An Analytical Field Study on the Principles of Sustainability in the Interior Design of Modern Egyptian Buildings

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Abstract

The world is constantly moving towards environmental-friendliness, and there are plenty of modern concepts that attempt to link architecture and the environment, in previous as well as current times. This is done in order to connect a heritage that's full of spirituality, with a modernity that's heavily influenced by material inclinations. This is to be accomplished through the use of engineering as well as technical capabilities that prepare and adapt the environment to make it suitable for living and that allow it to maintain its quality. Furthermore, "sustainability" has become part of the mainstream discourse. It refers to "developmental strategies that take into account the requirements and aspirations of current and future generations at once, and is simultaneously aimed at providing a balance of interests that serves everyone in the fields of economy, society and environment." This is in addition to the emergence of the ecological infrastructure concept, which is concerned with the natural and material environmental surroundings. This concept also recommends the use of environment-friendly material, calling towards the preservation of the natural resource base.

Sustainable development has adopted a set of strategies, including the following: optimally orienting the building, exploiting natural energies and taking into account planning systems, building details… etc." In addition to that, it has adopting strategies to improve the quality of life for the tenants in matters of public health. Sustainable design is also regarded as an essential step to achieve economic growth while protecting natural resources and raw material, in order to achieve sustainable design, and principles of sustainability.

Research objective: The research aims to study the concept of sustainable development and its applications in the field of interior design, and the extent to which this concept is used in preserving natural resources from extinction.`1

Research problem:

• Failure to plan for future needs and depletion of natural resources due to the delay in applying the concept of sustainable development in the field of interior design.

• The existence of designs that are not suitable for the Egyptian environment that do not meet the needs of its users, which were present in previous eras.

Research Methodology: Descriptive and Analytical Approach

Research Boundaries: Objective boundaries of the sustainability principles of architecture

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1- Introduction

Sustainability is a term used for a diversified ecological environment with diverse natural factors; an environment that sustains its existence for the longest possible period of time. Sustainability is also defined as the preservation of life by adapting to the environment through utilizing natural resources for the longest possible period of time that would lead to preserving the continuity of life. Another definition of sustainability is that it is a collection of vital processes that provide means of life to living organisms of all kinds, which in turn would assist them in preserving their kind and develop their own means of growth over time. [1]

In order to apply the concept of Sustainability, it's important to have those 4 elements in any ecological environment:

Scope of Sustainability: It is the field, or community to which sustainability is applied. Usually, its existence is linked to a set of social, economic and environmental factors that commonly constitute the full support required by the sustainability scope, with all its components.

Consumption: It is the utilization rate for the natural ingredients that are important to sustain the life of living organisms. The higher the rate of consumption, the better the preservation of life's sustainability, and vice versa.

Resources: This refers to all of the natural and industrial resources that contribute to support the scope of sustainability, so as to enable it to play its role. When those resources are sufficient and appropriate for the number of living organisms using them, they lead to having a maintained sustainability in those organism's lives for as long as possible.

Technology: It is the modern scientific impact on the nature of life, leading to its development. When technology is used correctly, it leads to the maintenance of sustainability by way of providing a set of modern scientific discoveries.

The sustainability scale is a tool that uses a set of numerical measurements that contribute to managing the components of sustainability. This is done by a way of relying on the understanding we have from our human knowledge. The sustainability scale measures the nature of sustainability in the various life forms by working to provide a set of vital indicators that present accurate measures. Those accurate measures in turn, assist in conducting a number of vital studies linked to the concept of sustainability. Following are some of the most important sustainability scales: Population Scale, Urban Development Scale, Urban Planning Scale, in addition to other measures that also exist [2].

Sustainable architecture or green architecture is a general term that describes environmentally conscious design methods in the field of architecture. It is the process of designing buildings in a way that is respectful to the environment, while taking into account reduced consumption of energy, materials and resources, in addition to minimizing the effects of construction and overall consumption on the environment, which is done by being in harmony with nature. Sustainable architecture seeks to reduce the negative environmental impact of buildings by enhancing the usage efficiency of materials, energy and space. Simply put, the idea of sustainability or of environmental design guarantees that our activities and decisions do not

deny opportunities to future generations. This term can be used to describe design energy that's environmentally-based and environmentally conscious. That is, sustainability is to not deplete natural resources so as to ensure their permanence and continuity for future generations. Therefore, sustainable architecture means to design buildings that consume water, energy and natural materials as little as possible, by reprocessing sewage water and using it to irrigate the gardens, in addition to using modern technologies that automatically provides the energy required in the building. This can be for purposes of cooling, air conditioning and lighting, and by using recycled building materials, or material that can be recycled later when they are no longer fit to be used in the building.[3]

