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Tracing the Roots of Historic Cities: Embracing Sustainable Green Cities and Navigating Threats through Original Characteristics

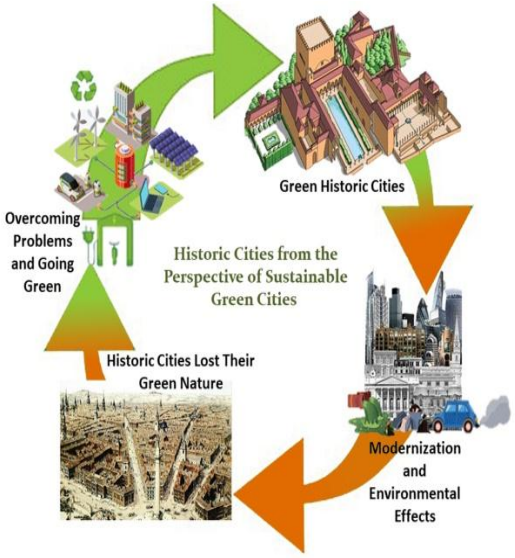
Aalaa Gamal Mahmoud Ali*

Department of Architectural Conservation, Faculty of Archaeology, Cairo University, Giza, Egypt.

HIGHLIGHTS

- Studying the characteristics of historic cities and originating them from the perspective of green cities.
- Historic cities were green cities that adapted to the environment and limited environmental changes.
- Historic cities are exposed to risks that threaten their sustainability and being green, mainly modernization and environmental changes.
- Proposing ways to go green and preserve historic cities to ensure their preservation and sustainability.

GRAPHICAL ABSTRACT



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ABSTRACT

Historic cities arose under the influence of many factors that shaped the ancient city with its distinctive characteristics and values. When planning cities, it was taken into account to provide comfort to their users, preserve the surrounding environment, and not consume its resources. This was reflected in the historic city by directing its streets, securing its boundaries, providing sources of fresh water, and paving roads. Then, the historic cities went through many stages of deterioration, decline or prosperity till today.

*** Corresponding author:** aalaa_gamal@cu.edu.eg

Recently, the concept of green cities has emerged, which aims to sustain buildings and preserve the environment, through a set of standards based on adapting and reducing the phenomenon of climate change. Therefore, the study came with the aim of rooting historic cities from the perspective of green cities by applying green city standards. Then, develop solutions to overcome the problems of cities in a way that ensures the transition to green with respecting their characteristics and values.
The current study relied on the use of analytical methodology to analyze the characteristics of historic cities and green cities standards, which was followed by the applied methodology to embrace these characteristics and standards in historic cities in the light of current threats to support their green transformation. From the study, it was found that the historic cities were green cities, but as a result of modernity, environmental changes and changing activities, they no longer meet the standards of green cities. Therefore, the study suggested a proposal for converting to green through a set of measures.

1. Introduction

Historic areas are defined as a homogeneous space that is characterized by specific features and a group of heritage items and values that indicate the characteristics of society, such as urban and architectural values, customs and traditions, historic buildings, buildings of architectural value, buildings that represent valuable eras or stages, and related to the history of peoples [1]. Historic surroundings can be distinguished as an urban area that includes historical accumulations of cultural and natural values and extend beyond the concept of "historic center" or "historic group" to include the site's topography, geomorphology, and natural characteristics, its historical and contemporary urban fabric, its infrastructure and superstructure, spaces, parks and land uses as well as social, cultural and economic characteristics and values, and intangible dimensions of heritage related to diversity and identity [2].

According to what was stated in the 1976 Nairobi Conference [3], historic cities mean groups of buildings and facilities and the spaces between them, including historic sites and any surrounding settlements in a rural or urban setting. They are the material image of culture, and have archaeological, architectural, historical, aesthetic, social, or cultural values. These sites include: prehistoric sites, historical sites, ancient urban neighborhoods, villages and memorial groups.

Human history has gone through many civilizations and historical periods that were reflected in archaeological and historic cities through the factors that influenced their emergence and the characteristics of those cities. In the beginning, the necessary needs were to bring together a number of families and tribes to reside in a common habitat and in a number of close communities to organize food gathering and hunting. These sites were chosen based on the presence of a water resource and the presence of means of natural protection, such as an easy-to-climb hill, a river, a swamp, or a mountain, and the residents might construct artificial protection such as barriers or trenches [4].

Man needed to organize the society and share responsibility, as there was a need for rules, and principles that govern relations between the residents. This required a place for governance, meetings, so the square appeared in front of the residence of the village wise man or the ruler later. The transformation from a village to a small city required important external factors, such as the invention of the potter's wheel [5], where markets appeared to sell products and carry them from the village to the city, and the invention of the plow [6] which contributed to increasing agricultural products, which saved time for handicrafts to be marketed in the city.

Over time, the population began to increase inside cities. Activities, needs, and urban expansion increased with the increase of population, raising concerns about the sustainability of these cities. To overcome this, the concepts of urban sustainability, sustainable development, green cities, and so on have emerged. Rostami's study [7] stated that sustainable development is a strategic framework that contributes to city planning, as the identifying of historic urban green spaces contributes to enriching human life,

enhancing the citizens' quality of life, the sense of belonging and connection to the place, which helps in creating sustainable urban environments.

Studies have often relied on discussing the impact of the environment and the phenomenon of climate change on historical cities, how to reduce carbon emissions, reduce energy consumption and how to manage waste. The previously mentioned solutions are technical solutions. In addition, there are solutions at the level of historical cities that stem from the city's distinct character and provide cultural identity. This is what the Tweed [8] study addressed to prove what built heritage can offer to contribute to sustainable urban development by meeting human needs, highlighting the problems of intangible heritage, and developing solutions to overcome them by understanding how people interact with the urban environment and its heritage.

Studies have developed different urban green rating systems (UGRS) to evaluate sustainability in urban planning, and some studies [9] have considered the possibility of applying these criteria to historical urban environments to achieve a balance between heritage preservation and sustainable development. Most of the previous studies did not highlight the values of historical cities that can achieve sustainability standards on their own, so the study came with the aim of rooting historical cities from the perspective of green cities by highlighting their potential and evaluating their data in light of the standards of modern green cities.

The current study relied on the use of analytical methodology to analyze the characteristics of historic cities by studying these characteristics in some of the most important ancient civilizations (Egyptian, Mesopotamian, Greek, Roman, Islamic) and green cities standards that was organized by the United Nations program within the Urban Environmental Accords. The study also relied on the applied methodology to embrace these characteristics and standards in historic cities in the light of current threats to support their green transformation.

2. Practical development

2.1. Studying the Characteristics of Historic Cities and the Factors Affecting their Development

2.1.1. Cities in Ancient Egypt

In the pre-dynastic era, the communities were separate from each other and governed themselves. From the beginning of the rule of King Menes, the rule was based on a religious basis, as a city was built for the dead, which consisted of *mastabas* (benches) placed in regular rows separated by parallel and intersecting streets.

Then cities were built for the slaves and craftsmen who contributed to the construction of the pyramids and royal tombs. They are mud-brick rooms gathered around an inner courtyard. They are characterized by their regular planning and the extension of their streets with the direction of the compass. There is a grid layout in Amarna and Kahun (an ancient Egyptian town) [10] (Fig. 1: a, c). Defensive cities also appeared, as they were built in distinct defensive sites and were distinguished by the presence of an external wall for fortification. Egyptian cities emerged as a result of a number of factors, the most important of which are: a. natural factor: where the locations of cities and villages were chosen in the higher parts of the valley, in order to preserve the alluvial lands and avoid the danger of flooding [11] that threatened the centers of urbanization. As for walls, there was no need for them around cities to give them the opportunity to expand, but walls appeared around some cities such as Medinat Habu for fortification, b. social factor: where housing is divided into residential groups, each group has its own grain silos and warehouses. Besides the separation between the groups of society, by using inner walls "Dividing Wall", as in the case of the city of "workers in Tel Amarna" [12] and "Kahoun", and allocating separate neighborhoods for them through the zoning distribution of the neighborhoods of the city itself, as in the case of the city of " Tel Amarna" .

