-style-type: none"> • Ensure access to people, goods, and services. • Variety of transportation options 	A mixed-use city that facilitates universal access with multiple transportation options and provides environmentally friendly life requirements.	high quality of life in Masdar City
Achieving social justice.	<ul style="list-style-type: none"> • Improving the quality of life • Achieving justice between different social classes 	Masdar City is designed to provide a high quality of life with minimal negative environmental impacts.	
The integrated planning of transport	<ul style="list-style-type: none"> • Coordination between all parties of the public and private sectors • Integration of transport-related decisions with the environment, health, energy, and land use in urban areas • Future forecasts of expected social or environmental impacts • Concentrate growth and reduce urban sprawl. • Designing pedestrian and bicycle roads in urban areas and providing alternatives to private cars with attractive and safe public transportation • Integration of modes of transport, whether for travelers or goods, to increase the efficiency of the movement of goods • Reducing noise and acoustic pollution • Reducing environmental pollution and reducing the impact of transportation on the environment 	<p>Low buildings and high density are two aspects of pivotal importance in an urban society that does not consume much energy for various reasons, including using less energy in transportation (between and within buildings) with less heating/cooling loads. Ideally oriented, the city and the road network were directed on a southeast-northwest axis to provide shadows on the road throughout the day in a way that reduces the walls' acquisition of thermal glare and facilitates the flow of cold breezes around the city. The focus of urban growth and the city is living in an environment free of carbon and waste in a new boom. It is directed towards focusing entirely on solar energy. It is also an Incubator for companies based on clean technology, from water to trash.</p>	
Health and Safety	<ul style="list-style-type: none"> • It brings social welfare and safety to all people. • Improving the quality of life in the community 	High quality of life, which confirms that meeting the requirements of an environmentally friendly life is not difficult and can contribute to providing a commercially rewarding business model	
Environment quality	<ul style="list-style-type: none"> • Ensure that the rate of utilization of renewable resources does not exceed their renewal rates. • Filling transportation needs without generating emissions that threaten public health and the global climate • Waste reduction • Ensure the existence of emergency management within the components of transport systems. • Reducing fossil fuel consumption and emissions • Keeping pace with the development and scientific research of innovative alternative technologies 	A special focus on sustainability contributes to achieving the city's goal of becoming one of the most sustainable cities in the world and a wonderful place to live and work. The design, in particular, takes into account facilitating power generation wherever possible.	
The economic efficiency	<ul style="list-style-type: none"> • Expenditure of sustainable transportation systems is cost-effective • Achieving the standard of equality and fairness in payment by transportation users in comparison with the total costs 	In an integrated city, there are no separate areas for companies and culture; the university and traditional business elements are integrated into the heart of society, as are entertainment and entertainment facilities, so that residents and those traveling to the city can find their demands close to them, in a manner that achieves justice and equality.	

7. Conclusions:

Sustainable transportation achieves accessibility and mobility through multiple, highly efficient methods and mechanisms to achieve social, environmental, and economic goals for current generations in a manner that develops and maintains non-renewable energy sources to meet the needs of future generations. The basic principles of sustainable transport are accessibility, social justice, integrated transport planning, health and safety, environmental quality, and economic viability. Sustainable transportation is essential in achieving city sustainability, prioritizing pedestrians, bicycle use, and public transport, and increasing accessibility to services without relying on private transportation. Public transport plays an important role in the economy by increasing the efficiency of investment in infrastructure, giving residents easy access to services, providing job opportunities, and activating social networks. The strategic urban plans related to the development of infrastructure facilities can contribute to promoting the emergence of better forms of urban expansion focused around the places of spread of public transport facilities. Urban sustainability indicates that there is a need to work in several areas. The first is for cities to reduce their environmental footprint. In contrast, the second area focuses on the wise management of resources, especially depleted ones, investing in human capital, and increasing economic production, which are the keys to wealth sustainability in urban areas. The third calls for improving environmental health by reducing pollution and conserving resources.

When applying the theoretical framework to the two urban models, the principle of sustainable transport was adopted as a basis for planning and design, with different heights for each. It became clear that the city of (Masdar) has adopted the provision of multiple transportation options and environmentally friendly life requirements for easy access and environmental purposes to achieve urban sustainability, and low buildings, with high density and using less energy in the field of movement (between buildings and within them). The city is integrated; there are no separate areas for companies and culture, and the university and traditional business elements are incorporated in the heart of society, as are entertainment facilities, so that residents and those traveling to the city can find their demands close to them, in a manner that achieves justice and equality, which fulfills the research hypothesis: that sustainable transport meets the requirements of urban sustainability.

As for Shanghai in China, the concentration of six adjacent neighborhoods of different heights, with an average of 80,000 people in each, around each significant transportation switching places connected to the province's main public network. Emphasizing public transportation reduces the need for car trips, and thus, to the streets by about 60%. The designer worked to expand pedestrian road networks far from streets, bike paths, shopping places, and wooded paths. The network of public spaces has also opened the way for cultural activities to open in the city. All this has been carefully woven with the public transport system to create a single interconnected network of public spaces and movement that starts from the house's door and leads by car parks, buses, or trams to airport terminals. A flexible chain of different modes of transportation

of safe sidewalks, high-speed trains, and air travel facilitates movement and transportation for all residents to achieve sustainability in environmental, psychological, social, and recreational aspects, to the residents, and this also fulfills the research hypothesis.

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<https://uomustansiriyah.edu.iq>

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Author Contribution Statement

Ashwaq Fadhel Muhkaber Alomari: Proposed the research problem, conducted the initial writing, performed data analysis, and provided overall research supervision.

Tahrir Taki Ali Almusawi: Discussed and interpreted the results, ensured the validity and efficacy of the findings, and contributed to revising the manuscript.

Lina Kifah Kadhum: Compiled and formatted the tables and contributed significantly to the final version of the manuscript.

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