Environmental architecture appeared in early civilizations as an attempt by humankind to adapt and coexist with his environment. The forms of this adaptation took various forms such as using construction material available in the local environment, in addition to using those materials in different ways, as well as coming up with methods to deal with environmental elements and their causes such as rain, wind, heat, sunlight and other things.[4]

In Egypt, we find that people of the early Egyptian civilizations used local materials such as mud bricks, papyrus and wood in their private architectural systems (such as the workers' quarters); whereas they used natural stones and mountain carvings for their sacred architectural systems (such as temples). For this reason, those buildings have maintained their interior design and furniture up to this day.[5]

This necessitated the study of some modern design models that were designed with a sustainable mind-set, and that used modern technological methods to benefit from the concepts and principles of sustainability to the largest extent possible, with the end goal being the creation of a design that respects natural factors and creates a harmony with them.

Potential benefits of sustainable building:

Improving the productivity of the occupants or tenants.

Reducing risk and liability.

Increasing understanding and awareness of environmental aspects and their ramifications.

Reducing costs over the lifespan of the building: initial cost, operating cost, as well as renovation or demolition costs.

Raising the performance level of the internal environment: through improved lighting, achieving thermal comfort and achieving a healthy internal environment for the comfort of those using the space.

2- Sustainability Standards:

There are numerous standards by which sustainable buildings can be evaluated, which include:

2-1. The LEED standard (in the U.S.).

This stands for Leadership in Energy Environmental Design which was first brought into use in the year 2000. This standard was developed by the USGBC (United States Green Building Council).

Today, the LEED certificate is awarded to outstanding projects in green sustainable architecture applications across the world.

2-2. The BREEAM Standard

This is one of the leading systems for the environmental evaluation of buildings. It lays a set of measurable standards for sustainable design, and its evaluation system is based on the following points: (Project management - pollution - land and environment use - raw material and waste - water - transportation – energy - health of occupants and environmental quality) where each of the previous points is evaluated and the evaluation scores are grouped to provide a building evaluation that ranges between (excellent - very good - good).

2-3. The GPRS Standard

As a result of realizing the importance of maintaining the ecosystem, in addition to realizing the industrial and social challenges in the region, the need arose for a classification system that would assist in defining the shape of the ideal Egyptian green building. There are three levels to obtain a green building certificate according to the Egyptian green building classification system: (Silver Pyramid - Golden Pyramid - Green Pyramid). Unlike other international classification systems, the highest level of certification is called "green" instead of, for instance, "platinum" to raise awareness and affirm the end-goal of reinforcing the fact that the most valuable level is to attain "green". The Egyptian Council for Green Architecture is a complete building approach to sustainability through the realization of performance in seven key areas which are: (Sustainable development sites – rationing water consumption - efficiency in the use of energy and environment - choosing building systems and materials - indoor environmental quality - design and innovation process - solid waste recycling).[6]

3- Obstacles facing implementation of the sustainable practices in Egypt:

There are several obstacles faced by the efforts towards implementing sustainable development in Egypt due to the nature of architectural, economic, political and social conditions present in Egypt, which are:

- Architectural Obstacles

Which is a result of big-city swelling, resulting from overpopulation.

- Social Obstacles

Among the values hindering the achievement of sustainable development is the inability to believe in anything that is new and the fear of all novel creations. In addition to there being an actual need for change in individual and societal behaviours.

- Economic Obstacles

This is due to the lack of employment opportunities and the rising levels of poverty in rural as well as urban areas.

- Regulatory Obstacles

The gap between the central and regional government due to the absence of effective participation mechanisms and non-availability of organizational approaches and parties that would guide and organize roles.

4-The main aspects that makes building design conform to the concept of sustainability in Egypt are:

Reducing the use of petroleum generated energy in energy-consumption areas; that is, energy used in Transportation, construction, manufacture, installation as well as the energy used throughout the building's lifespan.

Using reusable and recyclable materials.

Relying as much as possible on natural light during the designing process.

Ensuring simplicity in building management in addition to avoiding complexity in management forms and methods.

Relying on natural ventilation and its effects in space; reducing energy use to achieve thermal comfort.

Using solar energy in heating and cooling systems and using machines in small limits.

Exploiting opportunities to generate renewable electrical energy on the site and using photovoltaic cells.

Rationing water use by doing things like disinfecting unclean water and reusing it.

Creating an outdoor environment that is comfortable to watch and provides environmental benefits such as shading of trees during summer.