2.1.2. Cities in Mesopotamia

Cities in Mesopotamia appeared as a result of a group of factors, the most important of which are:

a. Geographical factor: the Mesopotamian civilization extended in the area between the Tigris and Euphrates rivers in the flat plain part called the "Garden of Eden", and the main streets were paved in the north-south direction parallel to the direction of the two rivers;
b. Geological factor: the presence of stone was rare in the Mesopotamian region, as was the presence of metals such as iron and copper, so the Mesopotamian architect relied on clay in construction, and used it in its various forms: as mud bricks in construction, and fired, glazed bricks and tiles for decorative purposes in the facades, while the use of stones was limited to the foundations of large buildings such as temples and palaces. Because of the floods, agriculture was not stable until they dug canals and stored water in wells for drought times;
c. Religious factor: The Mesopotamian believed in the existence of gods, so ziggurats appeared for serving and worshiping gods which are huge, high-rise buildings consisting of several layers, their height reached upto 20 meters and it was topped with a temple [13]. There was no interest in building tombs because they did not believe in life after death as the Egyptians did;
d. Social factors: The Mesopotamian region was ruled by several peoples, such as the Sumerians, Babylonians, Assyrians, Greeks, Persians, Romans, and Muslims (Umayyads, Abbasids, and Turks). The king among the people of Mesopotamia was the holder of religious and worldly authority, and in this way they differed from the Egyptians, where the king was the representative of the god;
e. Climate factor: The hot climate in Mesopotamia led to a compact urban fabric, such that the streets were very close so that the houses shaded them, taking into account that the direction of the street was opposite to the direction of the sun, and the houses were designed to include internal courtyards for ventilation and to lower the temperature. The streets within the city represented one of the most important elements in any urban environment as they contribute to the sustainability of the city's borders. Two types of streets can be distinguished in the cities of Mesopotamia. The first is the procession street for celebrations, which was a large straight street extending from north to south (parallel to the direction of the river), and the second was the side streets extending into the heart of the city. These were narrower and perpendicular to the procession street. In general, the topography of the land in Mesopotamia prevented the paving of roads and good planning of streets to connect cities to each other [14];
f. Political factor: the king was the sole ruler of the city, and states were established in the form of cities, each with a terrain, a government, and people [15]. Due to this multiplicity, wars spread between states or cities, and then attention was paid to fortifying the cities by erecting huge walls around these cities (Fig. 1: b, d).

2.1.3. Cities in Greece

Greek civilization is considered one of the most important civilizations in Europe and the most influential in the world at the level of architecture and arts. It also represents a distinguished position between Asia, Africa and Europe [13]. The following factors affected the emergence of Greek cities:

a. Geographical factor: the land of Greece is surrounded by the sea on three sides, which led to the emergence of natural ports and ease of trade. The Greek city (Fig. 2: a, d) is divided according to its layout into two types: 1. the natural ancient (unplanned) city that arose near the artificial plateau "the Acropolis", which was the heart of the unplanned city, its height reached 156 meters above sea level, and was walled to protect the ruler's palace and includes the temples (with the entrance directed towards the east) and the important buildings of the city, 2. planned cities (grid layout) at the bottom of the plateau, appeared later and were distinguished by the public square (agora), theaters and

b. residential buildings, and the agora was the heart of the planned city [13];
c. Geological factor: marble was widespread in Greece, which enriched the structural aspect by using it in construction;
d. Social factor: public facilities appeared among the Greeks, such as the agora, the market square where the people of the city gathered, theatres dedicated to artistic performances, sports arenas (stadiums), ports in coastal cities, and public baths. A road appeared in the Greek city similar to the processional street in the cities of Mesopotamia, and it was known as the Panathenaic road. It was the road along which the procession passed and included sporting events and musical competitions. It started from the Double Gate (Diplone) and ended at the Acropolis, passing through the Agora [19].

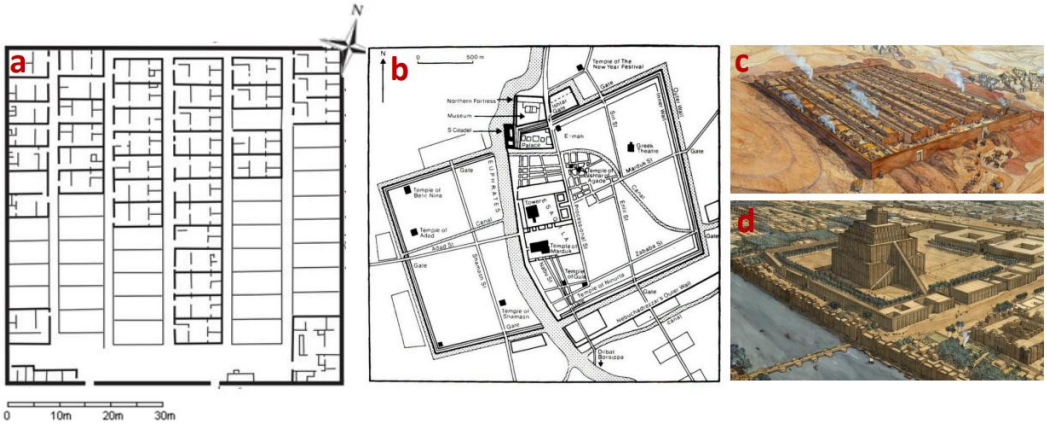

Fig. 1. Planning systems: a. city of workers at Tell El-Amarna [16], Its surrounding wall and the internal division wall, b. Ancient city of Babylon [17] showing the two parts of the city to the right and left of the Euphrates River, the paving of the roads and the procession street, c. An imaginary drawing of the workers' city [18], d. An imaginary drawing of the ancient city of Babylon [18].

2.1.4. Cities in Ancient Rome

Roman civilization flourished in Italy in 343 BC, covering a wide area of Europe, North Africa, and Western Asia, and continued until its fall in 476 AD. Roman cities (Fig. 2: b, e) focused on civil buildings rather than religious buildings and public places rather than private places. The Romans practiced the art of city planning since ancient times. Before establishing a city, they would prepare its planning, and once the site was determined, they would begin creating the forum. The Forum was the center of the city and included the sacred area and the Agora of the Greek city.

In planning most of their cities, the Romans adopted the checkerboard method (perpendicular planning), especially in military cities. The city consisted of two main streets, one of which was (Cardo) and extended from north to south, and the other (Decumanus) extended from east to west. Both streets had arches that distinguished them from the rest of the city's streets. The city was divided into four sections, with an entrance on each of the four sides, and the plots of land were similar.

Roman cities included several buildings, such as the temple, the headquarters of the municipal council (Korea), the court, the business forum (basilica), theatre, public baths, and the Coliseum. The buildings were mostly open, and to protect from the sun and rain, part of the courtyard was covered by a surrounding portico or with sails (tarps) [13].

2.1.5. Cities in Islamic civilization

Due to the advent of Islamic civilization at a later period than other civilizations, Islamic cities (Fig. 2: c, f) were distinguished in their planning by one of two plans:

a. Existing cities before Islam that were planned in previous civilizations, which later acquired the character of Islamic cities, by adding planning changes and religious, residential, and service buildings, such as the city of Damascus;
b. Cities established by Muslims to be the residence for the government and camps for the armies, such as the cities of (Basra, Kufa, Fustat, Cairo, and Al-Zahraa).

There was a number of factors that influenced the planning of Islamic cities, the most important of which are:

- Natural factor: Islamic cities took into account adaptation to the surrounding environment (weather and topography), by directing the streets, the relationship between buildings, and the use of some architectural elements such as open courtyards, terraces, covered streets, and gardens;
- Religious and ideological factor: this factor was demonstrated by locating the mosque in the center of the city, as well as the separation of public areas from private areas. The Islamic city consisted of three types of streets: the main street (Qasaba) in the public areas of the city and included economic activities, the lanes with less public areas, then the alleys with closed ends and included residential units.

  The minimum width of the street was (3.23 - 3.50 m) to allow the passage of loaded camels through it, and it was preferable that the heights of the main street be (3.23 - 3.50 m) to suit the maximum height of the loaded camels as well.

  It was necessary to share water, whether for drinking or agriculture, and to remove any source of noise or unpleasant odors from mosques. The market was adjacent to the main mosque in the city;
- Social factor: the organization in the Islamic city was based on ties of kinship, the existence of a common culture, and the existence of religious ties [20];
- Economic factor: trade flourished in Islamic civilization and therefore a group of buildings appeared to serve this, such as markets, agencies and neighborhoods that brought people of the same craft together, such as *Nahhasin* (Coppersmiths) and *Khayamiya* (Tentmakers) [21].

