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Moataz M. Abdel-Aziz, Riham Salah

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Green Buildings on The Egyptian Coast: Prospects and Obstacles

Moataz M. Abdel-Aziz [1,], Riham Salah Mohamed [2]*
[1,*] *Mechanical Power Engineering Department, Faculty of Engineering, Horus University, New-Damietta, Egypt, email: dr.moataz86@yahoo.com, mmostafa@horus.edu.eg*
[2] *Lecturer of Architecture, Architectural Department, Faulty of Engineering, Horus University-Egypt (HUE) , email: rsalah@horus.edu.eg*

Abstract- **Egypt's 2030 Sustainable Development Strategy seeks to add 140 million people to the nation's population by 2050. This expands the built environment, which raises the demand for energy and natural resources. Due to the current extreme weather conditions and advancements in construction technology, which have contributed to the squandering of natural resources. The need for comfort inside structures has grown pressing among residents. nonetheless, without raising prices or diminishing resources.**

Recent years have seen a rise in the use of the term "green building" (GB) due to the fact that it provides workable solutions to pressing global concerns like the depletion of energy and water resources and problems with the buildup of waste. The variables affecting the spread of GB on the Egyptian coast are looked at in this research, along with an overview of GB assessment methods.Since Egypt leads the region in construction technology, the findings of this study are practically applicable to every nation in North Africa. Many studies have attempted to categorise the challenges that globally sustainable development programmes confront. This study will discuss Egypt's challenges as well as the rise of green structures there. Additionally, it will draw attention to problems with GB practises all throughout Egypt, but particularly in coastal regions. This covers obstacles and forces that aid in the planning of global factors for green projects.

Keywords- **Green Buildings (GB); Sustainability; Egyptian Coast; Affecting Parameters; Challenges; Obstacles; Urban Heat.**

I. INTRODUCTION

Global warming and rising temperatures in metropolitan areas are producing problems for many cities, putting stress on residents and requiring large amounts of energy and water. The creation of a dwelling has long been among the utilitarian objectives of architecture. In light of the ongoing population growth, which may exceed a billion people in 2040, architecture has continued to improve, developing many styles to make buildings appropriate with climatic conditions in many places **[1]**.

The development of facilities to keep up with structures using mechanical ways that consume energy for heating and cooling and move away from finding natural alternatives is another factor. This contributed to the issues we are currently facing since buildings became climatically unsuited and only dependent on industrial ways to provide thermal comfort, which increased energy use, continued resource depletion, and water and air pollution **[2, 3]**.

This is what spurred global attention to the environment and its natural resources, emphasized the role of architecture in attaining goals, and encouraged the adoption of numerous new practises that are more concerned with the environment **[4]**. According to studies, building operations account for 28% of carbon dioxide emissions and 60% of the world's electricity use **[5]**. It is also discovered that the building industry consumed energy and resources at a 30%–40% rate, making it one of the most energy and resource-intensive industries **[6]**. This is because more air conditioning units will be used worldwide by 2050, when there will be 5.58 billion of them **[7]**.

This increase in the number of units is offset by an increase in electricity consumption. Therefore, in order to combat climate change, strategies that lower carbon emissions and raise the temperature through the use of green or blue infrastructure, as well as changes to the urban form and sustainable development programmes for buildings and urban areas, must be implemented. One type of architecture that exhibits harmony with the environment through its various and varied aspects is Mediterranean architecture. Due to its natural environmental treatments, Mediterranean architecture is a particular style that is rich in vocabulary and creative ideas. The Arab region, which is part of the Mediterranean basin, has a notable architectural past. It is currently occasionally referred to as the Mediterranean Revival style. Spanish architecture with its lofty ceilings and ceramic floors is reflected in the light paints and red tiled ceilings. windows with wide holes to let in as much natural light as possible. Using covered balconies and internal courtyards to connect interior and exterior spaces. These inside courtyards are crucial for climate treatment because they can regulate temperature. In addition, because of its harmony with the environment, it is regarded as sustainable architecture. This is one of these recent ways that helps lessen negative environmental effects and enhances the quality of life for people and the built environment, along with green building architecture **[8, 9]**.

"Green building technologies" (GBTs) have advanced quickly in recent years to improve the social and economic aspects of the building process. This actually calls attention to the global effects of the CO2 environment's natural effects. Green buildings (GB) are regarded as a technological collaboration in the expansion of the construction industry because they push conventional buildings towards sustainability in building technology and policies. As a result of the recent building revolution, Egypt has been one of the key countries in the Middle East and Africa on the path to expanding GBTs. The 1992 conference in Rio de Janeiro, Brazil was the first to discuss the idea of GB **[10]**.

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From that point on, a lot of insights into supporting structures and their various ecological, financial, and social angles are concentrated. One of the most significant trends in the construction industry over the past two decades has been green research **[11]**.

Any building that reflects the three pillars of environmental, economic, and social green building concepts gone through extensive effort to define and measure the degree of sustainability. Depending on this factor, many internationally accepted criteria were chosen to evaluate sustainability:

1. The utilization of nontoxic resources
2. Installation of systems for efficient water use and water recovery
3. The use of naturally happy machines in production uses less energy.
4. The use of endless resources
5. Imaginative idea.
6. Enhance the living conditions in the building for people's comfort and wellbeing.
7. Develop controls that limit energy consumption and the waste of essential resources, most notably water, using the system as a guide.
8. Limiting the growth and operation of the building's exposure to CO2 and other contaminants.