The Islamic city included a group of architectural elements, the most important of which were:

- The Grand Mosque: it occupied the center of the city and was used as a school for teaching the Islamic religion.
- Market: was the center of commercial activity in the city,
- Citadel: known in some areas as the *Kasbah*, it represented the ruler's residence. It was surrounded by a wall for protection, and inside it there was a mosque and guard quarters.
- Road network: The residential neighborhoods were connected to the central area through a network of narrow, winding roads, including public and private streets, semi-private streets, and *cul de sacs* (closed ends) alleys.

Outside the city: There were cemeteries, a weekly market held outside the city gates, private gardens, and agricultural fields [20], [21].

2.2. Challenges Encountered by Historic Urban Centers (Problems and Threats)

Archaeological and historical cities are exposed to many problems that negatively affect them and threaten their heritage in the short or long term. Therefore, it was necessary to identify these problems and their main causes in order to overcome them [25].

2.2.1. Problems Related to the Human Factor

Problems resulting from the human factor are mainly represented by the modernity it imposes on the historic city, or the neglect or abandonment of it. The problem of modernization in the historic city can be clarified through the following actions:

a. Using different building materials [26] (Fig. 3: a) in the historic urban, results in a distance or remoteness from the traditional style;
b. The use of modern means of living in old buildings in a distorted manner, such as electricity, drinking water, sewage and telephones, these uses of modern means often lead to a change in the internal planning of the buildings, and eliminating some ele-

ments such as ventilation openings, places and spaces of kitchens and bathrooms;

c. Problems arising from the use of modern vehicles and transport (Fig. 3b), which represent a burden on the streets and lanes of the old city, which were not planned to suit the needs of modern traffic, in addition to the vibrations caused by these means and negatively affecting buildings, and emitted fumes carrying polluted gases;
d. The change in traditional lifestyles, which led to the loss and neglect of many of the old uses of these buildings, as in the case of *sabil*, *tekia* and *wikala*;
e. The architectural extension of the city outside its walls requires the provision of a large number of housing at the expense of local architectural and artistic patterns, which leads to the loss of harmony between the old city and its surroundings [27].

The abandonment of the historic city is one of the most important problems it faces; it results in misuse of the building as a result of the different cultures, education and customs of the new residents and thus neglecting these buildings and changing their styles [1].

Negligence results mainly from a lack of awareness of the value of buildings within the historic city, the images of neglect are abandonment of old buildings without monitoring or evaluating their condition and consequently suffering from deterioration and collapse.

Similarly, historic buildings that are inscribed on the List of Heritage or Antiquities are neglected even after restoration, thus causing them to enter the cycle of damage again [27], in addition to neglect of periodic conservation [28].

2.2.2. Environmental Problems

Environmental problems can result from: the fluctuation of groundwater levels (Fig. 3c), natural phenomena such as earthquakes, floods, or hurricanes, the non-resistance of some materials used in historic buildings to gases, dust, fungi, and bacteria, the succession of expansion and contraction processes resulting from continuous changes in temperature.

2.2.3. Economic Problems

The availability of financial support is an important factor in preserving historic cities, and the lack of this support constitutes a real problem, especially in developing countries. This is demonstrated by the lack of funding sources that are needed for architectural and urban improvement projects, lack of government capabilities to upgrade these areas and the priority is primarily on developmental and educational projects. Therefore, to overcome this problem, there is an orientation to reuse historic buildings in appropriate uses that fit their value, surrounding urban and at the same time, it generates revenue that supports conservation plans [27].

2.2.4. Political Problems

In some countries, political problems result from the absence of laws and legislation necessary to preserve historic buildings, the absence of laws and legislation regulating construction work and the nature of the juxtaposition within the historic city, the lack of monitoring and follow-up of the implementation of legislation, or the change from one government system to another, such as the change from the monarchy to the republic, which results in the abandonment of some palaces [1].

2.2.5. Scientific and Technical Problems

These problems result from the lack of qualified specialties that concern the conservation of historic cities [27], the lack of technical bodies and institutes specialized in graduating architectural restoration specialists, and the availability of restoration laboratories with their equipment [1].

2.3. Green Cities and Urban Sustainability

2.3.1. Definition of Sustainable City or Eco-city (Green Cities)

The concept of “sustainable cities” appeared as a major vision for urban development in connection with sustainable development in

the early nineties. A sustainable city is one that balances and strengthens the social, economic, and environmental dimensions. They are "fair, safe, well designed, reachable, inexpensive, flexible and sustainable cities" [29].

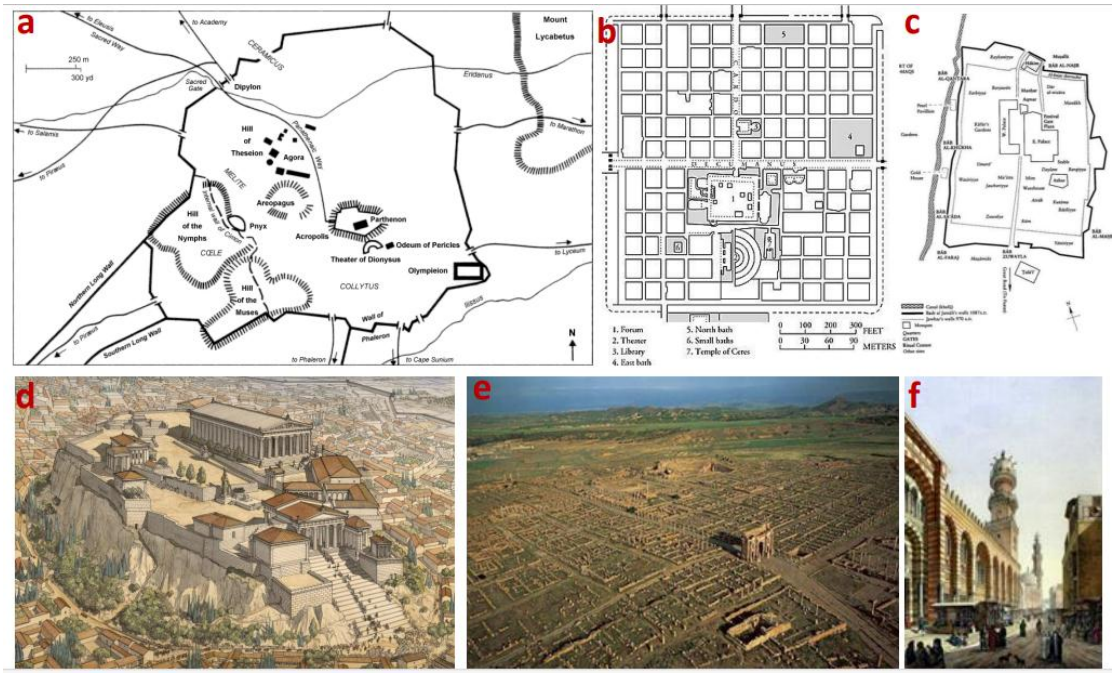

Fig. 2. a. Map of the ancient city of Athens showing the Panathenaic Road, the Agora, and the Acropolis [19], b. Planning of the Roman city of Timgad [22], c. Planning of the city of Fatimid Cairo [23], d. An imaginary drawing of the ancient Greek city [18], e. City of Timgad in Algeria [22], the main street (Qasaba) in Fatimid Cairo [24]

Fig. 3. a. The construction of modern buildings which are incompatible with the planning of the historic city and with different building materials (the modern building in the Fig. hindering the Qasaba in the Islamic City and threatening the sustainability of the historical planning), b. The use of modern means of transportation that rely on the use of fossil fuels negatively affects the environment and fabric of the historical city, c. The effect of rising ground water levels on rock-cut tombs in the city of Alexandria (Ancient cemetery of Shatby).

A Green City can also be defined as a habitable and more suitable city with a low ecological footprint, where the inhabitants get a decent quality of life. It is also the city that achieves economic growth while reducing the burden on the ecosystem to a minimum [30]. The green city is expected to be resistant to natural disasters and epidemics, and it has synonyms as Eco-city, Sustainable City, and Green Development [31].

A green city, as defined by the European Bank for Reconstruction and Development (EDRD), is one that maintains the quality of its environmental assets (air, water, land/soil, and biodiversity) and uses these resources sustainably. It is a city that mitigates and adapts to the risks of climate change, and emphasizes that environmental policies and developments contribute to the social and economic well-being of inhabitants.

Environmental and Sustainable Cities Initiative (ESCI) uses a multidisciplinary approach to identify, organize and prioritize urban interventions to address key obstacles preventing sustainable growth. This approach includes achieving the following:

a. Environmental sustainability and climate change sustainability;
b. Urban sustainability;
c. Financial sustainability and governance [32].

In developing countries, the relationship between green growth policies and initiatives aimed at reducing poverty and combating urban geographical and social fragmentation should be reciprocal, such that green growth policies support poverty reduction initiatives, and at the same time these initiatives are means of achieving green growth, which cannot be separated about broader policies for achieving global sustainability [30].

2.3.2. Green City Standards

There are different opinions about the urban environmental measures that determine whether the city is green or not [32], but there is a set of standards that organized by different authorities to evaluate green cities. One of them that the study relied on is the standards organized by the United Nations program within the Urban Environmental Accords [33] that define a green city strategy, which includes seven factors described below.

2.3.2.1. Energy Efficiency (Renewable Energy, Climate Change)

Moving towards green cities requires identifying, configuring and processing the environmental challenges facing the city through investments and aimed services. One of the solutions to go green is to "green" a number of urban infrastructure services, such as developing energy sources for urban areas [32]. This can be achieved by improving energy efficiency through: increasing the use of renewable energy to meet the needs of residents, reducing electrical load and rationalizing consumption, reducing greenhouse gas emissions [33], reducing solid waste generation in industries, recycling industrial materials, saving energy (electricity, thermal energy for buildings and transport fuels) [32], and increase dependence on non-fossil renewable energy sources.

Means of energy conservation include rehabilitating public buildings, using sustainable building materials, supporting individual investments in energy efficiency technology, and distributing renewable energies such as solar photovoltaic energy [30].

2.3.2.2. Waste Management (Zero Waste, Manufacturer Responsibility, Consumer Responsibility)

It is one of the means to green urban infrastructure services [32]. Waste can be managed and reduced by: achieving zero waste in landfill sites and furnaces, reducing the use of single-use products, toxic and non-renewable products, implementing user-friendly recycling and composting programs, while reducing solid waste [30], [33].

2.3.2.3. Sustainable Urban Design (Green Building, Urban Planning, Slums)

Urban style is defined as a group of environmental, social and economic characteristics that interact together to result in the urban pattern or character that varies with the diversity and multiplicity of those characteristics. Social characteristics in particular in-

fluence the formation of the urban character of the city, resulting in rural, semi-urban, urban or other patterns [34].

Sustainable urban planning requires evaluating the city's greening opportunities at various points such as (energy, transportation, natural resource management, pollution reduction, architectural design, landscape and integrated infrastructure systems) [30], taking into account the needs of the elderly, people with disabilities, the nature of users and residents of the area and their needs to ensure the design of housing, public and green spaces, and transportation systems in the city respond to the needs of everyone [29].

Sustainable urban development can be achieved by: adopting the Green Building Classification System standard and applying it to all new buildings in the city, adopting high-density (reducing urban sprawl) [30], developing mixed-use neighborhoods, facilitating access and walking in the city for all users of all abilities (including facilitating accessibility for the disabled), and creating environmentally beneficial job opportunities in slums and low-income neighborhoods [33], in addition to the necessity of involving the local community and stakeholders in the urban planning of the historic city by participation, consultation. This helps to identify the different needs and habits of citizens and supports decision-making to achieve the green transition [29].

2.3.2.4. Urban Nature (Parks, Habitat Restoration, Wildlife)

The world population is growing at a significant rate, especially in developing countries where the majority tends to migrate to cities. Urban expansion has increased the negative impact of climate change, and recently this has led to many natural disasters which called for the need to achieve a balance between urban development and nature [31]. Therefore, cities, as consumers of environmental resources, play an important role in ensuring environmental stewardship to reduce the phenomenon of climate change [29].

Urban nature can be preserved in green cities by: ensuring the presence of a public park or open space that is easily accessible to all residents, conducting an inventory of shade sites in the city, then developing a plan for afforestation and preservation of shade sites, protecting wildlife corridors, their characteristics from unsustainable development and protecting their needs such as providing water, food, shelter, and preserving local species [33].

2.3.2.5. Green Means of Transportation (Public Transportation, Clean Vehicles, Reducing Congestion)

The transportation sector is among the six sectors that put pressure on cities that hinder their transition to green. These six sectors are defined by the Pressure-State-Response (PSR) framework for green cities, which are human activities that exert pressure on the urban environment (transport, energy, construction, industry, water, solid waste, and land use). So among the means that must be followed to move towards green cities is supporting the greening of urban transport [32]. Transportation contributes to the transition to green cities through: expanding the coverage of public transportation to all parts of the city, reducing sulfur levels in diesel and gasoline, using advanced emission control methods for all public transportation, and reducing particulate matter and smog emissions from those means, implementing a policy to limit the proportion of vehicle trips occupied by one person [33].

2.3.2.6. Environmental Health (Toxics Reduction, Healthy Food Systems, Clean Air)

Human activities result in negative environmental impacts that are reflected on society in the form of health effects and degradation of living environments. These impacts are socially uneven, as the homes of the poor are more at risk due to poor quality of housing. Therefore, green cities promote overcoming these impacts through comprehensive solutions environmentally, economically, and socially [29].

2.3.2.7. Reducing Water Consumption (Water Access and Efficiency, Source Water Conservation, Waste Water Reduction)

Water consumption can be reduced to serve green cities by developing policies to increase access to safe drinking water that reaches everyone, taking measures to reduce consumption, protecting the ecological integrity of basic drinking water sources (groundwater, rivers, lakes, and water systems), managing city wastewater (sanitation services) [32], and reducing the volume of untreated water by expanding the use of recycled water, and planning sustainable urban water areas depending on economic, social and environmental principles [33].

3. Results and discussion

3.1. Distinctive Characteristics of Historic Cities

Historic cities are distinguished by many characteristics (Fig. 4) that distinguish them from other modern cities or post-industrial revolution cities. These characteristics were essentially the result of the factors influencing the emergence of these cities. To take appropriate measures to go green and limit the phenomenon of climate change, it is necessary to analyze the different environmental conditions affecting the planning and preservation of historical sites [35].

The planning of cities in hot areas differs from cold areas in terms of the width of the streets, their straightness, or their inclination. The characteristics of cities in large empires varied according to the location of the city's layout that depend on the nature of the climate, the availability of raw materials for construction and the influence of the religious factor. The following are the most important distinguishing characteristics of cities in ancient Egypt, ancient Mesopotamia, ancient Greece, ancient Rome, and ancient Islamic civilization.

3.1.1. Characteristics of Ancient Egyptian Cities

Ancient Egyptian cities are characterized by orthogonal planning; main north-south street and smaller east-west streets intersect near the city center with parallel side streets (due to the geographical factor as the Nile goes from the south to the north), so main streets are parallel to the direction of the Nile. Then other side streets come perpendicularly and intersect with them. The city's layout is mostly rectangular, especially for workers and employees' cities [10], ensuring the use of fertile lands in agriculture, unless there are strategic reasons. Social factors characterized the location of the Governor's Palace, with easy supervision of the city and a distinguished location.

The geographical factor participated with the religious factor in determining the location and organization of the cities, so that the cities of the dead are located to the west of the Nile from durable building materials (such as stones), while the residential cities are located to the east from weaker building materials (such as mud bricks), with the exception of the cities of Tell el-Amarna and the city of its workers, where the religious factor influenced it, so it came to the east of the Nile River, was used as a source of water or a waterway in Ancient Egypt. Therefore, cities grew near the Nile and on its banks and major cities had marinas.

The geographical and geological factors also influenced the degree of preservation of ancient Egyptian cities. The cities of the dead were established west of the Nile River in the desert, were safe from the flood and were made from strong building materials, which helped to preserve them to this day, while residential cities were established to the east, near of agricultural land and from weak building materials, which make them more vulnerable to being destroyed by floods.