A few ranking systems had been created using the earlier standards. In the US, they are employing the "Leadership in Energy and Environmental Design" (LEED) rating system. The four levels of the LEED programs' testing are LEED Certified (40-49 points), LEED Silver (50-59 points), LEED Gold (60-79 points), and LEED Platinum (greater than 79 points). The renovation of conventional buildings to create green buildings has been added to the "Building Research Establishment Environmental Assessment Method" (BREEAM). Unclassified (0-29%), passing (30-44%), good (45-54%), very good (55-69%), excellent (70-84%), and outstanding (85-100%) are the six green building classifications offered by BREEAM.

The GB scoring frameworks LEED and BREEAM have been adopted globally in many countries, with some local adjustments made by each country depending on their level of eco-friendliness.

The aim of the study is to promote green buildings on the Mediterranean coast by understanding and evaluating the obstacles that hinder it, and knowing the extent of the importance of green buildings, especially for Egypt. This study explores what combination of laws and incentives aimed at municipalities could hasten the upgrading of GB standards in Egypt, particularly in coastal areas. The prevalence of Egypt (GB) may rise as a result of improved laws, opportunities, and campaigns to raise environmental awareness. To better understand the issues at hand and the potential policy changes that could aid in resolving them on the Egyptian coast, a historical and comparative context is first provided. The major figures who influenced GB approaches are then discussed. A combination of tactics for GB improvement are then compiled.

II. Green Building

The idea of "green building" refers to structures with high performance levels or structures that have been handled in a way that is sustainable in the use of natural resources. They are buildings that are made to make the best use of resources possible over the course of their lives in order to minimise negative effects, according to the US Environmental Protection Agency (EPA). regarding both the environment and people **[12,13].**

The US Green Building Council, on the other hand, defines green buildings as those that adhere to a set of standards that, when met, have a good effect on both human health and the environment **[14]**.

- Better use of resources (energy, water, land, and other resources) is one of these principles.
- Improving the working conditions for staff to increase output
- Decreased pollution.
- An increase in building performance efficiency improvements.

The Egyptian Green Building Council was established with the intention of utilising green buildings, whose main function is to conserve resources and lessen pollution, to improve the environment and economy of society **[15]**.

1. Advantages of Designing Green Buildings

Environmental, social, and economic benefits are the three main advantages of sustainable construction.

Environmental: decreasing pollution and the rise in temperatures (global warming), as well as maintaining the environment and its natural resources.

Social: improve public health and educational services and enhance individual quality of life - lowering poverty and improving residents' comfort and well-being

Economic: Boost productivity, spur economic expansion, cut down on resource waste, and lower utility bills

Due to the fact that they evolve through time, it is challenging to experience all of these advantages at once.

2. Green Buildings' Influence on Urban Areas

Buildings and the spaces around them, or the interior environment of the building and the exterior environment of the building, make up the urban environment. Green construction can be seen as a response to the problems brought on by urban heat. Global warming is a problem that is exacerbated by urban heat. It results from petrol emissions brought on by the transformation of the natural environment into a constructed one. Transportation, residential and commercial construction, industry, and electricity generation all contribute to the production of these gases **[16]**.

Due to the urban nature of the built environment, these emissions may become more intense. These emissions can be decreased by:

Finding other modes of transportation, establishing pedestrian paths, and promoting bicycle use. In addition to employing

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sources of renewable energy. Providing intensive tree and shrub planting to promote green infrastructure. Use of roof gardening for structures and walls.

The composition of buildings, their shape (height, length, and width), and their interaction with the local environment and traffic patterns all have an impact on heat output. The utilisation of water bodies, which once assisted in cooling but are no longer present, is one method of decreasing heat. It is also important to remember that raising building heights aids in heat retention.

Green buildings are not only the solution to reduce the internal heat of buildings, but also to reduce heat in urban areas. This is done by reducing global warming, reducing energy and natural resource consumption, and improving land use by reducing negative impacts on the built environment to improve the quality of life for residents by providing a sustainable environment.

III. FACTS OF EGYPT COUNTRY

1. Energy supply and demand

Green buildings are not only the solution to reduce the internal heat of buildings, but also to reduce heat in urban areas. This is done by reducing global warming, reducing energy and natural resource consumption, and improving land use by reducing negative impacts on the built environment to improve the quality of life for residents by providing a sustainable environment.

Egypt has been around since 4,000 B.C. According to **Fig. 1 [17]**, Egypt has a total area of 1,001,450 km2 that is divided between 995,450 km2 of land and 6,000 km2 of water. The second-largest nation in Africa is Egypt. Through the Mediterranean Sea, it also links the three continents of Africa, Asia, and Europe.

Fig. 1. Map of Egypt **[17]**

Egypt's oil consumption has surpassed its production, as shown in **Fig. 2**. Additionally, Egypt produced 660,000 barrels of oil per day on average in 2021 **[18]**. Additionally, Egypt experiences frequent power outages as a result of rising demand and natural gas supply shortages. Egypt generated about 183 giga watthours (GWh) in 2019 with a total installed capacity of 57 giga watts (GW). About 90% of Egypt's total power generation capacity was derived from fossil fuels, with the remaining 5% coming from hydropower and the rest from renewable sources. Egypt doesn't produce electricity using coal. Additionally, Egypt's electricity consumption has increased approximately by a factor of two, reaching 57.4 GW in 2019. Egypt's net electrical generation from 2010 to 2019 is depicted in **Fig. 3 [18]**.