Walls are mainly designed for two purposes:

a. for protection in defensive cities as it designed surrounding the city,
b. for separation inside workers' cities between different classes (according to social factor). Workers' cities included houses of the type known as row houses [10], which are best suited to create large economic and social housing groups.

Paved streets were rarely found in ancient Egypt, but ancient Egyptians were interested in paving roads to connect religious build-

ings, such as temples, to hold celebrations [11] (such as the road of rams between the temples of Karnak and Luxor). The lack of paving roads affected the connectivity between cities and did not support their growth, so the ancient Egyptian cities were small, and the Egyptian farmer's connection to his land ensured that he would not move to the city.

As for transportation inside ancient Egyptian cities, Animal-drawn carts and chairs were used for carrying [3].

3.1.2. Characteristics of ancient Mesopotamian cities

The geographical factor influenced the emergence of cities in Mesopotamia. Cities arose mainly in the area confined between the Tigris and Euphrates rivers and on both banks of the two rivers. The main streets took the north-south direction parallel to the two rivers, and the two rivers were a source of fresh water.

The political factor greatly influenced the cities of Mesopotamia where city-states emerged. This meant each city was an independent state in itself, which imposed its fortification with strong external walls, so the city consisted of three main parts [13]: a. the inner city (holly area) was the oldest part of the city and had a wall that included the temples or the palace. Surrounding the palace were the headquarters of the courtiers and then the residences of the people of the city. The center of city administration was at the gates where the market and meetings of the residents were located, b. the outer city was where there were houses, homes, pastures, fields, and orchards that provided the food and raw materials that the city needed outside its borders, c. guard area: Kara - Kara, which was the center of commercial activity, especially for trade related to the outside of the city. It was an independent area and had special legal characteristics. Strange merchants lived there and had their own shops.

The social factor also influenced the planning of the city in Mesopotamia, as the location of the ruler's palace was distinguished by choosing the best view and an elevated location that protected it from floods. The same applied to the religious factor that determined the location of the ziggurat (which held the temple) within the city so that it was in a distinguished location that achieved its eminence and advancement.

Their interest in the road network was not proven due to the lack of interest in connecting cities, as each city was an independent state from other cities.

Local building materials related to the environment of cities with flood deposits were used, and they were mainly made of clay in its various forms which affected the lack of sustainability and preservation of these cities throughout history.

3.1.3. Characteristics of Ancient Greek Cities

One of the most important features of Greek cities is their establishment on the top of an artificial plateau (the Acropolis). The Greeks followed the human standard in building their cities. The Greeks did not create large cities, but rather their cities were keeping in with the size and proportions of man. They did not care about planning cities greatly as they considered this a means of defense, but some parts of the city were planned in a regular geometric layout (for cities to combine art, beauty, security, and safety), in which roads intersected length and breadth at right angles, and in which spaces were regularly located at the intersection of the main roads.

The irregular layout of Greek cities and their winding, unpaved roads can be explained in two points:

First: due to the influence of the political factor, cities were planned as city-states [15], where each city had a group of tribes and residential clusters each separate from the other. There was no need to connect population clusters to others, and unpaved roads made it difficult for invaders to storm the city when they entered or left it;

Second: from the influence of the geographical factor, as the land of Greece is not flat, but rather a rugged land in most of its regions. This ruggedness was what necessarily determined the paths that represented roads, and hence these paths and non-straight roads came.

The political factor affected the Greek cities (city-states) which led to the necessity of surrounding the city with an external wall, and the doors in these walls did not face the heads of the main roads in the city in most cases. The city had two perpendicular, unequal axes, distinguished by its width and the agora (the activity square) that came where they met.

Moreover, there was the influence of the geographical factor on the Greek cities as they were subject to the topography of the site, so cities were established on high sites, mountain peaks, and seashores. The influence of the religious factor combined with the geographical factor was a reason why temples were built on heights in the city whose door faces the rising sun.

The effect of the climatic factor is such that the houses are designed facing inward (internal courtyards) and have no openings on the street except the entrance.

The social factor did not appear to have a clear influence in Greek cities as there was no distinction between the groups of society and their buildings within the city, and the Greeks did not care about building palaces, but rather they cared about public places, and there were wages. There were no channels for rain drainage or sewage, and it is mentioned that waste was thrown in the streets, and wells were dug for fresh water.

The development of agriculture was mainly linked to water sources, and hot climatic conditions forced the ancient Greeks to develop mechanisms for collecting, storing and transporting water. Wells, cisterns, fountains, tanks, water channels, and dams appeared, and separate systems for water management emerged: for supply, for surface runoff drainage, and for wastewater drainage. Ancient Greek cities depended on collecting rainwater in fountains and rock cisterns at the foot of the Acropolis and on the islands, and a dam built on an impermanent river allowed for the creation of a reserve of fresh water [37].

3.1.4. Characteristics of ancient Roman cities

Roman cities arose for two main reasons: as the headquarters of the empire, or as a colony. The political factor greatly influenced the planning of the Roman city, as the location of the city was determined on flat land, and the grid plan was drawn up to include the two main streets of the city (Cardo and Decumanus), and the two streets ended at the outer city walls with fortified gates for security.

The moderate climate factor enriched the architectural elements of the Roman city as the buildings and open squares within the Roman city varied between the Forum (the center of activity in the city), markets, temple, basilica, theatre, triumphal arches, stadiums, and public baths.

The Roman Empire was interested in the road network to connect its parts, and in constructing bridges, dams, and water canals.

3.1.5. Characteristics of Ancient Islamic Cities

The Islamic city was divided on the basis of functionality, not class, as the city was divided into three main areas: A. the semi-public area which was located on both sides of the central streets of the different neighborhoods that branched off from the main street and contained (commercial and craft activities - the mosque - public bathrooms - residences and high-rise buildings), b. the private area that was located along the narrow dead-end lanes that branched off from the central streets of the neighborhoods [21], and the residential buildings in it were low in height and openings, c. service institutions such as educational, cultural, health, judiciary, parks, public parks, and sanatoriums (*bimaristans*).

The compact urban fabric was an essential feature of residential areas, and the dwelling was generally open inward to provide privacy. Squares and open areas were few in cities due to the hot climate, but they were widely available in large buildings represented by open courtyards in palaces, commercial areas such as agencies, inns, markets, and market places, and religious buildings such as mosques, schools, and *Khanqawas* (plural of Khanqa- a worshipping place in Islamic civilization).

Some Islamic cities did not have walls from the beginning of their establishment

and were surrounded later with walls when the dangers increased to secure them, such as the cities of *Fustat*, *Al-Askar*, and *Al-Qata'i*.

The road networks in the Islamic city were characterized by an organic formation, "winding and irregular," appropriate to the type of movement and the human scale.

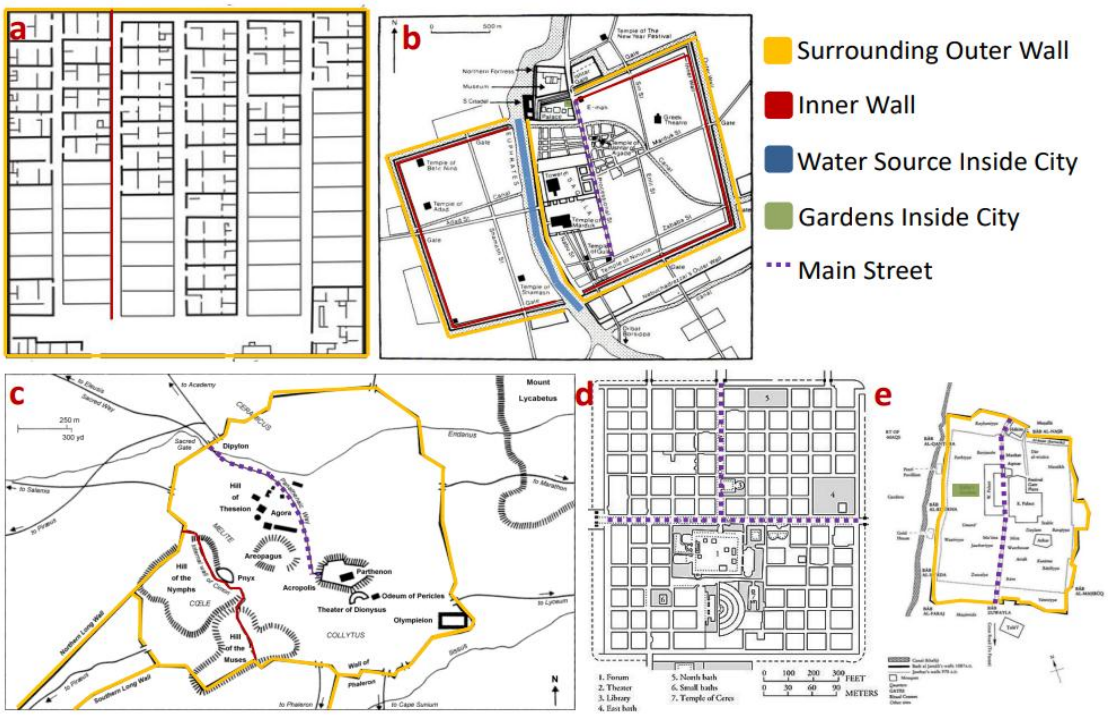

Fig. 4. Distinctive characteristics of ancient historic cities a. Egyptian cities, b. Mesopotamian cities, c. Greek cities d. Roman cities, e. Islamic cities.