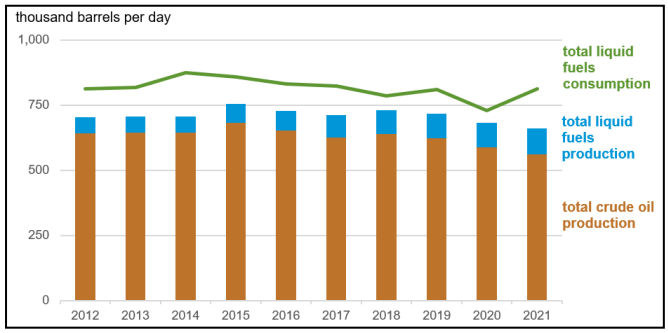

Fig. 2. Total annual fuel production and consumption in Egypt **[18]**

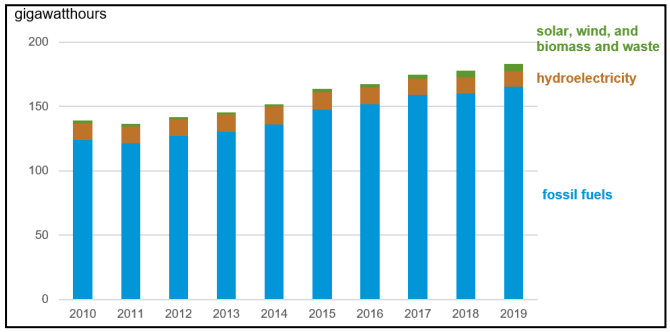

Fig. 3. Net electricity generation in Egypt **[18]**

The increased use of energy resources has resulted in significant environmental issues like air pollution and global warming. The secret to effective green building promotion in Egypt is setting standards and regulations among all stakeholders, including building owners and occupants.

2. Supply and demand for water

According to the Egyptian Ministry of Water Resources and Irrigation (MWRI), the current state of the country's economy has been hampered by a lack of water. The global threshold for water scarcity is 1000 m3/capita/year, and Egypt has already gone over this mark for more than 20 years. According to projections, Egypt will experience a complete water shortage by 2025, with a demand of 500 m3/person/year **[19]**.

3. Generation of waste and disposal

The management of waste presents one of Egypt's biggest challenges. In Egypt, "municipal solid waste" (MSW) makes up about 21% of all waste produced, with an average annual production of 15 million tonnes **[20]**. Both the environment and human welfare are impacted. Additionally, 3-4 million tonnes of construction and demolition waste are produced annually in Egypt. Therefore, it is evident that managing this expanding amount of waste and reducing the amount of waste is necessary. According to **Fig. 4 [21]**, the infrastructure

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project was the most wasteful in terms of the proportion of total wasted materials cost to total purchased materials cost.

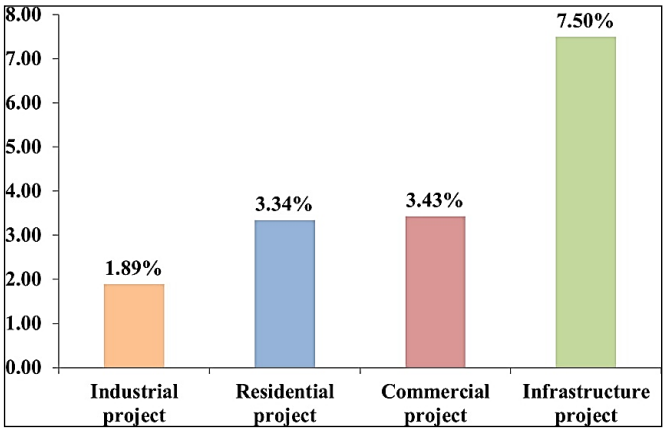

Fig. 4. Percentage of total wasted materials cost in relation to total purchased materials cost in different construction projects in Egypt **[21]**

4. Environmental Impact and Climate Change

Black clouds have formed as a result of rising CO2 emissions. Egypt's per-person environmental impact is increasing. According to the World Bank, as shown in **Fig. 5 [22]**, Egypt's carbon dioxide emissions increased from 1.6 metric tons per person in 2000 to over 2.4 metric tons in 2017, then fell to 2 metric tons in 2020.

Implementing the code, as shown in **Table 1 [23]**, will result in energy savings in buildings, according to the Egyptian Building Energy Efficiency Code. The largest industry with a direct impact on climate change is the construction industry. Within permitted building limits, fresh water consumption is 17%, wood conservation is 25%, and material and energy use are 40% **[24]**. Therefore, the information in this section suggests that the Egyptian economy has a disturbing need for incorporating sustainable solutions and building systems.