3.2. Originating Ancient Cities from the Perspective of Green Cities

After studying in the aforementioned sections the most important criteria used to evaluate cities from the perspective of green cities, the historic cities will be evaluated from this perspective through the previously mentioned standards (Energy efficiency**,** Waste management, Sustainable Urban design, Urban nature, Green means of transportation, Environmental health, Reducing water consumption), and in light of that the study will reach the conclusion of whether historical cities can be classified as sustainable green cities or not.

3.2.1. Energy Efficiency

Since ancient times, humans have relied on energy efficiency to improve living conditions in the city through their buildings and construction techniques. Each era added new solutions and improved existing technologies, but their combination depended on the use of renewable energy sources. The ancient Egyptians relied on the use of thick walls of stone or brick to improve thermal comfort inside the building they also used ceramic tiles in the pyramids' corridors for thermal and sound insulation [38].

Later the Greeks and Romans used cavity walls; the internal cavity between the walls helps in insulation, and reduces heat loss and gain. Insulating the external and internal air through the vacuum between the walls allowed a large amount of heat to be absorbed and disposed of before reaching the building's internal environment [39].

The Romans also used the heating system (Hypocaust) with burning gases flowing through cavities in the floor or walls to keep the building warm for longer periods. They also designed special rooms (*Heliocaminus*)

facing south with windows covered with mica to maintain solar radiation inside the space, but it caused an increase in Greenhouse gas percentage.

They used solar chimneys for natural ventilation of the house, the sun was used to warm the inner surface of the chimney, and buoyancy forces resulting from temperature differences helped increase flow along the chimney, which was placed on the southern side of the house [38].

In Islamic buildings, many technologies have appeared to conserve energy, such as internal courtyards, *mashrabiyas* (plural of *mashrabiya* – a prominent window that overlooked the street or the courtyard of traditional Arab houses), and shelters to use wind energy for ventilation and cooling.

Ancient cities relied on renewable energy sources, such as the sun and wind for lighting and ventilation. Buildings were designed with open internal courtyards, such as temples, and with internal courtyards directed inward, such as housing. Multi-use open courtyards spread, such as the agora and forum, and open service buildings in moderate climate areas, such as the theater and the stadium (in Greek and Roman civilizations) and hospice and agency (in Islamic civilization).
Streets in hot areas were winding and recessed, so that homes cast shadows over each other helping to moderate the city's temperatures and energy efficiency.

3.2.2. Waste Management

Methods for disposing of waste vary in ancient cities and odor pollution was a problem when cities could not dispose of waste [40]. The lack of disposal and management of waste in ancient cities caused differences in history as a result of the spread of epidemics. Greece created the first regulations regarding garbage which included prohibiting residents from throwing waste on the street, and requiring it to be transported and dumped within one mile of the city to preserve it [41], while some cities in other civilizations came up with how to burn waste or bury it in landfills and exploit the resulting waste from burning (garbage) in manufacture of mortars used in construction, such as *Qasroumel* mortar [42] and *pozzolana* mortar produced from volcanic ash.

Waste was not produced in ancient cities in the same quantities as it is produced today because the population was much smaller than today, and they were not familiar with modern non-degradable materials. The ancient Egyptians knew recycling as a means to reduce the consumption of natural resources and reduce waste, due to the scarcity of goods and materials and their great value. Materials reused in ancient cities included stones as building materials, metals due to their high value and ease of melting and reshaping into new elements, and wood due to their importance as a result of importing high-quality wood. Animal dung was used as fuel in rural areas of Egypt during Pharaonic times. During the era of Roman Egypt, pottery pieces were used as guideposts in the mines of the Eastern Desert, amphorae and mortar were used to build ovens, and amphorae were also used to build a dock for small boats [40].

In planning the cities of ancient Mesopotamia, it was taken into account that they were located upwind of the remote garbage dumps so as not to harm the city [43]. Residents of Roman cities had a habit of disposing of waste from their homes and workplaces and depositing their neighboring. Solid waste was placed in landfills on the outskirts of cities, and liquid waste was disposed of in sewers, but there is no evidence of the spread of waste management in its current sense [44]. Dumping, burning, recycling and reducing waste have been the main waste management strategies throughout history [43].

3.2.3. Sustainable Urban Design

From studying the distinctive characteristics of historic cities, it becomes clear that all the elements of the city are the product of a group of different factors, the most important of which are environmental factors (the local geographical and geological environment of the site, climatic factors). These factors imposed on the ancient architects to orient the buildings in the city in the direction of favorable winds [45] and healthy sun. Also, increasing the thickness of the walls in hot and cold environments for thermal insulation,

orienting inward in hot environments and making openings overlooking the inner courtyards, using courtyards for lighting, ventilation and adding expansion [46], flat ceilings in the case of dry environments while sloping in the case of rainy environments to get rid of rainwater, and making many architectural treatments to control the interior environment of buildings, such as wooden *mashrabiyas*, *malaqafs* (wind catchers), and rattles in ancient Islamic homes. All of these solutions and treatments contributed to reducing energy consumption and reducing carbon emissions, which supports the sustainability of these buildings.

3.2.4. Urban Nature

Agricultural lands that provided food were of major importance in the past, therefore all the tools and equipment, such as the plow and clay pots to preserve seeds, were present in the design of cities, in which rulers paid attention to plants and created gardens within the boundaries of their palaces, such as King Akhenaten and King Nebuchadnezzar (the Hanging Gardens of Babylon). They developed the means to irrigate these gardens and preserve them, in addition to creating zoos within the boundaries of their palaces.

Animals were highly appreciated in ancient Egyptian civilization, where gods were represented in the form of animals or Fig.s with animal heads, and they were kept as sacred animals in temples, such as cats, bulls, and snakes. Animals were also domesticated for food and transportation as pets [40].

3.2.5. Green Means of Transportation

Ancient historical cities adopted primitive means of transportation such as domesticated animals, and the streets of ancient cities were not designed to accommodate modern transportation.

3.2.6. Environmental Health

The ancient historical cities took into account the public health of their users, through good ventilation, directing the sun to healthy parts of the city, and relying on locally grown organic food which contributed to clean air and keeping pollution rates to a minimum.

3.2.7. Reducing Water Consumption

All ancient historical cities relied on providing sources of fresh water, and cities often disappeared as a result of changing the course of the water or removing fresh water sources from them. Ancient cities relied on rivers or wells as a source of fresh water, and many methods were developed to change the course of water to increase the area of agricultural land, such as water canals. They also depended on several means and methods helped to sustain the ancient cities and adopt them as green cities; for example transporting water via aqueducts, facilitating the arrival of water to the city's residents with fountains, storing water in cisterns, and securing cities from the negative effects of floods or high-water levels by building dams.

Table 1 illustrates the result of the study in detail, as it includes the seven standards for evaluating historic cities from the perspective of green cities. The table includes three criteria for each standard (in total 21 criteria), and the points that achieve these criteria were set according to specialized references and field studies.

The fulfillment of each point was expressed with a sign (❶), which gives a single score (one point), and if the evaluation criterion was not met, it was expressed with a sign (−). The evaluation showed that the historic cities as a whole met the green city standards by 89.5%.