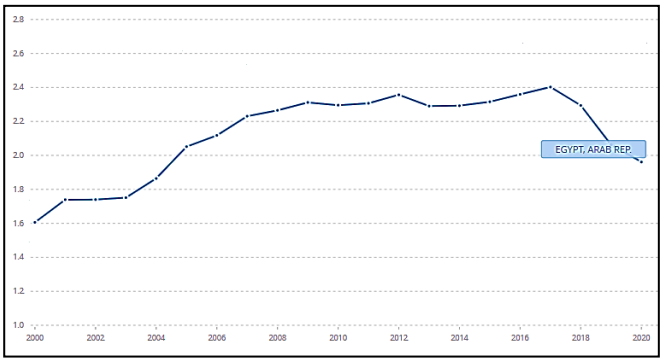

Fig. 5. CO2 emissions (metric tons per capita) in Egypt **[22]**

IV. Egyptian Green Building Projects

Buildings in Egypt are subject to a number of environmental issues, including: (a) the excessive use of air conditioning during the summer; (b) the use of antiquated lighting systems; (c) the wasteful use of water resources; and (d) the lack of efficient waste management methods. Energy use in buildings, which accounts for 45–50% of the total energy consumed across all industries **[25]**, is the indicator that causes the most anxiety.

Table 1

Associated CO2 and Energy savings in (% and Billion KWh) **[24]**

Energy saved, (%)	Energy saved, (Billion kWh)	CO2 Reduction, (Million Ton CO2)
5 %	2.7104	1.49
10 %	5.42	2.98
20 %	10.84	5.96

In conjunction with the Sharm El Sheikh Financial Conference, the Egyptian government recently unveiled its "Sustainable Development Policy of the 2030 Vision of Egypt," which focuses on economic growth, human capital, and the competitiveness of the Egyptian market **[26]**. The strategy's goals include enhancing the efficiency of the energy sector, decreasing waste disposal and associated costs, enhancing Egyptian citizens' quality of life, and lowering greenhouse gas emissions from various sectors **[27]**. As a result, a GB rating system will be essential to the effective implementation of this policy in the building and construction sectors. As a result, a GB rating system will be essential to the effective implementation of this policy in the building and construction sectors.

Systems of certification promote environmentally friendly building practices that help to mitigate climate change and promote the long-term viability of the environment, the economy, and society. The benefits of sustainable design and construction would be realized in three stages, according to a GB evaluation framework: (1) at the human level, (2) at the national level, and (3) at the global level. The development of various GB rating systems with various features and advantages is necessary for the Egyptian GB market **[28]**.

There are many applicable GB projects in Egypt such as: New Valley Farafra Oasis, Green Village and Traditional house in Toshka region, South of Egypt.

Egypt's Experiences

Hassan Fathi, the architect of the poor, is the first figure that comes to mind when we discuss sustainable building, particularly in Egypt. The use of regional materials that are environmentally benign and in harmony with the social, cultural, and economic aspects of the local area distinguishes his works. Domes and arches that promote natural ventilation are a defining feature of the designs.

1. New Administrative Capital

The state's efforts in sustainable development and establishing fourth generation cities in Egypt. For example, the New Administrative Capital, a green city, has a per capita green space of 15 square metres. A sustainable city, the roofs of buildings are covered with solar energy units and the road network is allocated 40% for pedestrians and bicycles. Sustainable and renewable systems for energy generation, waste recycling and water desalination. It also has the Central

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Park and the Green River, 25 km2. The Green River is a group of parks along the city, forming a central park.

Applying sustainability through natural ventilation in one of the buildings in the New Administrative Capital. The HVAC system is also used for cooling and heating the air, this is in addition to using a water cooling system.

Fig. 6. Green River in the New Administrative Capital

2. The City of Alamein

The City of Alamein is one of the smart sustainable cities located on the Mediterranean coast, relying on green architecture and smart infrastructure to rationalize energy consumption. The first green city on the Mediterranean coast, was established to achieve the United Nations Sustainable Urban Development Program. It is also an extension of the implementation of Egypt's strategy for sustainable and self-sufficient economic development, as it is a model for new cities that aim to attract investment through key industries **[29]**.

Fig. 7. The City of Alamein **[29]**

3. Eco-City Alexandria

To achieve the sustainability of the city of Alexandria, the city joined the European Bank's Green Cities Programme. This is done by developing a strategic plan until 2040 in main areas (climate change – transportation – energy – water sources – land uses and open spaces – solid waste – air quality). Approving the application of creating green buildings and raising their level from certified buildings to silver standard buildings. Strengthening the powers of the private sector by establishing a renewable energy station **[30]**.

V. Egyptian Initiatives for GB

1. Energy and Egyptian building codes

To review construction and practitioners for creating buildings and projects, the national plan of each nation needs a mandatory mechanism called rules and laws. In order to manage buildings efficiently, with high quality, and in a mandatory manner, the Unified Egyptian Building Code seeks to achieve sustainability. Egypt's participation and the execution of agreements reached with international environmental organisations are confirmed by the building code

To obtain a public or private building license, the following provisions of the Egyptian Unified Building Law must be met **[31]**:

- Wetland and agricultural areas, as well as areas close to the coast, are not to be developed.
- The area must be lit by a natural light source, including the kitchen, stairs, bathroom and service room.
- **ECP 301/1-2002** is the plumbing code for buildings. Both the public's health and the leakage of bad fragrance are protected by it. Every construction project must be designed to use less water and not discharge sewage into rivers and lakes.
- **ECP 304/2-2004** is a code for air conditioning that aims to protect public health, ensure a minimum level of comfort, and promote energy conservation.
- **ECP 501-2005** is a code for using sewage water for agriculture. Its objective is to give farmers instructions on how to safely recover and reuse sewage water.
- **ECP 306/1 and ECP 306/2-20005** are codes that increase the energy efficiency of building envelopes.
- **ECP 305/2-2007** is a code used to safeguard the structure from fire.