3.3. Proposals for Going Green according to Green City Standards

The nature of the problems is that cities are exposed to variables depending on their geographical location, as well as restoration and maintenance plans and intervention priorities. For example, coastal cities are different from inland cities, and hot areas are different from cold areas, and different from temperate ones. Therefore, the priority for coastal cities is to overcome the danger of sea level rise or coastal submergence. This challenge overshadows other environmental challenges, and the nature of the weather and climate in the inner city is also linked to investment decisions in current and future technology and infrastructure [30].

Cities have a major role in reducing the phenomenon of climate change by mitigating the effects of the phenomenon and adapting to it. Among the solutions are moving cities towards reducing greenhouse gas emissions and increasing their ability to resist and withstand the negative effects of the phenomenon of climate change [29].

Solving the problems of historical cities depends on a set of procedures that begin with identifying risks and threats, determining priorities for intervention in restoration and conservation work to ward off risks from historic buildings then developing plans to limit the migration of local residents to the historic city and improving the conditions of the population avoiding commercial and industrial activities that are inappropriate for the historic city and encouraging crafts and businesses that are compatible with the character of the city, upgrading the main and infrastructure of the historic city [47]. Therefore, the comprehensive concept of rehabilitation of historic cities is positively reflected on a number of levels: a. environmental: Improving infrastructure networks, reducing pollution in the historic city, b. architectural: restoring the structural problems of ancient and modern buildings and improving the architectural form of buildings and deteriorating parts, c. urban: upgrading the main and infrastructure and coordinating the site, d. social: improving and raising the standard of the residents' living environment, improving their behavior and habits, and increasing awareness of the city's values, e. economic: raising the economic level of the population through developing their business fields and creating new job opportunities within the city[1], [25].

In view of solving problems in light of going green, green transition actions should seek to enhance the city's environmental performance and maximize economic and social co-benefits [32]. The green transition includes a set of policies, the most important of which are: a. improving environmental quality and provision of urban services (e.g. revitalizing urban areas, enhancing public transportation, reducing harmful emissions, easy access to open spaces, improving water and sanitation services); b. reducing the consumption of environmental resources (such as increasing energy efficiency in production and buildings, increasing the share of energy from renewable sources, reducing urban sprawl, and reducing landfilling of waste) [30].

Criteria have been developed to measure the extent of greenness to develop green cities or transform an existing city into a green city. These criteria are related to the extent of mitigating or reducing the phenomenon of climate change and adapting to it [31]. These standards that have been addressed within the framework of the historical city are: energy efficiency, reducing waste (waste management), sustainable urban design, urban nature, green means of transportation (transport), environmental health, and reducing water consumption.

3.3.1. Energy Efficiency

Rehabilitation of historic buildings supports energy conservation [41], in addition to the possibility of using renewable energy sources to generate electricity in rehabilitated historic buildings and in modern buildings within the urban of the historic city (solar photovoltaic energy). Energy efficiency can be achieved through studying the possibility of utilizing the roofs of historic buildings to install solar panels, moving toward using environmentally friendly materials to restore archaeological and historic buildings, and using glass that reduces carbon dioxide emissions in the event of rehabilitating historic buildings and insulating roofs and interior walls (Fig. 5).

3.3.2. Reducing Waste (Waste Management)

Reducing waste is achieved by raising awareness in the urban of ancient cities about the necessity of reducing single-use products, toxic materials and non-renewable products, in addition to returning to benefiting from burning waste during the preparation of traditional mortars used in modern buildings or in restoration work in historic buildings, as well as the possibility of benefiting from waste dumped in sanitary landfills, so that cities can collect the methane that is released

during the decomposition of waste to gen- erate electricity [51].

Table 1. Evaluating Historic Cities According Their Achievement of Green City Standards

Green city standards	Criteria of evaluation	Originating historic ancient cities					Total Points
		Egyptian cities	Mesopotamian cities	Greek cities	Roman cities	Islamic cities	
1. Energy efficiency	renewable energy	Reliance on sun and wind in (heating, ventilation) ❶	Reliance on sun and wind in (heating, ventilation) ❶	Reliance on sun and wind in (heating, ventilation) ❶	Reliance on sun and wind in (heating, ventilation) ❶	Reliance on sun and wind in (heating, ventilation) ❶	15
	energy efficiency	Thick walls, inner courtyards, air cavity between two walls, thermal tiles❶	Thick walls, inner courtyards, very close streets, the direction of the street was opposite to the direction of the sun❶	Cavity walls, orientation of houses to the south (Socratic house) ❶	South oriented room, covering windows with mica (Heliocaminus), heating system (Hypocaust), solar chimneys❶	Inner Courtyards, wind catchers (malqaf), street refraction, variation in building heights❶	
	climate change	Few sources of greenhouse gases❶	Few sources of greenhouse gases❶	Few sources of greenhouse gases❶	Few sources of greenhouse gases❶	Few sources of greenhouse gases❶	
2. Reducing waste	Zero waste	Dispose of waste in pits [10] Recycling wood, metal and ceramics ❶	Dumping, burning, recycling and reducing waste❶	prohibiting residents from throwing waste on the street❶	No waste management (-).	Recycling broken materials to create mosaics and interlocking architectural units Using waste burning ash to make Qasromil mortar❶	14
	manufacturer responsibility	Scarcity of materials was directed to recycling❶	Recycling organic wastes❶	Creating regulations regarding wastes❶	Guidance for waste disposal❶	The necessity of disposing of waste❶	
	consumer responsibility	The ancient Egyptian was interested in recycling for multiple reasons❶	Dumping, burning and recycling❶	Transporting and dumping within one mile of the city to preserve it❶	Waste disposal in nearby places and outskirts of the city❶	Disposal of waste to preserve the city❶	

3. Sustainable Urban design	green building	Local building materials. Creating architectural treatments for environmental adaptation. Using strong, sustainable materials (in religious buildings) helped preserving the buildings❶	Local building materials. Creating architectural treatments for environmental adaptation. Weak building materials (mud brick) did not support the preservation of the buildings❶	Local building materials. Creating architectural treatments for environmental adaptation. Using strong, sustainable building materials helped preserving buildings❶	Local building materials. Creating architectural treatments for environmental adaptation. Using strong, sustainable materials helped preserving the buildings❶	Local building materials. Creating architectural treatments for environmental adaptation. The use of sustainable and strong materials helped preserving the buildings❶	15
	urban planning	Good Planning for religious and defensive cities. City's layout according the Nile's direction. Grid planning appeared in workers' cities. Walls were used in defensive cities for security, and within workers' cities to separate different classes. ❶	Exploiting the topography of the site to preserve the most important buildings. The city's planning was an organic (non-geometric) and sometimes orthogonal geometric. Walls were Used to secure cities (city-states) planning. ❶	The construction of artificial plateaus (acropolis) provided protection for cities. Combining regular and irregular city planning. Walls were used to secure cities (city-states). ❶	Clear and regular grid layout. Walls were used in defensive cities to secure cities. ❶	The streets are winding to reduce the heat. There is no grid layout. Walls were later used to secure cities❶	
	slums	No slums inside city ❶	No slums inside city❶	No slums inside city❶	No slums inside city❶	No slums inside city❶	
4. Urban nature	parks	Lands have been deforested for agriculture [40] Taking care of gardens inside palaces❶	Gardens inside palaces (Hanging Gardens) ❶	Gardens inside houses and palaces❶	Gardens inside houses and palaces❶	Gardens inside houses and palaces and public gardens ❶	10
	habitat restoration	habitat restoration to maintain the life❶	habitat restoration to maintain the life❶	habitat restoration to maintain the life❶	habitat restoration to maintain the life❶	habitat restoration to maintain the life❶	
	wildlife	Animals were sacred and domesticated. Unregulated hunting and deforestation led to the extinction of a number of animals by the end of the Pharaonic era [40] —	Lack of information (-).	Lack of information (-).	Lack of information (-).	Lack of information (-).	

5. Green means of transportation (Transport)	public transportation	Internal roads connecting parts of the city (Like the Rams Road between the temples). Weak road network between cities. Pedestrian movement and primitive means of transportation (animals and carts). ❶	Internal roads to connect parts of the city and main street (procession street for celebrations). Weak road network between cities. Pedestrian movement and primitive means of transportation (animals and carts). ❶	No care about paving the roads but the roads are wide to allow carts to pass Pedestrian movement and primitive means of transportation (animals and carts) ❶	The road network is very good and strong Pedestrian movement and primitive means of transportation (animals and carts) and the roads are wide and connect the parts of the empire ❶	The roads are winding and irregular, adapted to the type of movement and the human scale ❶	15
	clean vehicles	Clean transportation ❶	Clean transportation ❶	Clean transportation ❶	Clean transportation ❶	Clean transportation ❶	
	reducing congestion	Reduce congestion ❶	Reduce congestion ❶	Reduce congestion ❶	Reduce congestion ❶	Reduce congestion ❶	
6. Environmental health	toxics reduction	Lack of information (-).	Lack of information (-).	Lack of information (-).	Lack of information (-).	Lack of information (-).	10
	healthy food systems	Natural food sources ❶	Natural food sources ❶	Natural food sources ❶	Natural food sources ❶	Natural food sources ❶	
	clean air	Air quality was not high, as cooking, heating, quarrying and construction activities ❶	Good orientation of city streets ❶	Good orientation of city streets ❶	The spread of multi-use open spaces ❶	Good orientation of city streets ❶	
7. Reducing water consumption	water access and efficiency	Nile River (source of fresh water) ❶	Tigris and Euphrates rivers (sources of fresh water) ❶	Rivers and well drilling (a source of fresh water) ❶	Rivers and well drilling (a source of fresh water) ❶	Rivers and well drilling (a source of fresh water) ❶	15
	source water conservation	Enact laws to conserve water sources, establishing Nilometers Dams, canals ❶	Digging water canals, constructing dams ❶	Wells, cisterns, fountains, tanks, water channels, and dams appeared ❶	Digging water canals, constructing bridges and dams ❶	Digging water canals, constructing bridges, dams and water meters ❶	
	waste water reduction	Sanctification of the Nile River (water source) ❶	Sanctification of nature ❶	Water management emerged: for supply, for surface runoff drainage, and for wastewater drainage. ❶	Disposal of liquid waste in sewers ❶	Not wasting water ❶	
❶ Verifies evaluation (-) Not verified					Sum of Total Points		94
Percentage of the sum of total points = 94 × 100 / 105 = 89.5 %							

Fig. 5. a. Using glass that reduces carbon dioxide emissions and insulates interior surfaces and walls [48], b. Utilizing renewable energy sources to generate electricity in historic cities [49], c. Planting the roofs of modern houses in the urban of historic cities [50], d. Overcoming the problems of environmental and visual pollution and reducing the emission of greenhouse gases.

3.3.3. Sustainable Urban Design

This can be done by monitoring the changes applied to historic buildings within the historic cities and evaluating them within the green building classification standards to get rid of the inappropriate ones helps in sustaining urban design (Fig. 6). Adopting a green building classification standard and applying it to modern buildings in historic cities, in addition to getting rid of all the new inappropriate activities to maintain historic cities to their original status is based on green thought (Fig. 7a, b). Organizing movement paths in the historic city and facilitating access to it for all users with different abilities, supporting the use of primitive means of transportation in the historic city or modern means of transportation based on renewable energy sources, and educating the local community about the importance of preserving the historic city and turning green [30] are all means of sustainable urban design.

3.3.4. Urban Nature

There is a necessity of conducting periodic evaluation and conservation of historic buildings within the surrounding urban of historic cities to preserve them [28]. Preserving historic gardens, monitoring all their capabilities and enhancing them to avoid losing any of their elements while considering the possibility of registering them as natural heritage sites, protecting wildlife paths and studying their species and types to preserve them [52], monitoring the historic city spaces and considering using them as green spaces with

types of plants that suit the historic city environment should be a priority. There should also be a possibility of exploiting modern buildings in the surrounding urban of historic buildings to plant their roofs in a way that reduces the level of pollution and reduces the carbon footprint of the historic city.

3.3.5. Green Means of Transportation (Transport)

There is a need to facilitate pedestrian movement within the historic city, in addition to considering the use of primitive means of transportation, or the use of modern means of transportation that rely on the use of renewable energy sources (Fig. 7c). It is important to identify public transportation means leading to the historic city and all its parts, develop them and facilitate their use.

3.3.6. Environmental Health

A green city environment can be maintained through: reducing the use of chemical products or compounds used within cities that pose a risk to human health, supporting the public health and environmental benefits of locally grown organic food, using all city facilities to serve local agriculture, and creating an air quality index to measure the level of air pollution and reduce the number of days classified as "unhealthy" [33].

It is recommended that the use of chemical products or landfills that are not safe for the health of users is limited, whether in restoration or rehabilitation work for historic buildings or in construction work in the vicinity of the historic city. It is also preferable that we turn to environmentally friendly materials in the restoration, completion and rehabilitation work of all parts of the historic city and to use materials and techniques that reduces carbon emissions and unhealthy gases.

There is also a need to preserve the historic city's environmental assets and promote their efficient use, provide systems to ward off risks and disasters to preserve historic cities and their planning, and overcome all environmental problems through comprehensive environmental, economic, and social solutions.

3.3.7. Reducing Water Consumption

There should be a tendency towards preserving the historic city's water buildings (Fig. 7d, e) and considering the possibility of rehabilitating them in a way that does not affect their preservation, protecting the environmental integrity of the main drinking sources such as rivers and ground water, managing the historic city's waste water, and reducing the volume of untreated water through expanding the use of recycled water.

Fig. 6. a. Rehabilitating historic buildings and taking advantage of their potential to save energy, b. Paving roads for pedestrian according to their historic nature and regulating the movement of vehicles on them, c. Preserving the historic gardens and landscaping the site within the historic city.

Fig. 7. a. Excavating the ruins of the ancient city and preserving its layout, b. Creating buffers to secure historical coastal cities from the danger of rising sea levels, c. Limiting vehicle traffic to some main axes outside the historic city, and preservation of historic water buildings, d. Water cisterns, e. Animal watering basin.

4. Conclusions

Historic cities are the cities through which we can relive history. They are cities that include historical buildings with multiple uses, carrying architectural and artistic values, and still bearing the character of ancient life. They differ according to the circumstances of their formation (influencing factors) and the purpose of their establishment, and they also differ in the nature of the buildings they contain. The ancient Egyptian cities were distinguished by their religious buildings such as the temple, the pyramid, and the cemetery. The cities of Mesopotamia were distinguished by ziggurats and palaces. The Greek cities were distinguished by secular buildings such as the agora and the theater, and the Roman cities were distinguished by the forum, the basilica, and the Arch of Triumph. The Islamic cities were distinguished with their ruins, hospices, and agencies.

The ancient architect took care to meet the needs of the users, so the buildings and their designs varied according to the purpose of their use, whether religious such as pyramids, tombs, temples, ziggurats, or civil such as palaces, houses, agencies or multifunctional spaces such as agora, forum, or defensive such as casteless or walls. Therefore, the layout of each city differs, even if it dates back to the same historical period as another city. While studying cities several

groups of problems arise, mainly represented by problems related to the human factor or problems resulting from modernity. This factor causes an increase in the burdens of the historical city from the use of different building materials, the use of inappropriate means of living, and the use of cars and means of transportation. Modern projects rely on fossil fuels, changing the layout of the ancient city and changing the use of spaces in historic buildings, and abandoning the historic city and the subsequent economic, political and scientific problems. The second main problem is the environmental problem resulting from natural disasters or rising ground water levels in some historical cities, and the most influential problem at the present time is the phenomenon of climate change resulting from global warming and its negative effects on historical cities, their buildings and their residents.

In light of the modern trends of green construction and support for green transformation in all aspects of life, this study addresses the definition of green cities and the standards that define them as: a. energy efficiency, b. waste management, c. sustainable urban planning, d. natural environment, e. green means of transportation, f. environmental health, and g. reducing water consumption.

Historic cities were originated from the perspective of green cities by applying green city standards to them. The study proved that historical cities were green cities when they were formed, benefiting from the potential of the site and adapting environmentally to it, thus limiting environmental changes. As a result of the developments that have occurred in these cities, they currently need to be rehabilitated to turn them green again. The study proposes a set of solutions to restore historic cities to their origin. These solutions depend mainly on ridding historic cities of aspects of modernity that are unsuitable for their environment, preserving their original planning, and benefiting from modern scientific techniques that rely on clean and renewable energy sources within any activities in them.

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