Egypt's Unified Building Code No. 119 of 2008 and its Executive Regulations No. 114 of 2009 have raised awareness of the need to reduce energy use in buildings by 20%. There is no practical application to improve the environmental efficiency of buildings, despite the fact that it also discusses numerous environmental, economic, social, and cultural issues. Another initiative to raise awareness is developing a local work plan for environmental assessment called the "Green Pyramid." Through Egypt's participation in the World Green Building Council, this attempt was undertaken **[32]**.

As a result, it is clear that the Egyptian code needs to be developed. This can be accomplished by:

- Raising public knowledge of environmental issues and energy concerns among individuals and institutions.
- Analysing the demands of the Egyptian real estate sector and pressuring it to adopt corrective measures in accordance with global accords regarding the environment and public health.
- Constant monitoring of regional and international developments.

2. Environmental Evaluation and Efficiency of appliances

For Egypt's most popular appliances, the government has implemented energy efficiency standards and energy labels.

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i. Council for Egyptian Green Building

The Egyptian Green Building Council (EGBC), which was founded in 2009, has created a National Green Building Rating System (GPRS).

ii. Egypt's LEED system

There aren't many structures with the LEED certification in the Egyptian real estate market. This certificate has been granted to 23 properties.

iii. Green Pyramid System

As a method of gauging performance and certifying green buildings, it is a system based on the LEED system. It was issued in 2011 and was developed with the participation of the National Housing and Building Research Center and the Egyptian National Green Building Council. It offers four levels of accreditation (certified - silver pyramid - golden pyramid - green pyramid). Although more than ten years have passed since its establishment, this system is not widespread and well-known, meaning that there are shortcomings in its direction stemming from the responsible authorities for not making it known.

iv. TARSHEED

Based on Excellence in Design for Greater Efficiencies, it is a non-governmental approach to promote green buildings and assess environmental performance. In order to emphasise the concept of rationalising consumption to achieve the principle of sustainability, the framework is based on evaluating the efficiency of its usage based on the use of both (energy - water - environment). This system needs to be implemented widely, and the adoption level will rely on the rate of rationalisation (20, 30, and 40%).

Numerous studies have been done on how to rationalise energy usage and efficiency in environmentally friendly, sustainable buildings. 43 nations participated in these studies. Egypt is one of the few nations that was interested in such a study and its publication, as proved by the shown **Fig. 8** China, America, and Italy are the three countries with the most investigated and analysed cities **[33]**.

VI. Factors Affecting GB Spreading in Egypt

Green buildings are a solution for both the outer environment in urban areas as well as the inside environment of a building. By lowering energy consumption and boosting the usage of renewable energy sources, it aims to improve the indoor environment of residents. In terms of the environment outside, shaded places in cities and the usage of highly reflecting pavement materials are both necessary to combat urban heat.

Many cities have adopted the approach of using green buildings, but they are not widespread enough. This is because there are some obstacles that hinder its spread around the world. Each country differs from the other in these obstacles, due to the different characteristics of each country. Therefore, green buildings must be considered from a different point of view in order to be compatible with the characteristics of each country to implement them and ensure their success. For example, among the LEED strategies in the United States, which are based on green buildings, buildings include vegetated roofs, providing underground parking, or providing buildings for them. If these obstacles are taken into account, it will help reduce heat and carbon dioxide emissions and adapt to the current conditions of thermal regions **[34]**.

A number of variables may have an impact on the prevalence of GBs in Egypt. These elements can be broadly divided into political, legal, technological, cultural, social, economic, and environmental aspects, as shown in **Fig. 8**.

Fig. 8. Obstacles to the spread of green buildings in Egypt

Many important elements influencing the use of GBs in Egypt is shown in **Table 2**.

VII. Case Study: Egyptian Coast (New Damietta City)

At the intersection of longitude 31' 43° east and latitude 31' 27° north in the far north of Egypt, New Damietta is situated on more than 5,000 acres of irregular inland terrain and flat sand along the seashore. The Mediterranean Sea and Sandy areas, which are extensions of the Ras El Bar resort, encircle it on the east and north, respectively. **Fig. 9** shows the location of New Damietta City on the Egyptian coast. The city has a distinguished location overlooking the Mediterranean Sea and has a distinctive climate: dry, hot summers, and moderate, rainy winters.

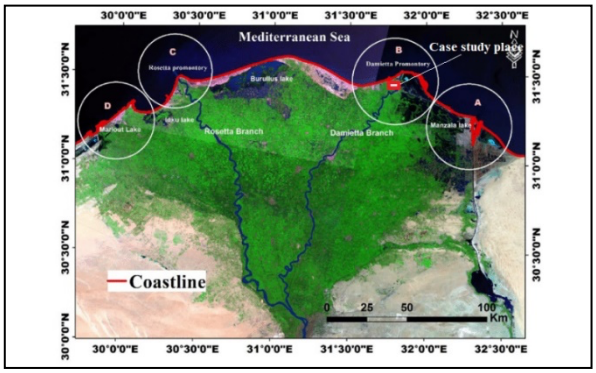

Fig. 9. A case study place on the Egyptian coast **[41]**

It was designed to complement the existing city of Damietta, with a population of 33,234, with building requirements. The building is on 60% of the flat surface of the plot of land, and it has specific heights that do not exceed the ground and four floors. New Damietta City now has a very active construction movement, although more than 40 years have passed since its

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establishment, it is still being built and vacant plots of land are being built there.

Eco-City Alexandria approach can be followed by adopting a successful strategy in each of the following areas (climate change, energy, transportation, land use and open spaces, solid waste, water resources, and air quality). In the short, medium and long term for both buildings and the urban environment, taking into account the obstacles and incentives mentioned previously.

1. The urban environment of New Damietta

Mitigating global warming in built-up urban areas: It is an integrated process between a group of parties (engineer, planner, owner, contractor, and others), the building, and the external environment in the process of constructing and maintaining the building until its demolition. Taking into account the principles of designing green buildings and the external environment, including the built environment and means of transportation, rationalizing the consumption of energy, water and materials used, and providing a sustainable environment.

The city, as we mentioned previously, is characterized by low elevations, which helps move the air, cool the surrounding environment, and reduce the temperature of urban areas

2. Green buildings in New Damietta City

Due to the location of the city, buildings must be designed and oriented in areas with waterfronts. Providing shaded paths (trees - pergolas) for the possibility of practicing activities. Providing short walking distances within the site and directing the prevailing winds and improving their speed for optimal direction to help reduce the rise in temperatures.

In addition, installing solar panels helps reduce electricity consumption, as the high urban heat leads to electricity consumption through the use of air conditioners, in addition to water consumption as a result of using them to cool surfaces. This has an impact on labor productivity, which has an impact on the economy.

Therefore, from the above it is possible to set standards for the urban environment to be compatible with thermal variables, which include the planning of the site - the building - the materials used - the land.

- Site planning: The state must move toward green infrastructure (sustainable transportation: cycling), environmental diversity, and provide shaded areas of buildings, trees, and umbrellas in order to treat the rays reflected from the pavement. - Protect natural water bodies.
- The building: the optimal orientation of the buildings - taking into account ventilation through the proportion of window and door openings - the proportion of the building's shading - the proportion of spaces - taking into account internal and external thermal comfort - the number of buildings in the area and how close they are to each other.
- Materials used: Flexible and strong building materials (internally and externally), with specifications commensurate with carbon dioxide emissions.
- Land: taking into account the proportion of urban green areas, density and improving planning.
- Energy: Use of efficient equipment - Use of renewable energy (sun, wind).
- Water: Create a system to conserve wasted water (water in sewage - rainwater) - Follow green irrigation.

On the other hand, the scorecard below (**Table 3**) shows the potential points that the project could earn in order to apply for LEED certification. Additional information about each calculated credit is provided in the following subchapters. The LEED rating system for the project scored 60 points (gold).

VIII. CONCLUSION

Buildings have an impact on the surrounding environment even though they are not intended to be inhabited. Building operations generate energy that has an impact on the nearby built environment. The search for alternate energy sources and solutions to the climate change crisis are contemporary global trends. GBs have become seen as an alternative style in the construction industry over the past few decades. Its importance is gradually increasing as a solution to issues related to bioavailability and water properties, as well as natural changes caused by carbon dioxide and other harmful gas discharges resulting from aging and bioavailability. The previous period saw significant changes for GBs, but there were also challenges. Despite the state's numerous attempts, there are still challenges that must be researched and determined in order to be removed before GB can become the standard construction technique.

This paper investigated to find these obstacles and incentives that exist in the country. These obstacles differ from one country to another, especially in developing countries such as Egypt. We find that the three most common obstacles are lack of government support - lack of skilled workers - high cost. On the other hand, the three most important motivating points are: promoting health and comfort - rationalizing water consumption - rationalizing energy consumption. In order to promote high-quality GB, three things are required:

- Until GBs are more generally accessible, the government promises to offer high-quality subsidies for at least a few years. Indirect subsidies, which can have a large impact, include things like lower municipal taxes, more affordable land in new communities, and better or more affordable credit for green building.
- GBs coastal projects in Egypt have a good chance of success because they have a LEED rating of 60 points (gold).
- Creating a solid database that is simple to use, working to produce educational practices that will improve workers' professional practices and raise their expertise.

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Table 2

Parameters influencing the use of GBs in Egypt

Elements	Obstacles	Catalysts
Political	- Insufficient promotion from government organizations **[35].**	- A policy framework for promoting GB practices may be made available by the alignment of GB initiatives with more comprehensive national sustainability strategies. The government can provide funding for GB projects that demonstrate the viability of sustainable building.
Legal	- Ineffective rules and regulations pertaining to green buildings. - Accreditation standards are challenging to meet **[36].**	- In order to encourage the adoption of GB practices, the government must update the laws that mandate or provide incentives for them. Offering tax breaks, financial aid, or other financial advantages to builders and property owners who invest in GB practices can encourage adoption. Adoption can also be influenced by government support for GB certification programs like LEED or BREEAM. - Applying urban planning strategies.
Technological	- Lack of local expertise and technical experience - Length of construction time **[37].** - Lack of databases **[38].**	- The construction of GBs may become simpler and more affordable thanks to developments in GBTs like energy-efficient HVAC systems, solar panels, and smart building controls. Innovation in the building industry may be sparked by investments in the creation of sustainable building materials and technologies.
Social & Cultural	- Lack of awareness of environmental issues and people's green constructions **[39].** - Not being open to change - Lack of scientific research and educational programs	- Promoting health and comfort - The adoption of GB practices in the community can be influenced by cultural attitudes towards sustainability. - Attracting distinguished workers - For sustainable construction practices to be successfully adopted, it is essential that training programs for engineers, contractors, and building professionals are readily available in GB practices. A future workforce with experience in sustainable design may result from the incorporation of GB principles into engineering education.
Economic	- High cost **[40]** - Lack of market needs for green projects - Lack of incentives to encourage investment	- Using green technologies and practices can be expensive at first. But over time, savings in energy and resources can make up for these expenses. Developers and property owners frequently think about the return on investment (ROI) of GB investments. Adoption can be sped up by policies that show the long-term financial advantages of GBs. - The degree to which investors and homebuyers are aware of the advantages of GBs can affect market demand. Campaigns for public education may aid in raising awareness. Higher property values and rental costs in GBs may encourage investors and developers to construct green structures. - Enhancing the quality and value of buildings - Obtaining financing: For developers, investing in sustainable construction may be simpler if they have access to financing options that support GB projects. - Collaboration between the public and private sectors: Collaboration between public and private sector stakeholders can create an environment that is conducive to the growth of GB.
Environmental	- Climate and environmental issues	- Egypt's particular climate and environmental issues, like water scarcity and extreme temperatures, can affect the style and characteristics of GBs. - Rationing water use - Rationalization of energy consumption - Reducing the consumption of natural resources - Reducing demolition and construction waste - Enhancing the internal environment of the building

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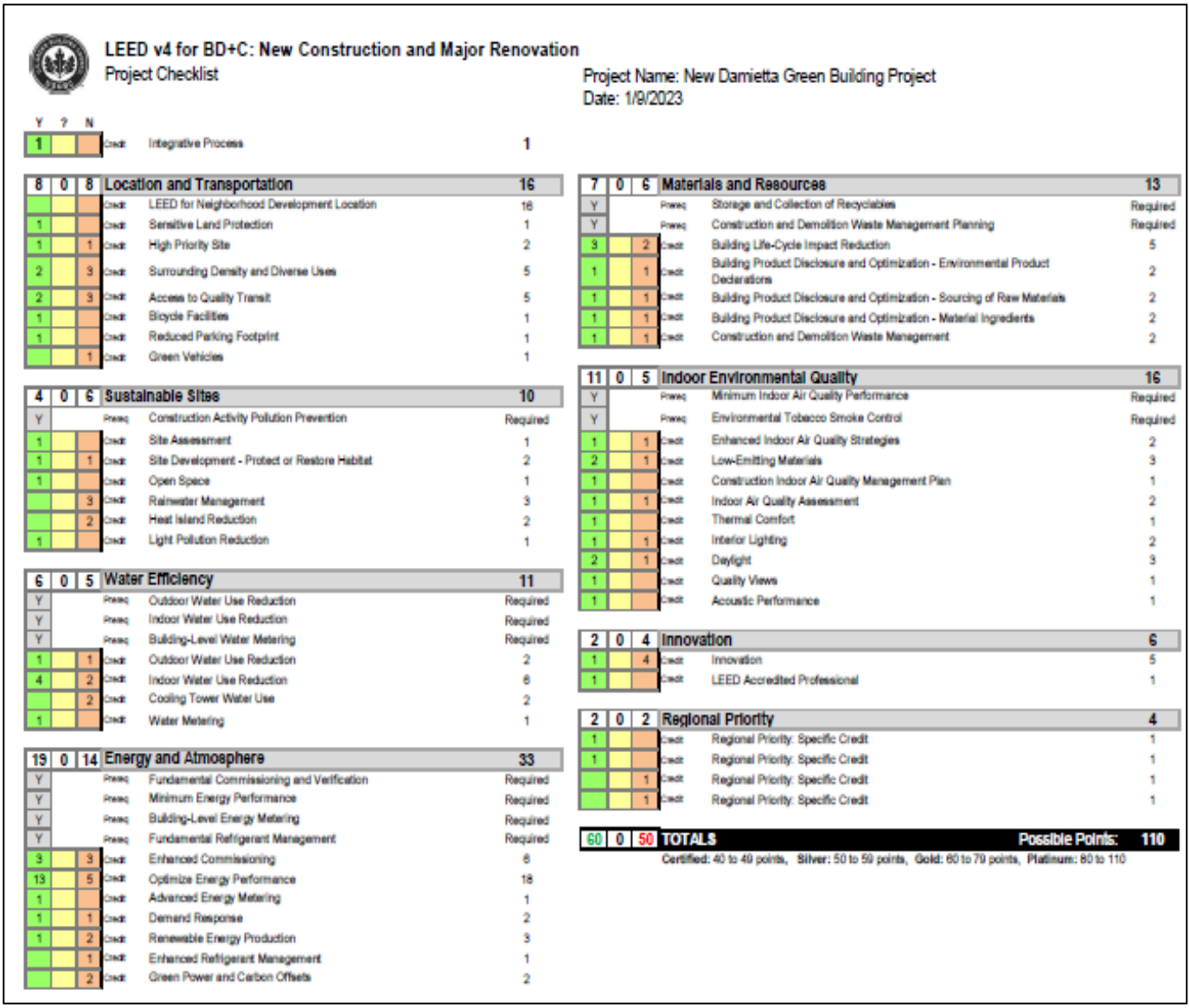
Table 3

Building Design and Construction v4 LEED New Construction



LEED v4 for BD+C: New Construction and Major Renovation
Project Checklist

Project Name: New Damietta Green Building Project
Date: 1/9/2023

Y	?	N			
1			Credit	Integrative Process	1

8	0	8	**Location and Transportation**		16
			Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
1		1	Credit	High Priority Site	2
2		3	Credit	Surrounding Density and Diverse Uses	5
2		3	Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
		1	Credit	Green Vehicles	1

4	0	6	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
1		1	Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
		3	Credit	Rainwater Management	3
		2	Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1

6	0	5	**Water Efficiency**		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
1		1	Credit	Outdoor Water Use Reduction	2
4		2	Credit	Indoor Water Use Reduction	6
		2	Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1

19	0	14	**Energy and Atmosphere**		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
3		3	Credit	Enhanced Commissioning	6
13		5	Credit	Optimize Energy Performance	18
1			Credit	Advanced Energy Metering	1
1		1	Credit	Demand Response	2
1		2	Credit	Renewable Energy Production	3
		1	Credit	Enhanced Refrigerant Management	1
		2	Credit	Green Power and Carbon Offsets	2

7	0	6	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
3		2	Credit	Building Life-Cycle Impact Reduction	5
1		1	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
1		1	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1		1	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
1		1	Credit	Construction and Demolition Waste Management	2

11	0	5	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
1		1	Credit	Enhanced Indoor Air Quality Strategies	2
2		1	Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
1		1	Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
1		1	Credit	Interior Lighting	2
2		1	Credit	Daylight	3
1			Credit	Quality Views	1
1			Credit	Acoustic Performance	1

2	0	4	**Innovation**		6
1		4	Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

2	0	2	**Regional Priority**		4
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1

60	0	50	**TOTALS**	Possible Points: 110

Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110

IX. RECOMMENDATIONS

Researchers

- Study of market behavior **[42].**
- Update energy consumption data
- Studying user behaviors with energy consumption and the environment **[43].**
- Providing solutions to design problems.
- Encouraging the use of active and passive design techniques in buildings (double-skin façades (DSFs)) **[44].**
- Presenting a study to fill the gaps in building evaluation methods in Egypt.
- Identify the different strategies in developing countries.
- Providing proposals for green buildings at different levels (residential - industrial - educational buildings).
- A research study on sustainable urban expansion, not just buildings.
- Finding alternative solutions to reduce the increase in construction costs.
- Urging stakeholders and residents to learn about green buildings.

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Stakeholder	**Designers**	- Design support with building simulation programs. - Emphasis on highlighting the principle of sustainable design. - Applying sustainability to all buildings, including historical buildings when developing them. - Continuous training for architects to deal with modern buildings. - Enhancing buildings with natural lighting by increasing the amount of natural light entering the building. - Reducing load burdens by cooling the interior spaces of buildings naturally. - Working to develop LEED standards.
	Professionals	- Study of population behaviour. - Designing sustainable buildings with passive systems. - Continuous training for building evaluators. - Urging the provision of awareness consultations to increase the owner's awareness to understand the principles of sustainable design.
	Consultants	- Stakeholders and technology developers must explore opportunities for knowledge exchange between them. - Promoting and developing professional education through continuous workshops, courses and seminars. - Urging to provide adequate information on how to apply sustainable design practices to solve the problem of high cost.
	Owners	- Awareness campaigns to introduce how to rationalize energy consumption.
	Investors	- Guiding the direction of designs towards LEED certification. - Pursuing the development of novel green construction technologies. - Encouraging investment for sustainable building programs.
	Marketers	- Advancing the industry by constantly coming up with useful innovations.
	Developers	- Urging the use of local means that promote green investment (materials, energy, etc.). - Promoting the benefits of green investment by finding new market channels.
	Practitioner	- Considering the price, technological viability, and management's willingness to adopt the sustainability concept. - Consider and research similar design practices from other experiments.
	Clients	- Consider project designs that provide adequate standards for green buildings.
	Users	- Urging the selection of technologies that help rationalize energy consumption with high efficiency and reduce emissions of gases that contribute to global warming. - Promoting knowledge of the community's environmental awareness. - Enhancing knowledge for stakeholders, technology developers and designers. - Educating users about how the facilities in their buildings work.
Government & policymakers	**Government**	- Working to implement government policies that support sustainable buildings. - Promoting registration for LEED accreditation. - Promoting the use of solar energy as an energy resource for home use. - Implementing technological development policies. - Consider offering incentives to users to implement government policies. - Finding ways to help the market and build new capabilities. - Urging the implementation of green buildings in the country. - Consider and understand the barriers that were previously presented to find solutions. - Promoting green construction with government support by contributing a percentage of the cost to stakeholders. - Strengthening and developing laws and regulations (Egyptian Building Code) with urban development policies. - Regulatory bodies must be established to monitor the progress of work related to green buildings.
	Policymakers	- Innovating new policies by scientific bodies. - Raising the cognitive awareness of policy makers. - Monitor changes continuously. - Implementation of artificial intelligence techniques. - Developing green building performance evaluation systems through questionnaires for both decision makers and investors for the real estate industry. - Promote planners, designers and decision makers with updated green building evaluation strategies to enhance planning and design.

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