Exploiting environmental diversity affirms the need for a highly technical approach for designs alongside aesthetic compatibility.[7]

5-Field Study:

The field study deals with a research study of some buildings in Egypt with the aim of evaluating and identifying their negative and positive aspects in the context of sustainability.

The buildings include:

5-1. The American University in Cairo:

The University's administration decided to relocate its headquarters in downtown Cairo to a new site in New Cairo as a result of an increase in the number of students and the university's inability to accommodate them in the current headquarters. The new headquarters accommodates 5500 students and 1500 faculty members. In consideration of the project site being in a desert area west of Cairo, care has been taken to keep the design suitable for this climatic area. The design focused on climatic treatments to suit the environment and was produced in the design seen in figure: (1).

Negative strategies in ventilation and cooling through distribution and size of vents / openings.

Shading and the distribution thereof.

Control of natural ventilation.

Wall sections and fittings to reduce thermal gain

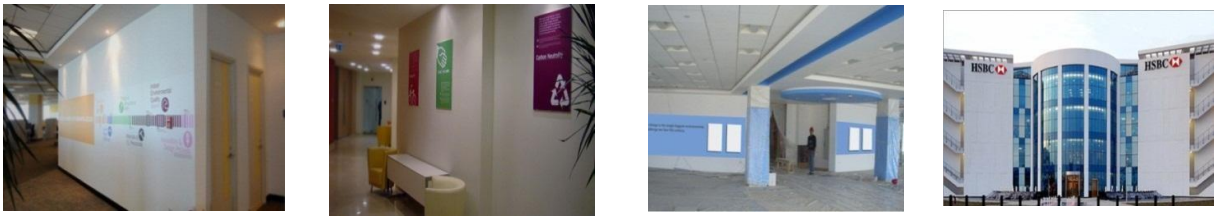
This, in addition to architectural treatments like wind-catchers and solar chimneys for environmental control in open, semi-open and indoor spaces.

The project studies focused on minimizing raw materials as much as possible and recycling them, and relying on locally available materials to a large extent.

Images highlighting the application of some treatments in the American University in Cairo Figure (1).
Photo source:
https://www.aucegypt.edu/news/khaled-tarabieh-auc-pioneering-green-architecture-egypt
https://www.aucegypt.edu/news/stories/auc-pioneers-simulation-technology-green-buildings-egypt

5-2. HSBC Bank - The Regional Headquarters

The building represents a pioneering experience that helps spread environmental awareness in Egypt Figure (2). The building consists of four floors in addition to two underground floors for parking.



Some pictures of the bank's headquarters located in the smart Village Figure (2).
Photo source:
https://www.academia.edu/21584913/%D8%A7%D9%84%D8%B9%D9%85%D8%A7%D8%B1%D8%A9_%D8%A7%D9%84%D9%85%D8%B3%D8%AA%D8%AF%D8%A7%D9%85%D8%A9

The building has received the LEED gold certificate for its outstanding performance in the following five areas:

Sustainable development of the site.
Water Conservation, where 47% of clean water is provided and 39% of water is recycled.
Energy efficiency, where the building saves 9% of energy in comparison to similar buildings.
Material selection and waste recycling, where 84% of construction waste was recycled as filler material.
The quality of the indoor environment
A system is being utilized to monitor and control energy in all parts of the building. This system records electricity consumption.
All building systems are also centrally controlled to increase the building's operational efficiency as well as its energy saving efficiency.
A system is used to improve the work environment through controlling dust. Similarly, building material was covered and sand was moistened using water unfit for drinking.

5-3. German School in Dokki, Cairo

A foreign school run by the German Embassy's administration in Cairo. It is one of the 14 projects that have been developed using photovoltaic systems across 11 different countries. Two German companies produced and installed the units at the school with the support of the German Energy Agency. The project is meant to demonstrate the diversity and quality of

German solar technologies across various countries. In addition to that, it's meant to exploit the high amount of solar radiation in these countries for the purpose of supporting their buildings. The school buildings consist of two floors with the exception of the administration block which contains three floors. The school is located on Dokki at Madares Streets in Dokki as shown in Figure (3). The photovoltaic system was added in 2008. The school consists of an administration block and a classrooms block alongside the school length. It is built adjacent to the school yard that is located between the two blocks. The swimming pool and playground fall in the west wing of the school.

Figure (3) highlights the location of the German school in Dokki. The photovoltaic system at the school consists of three groups as in Figure (4).
Photo source:
https://www.google.com/search?q=German+School+in+Dokki%2C+Cairo&tbm=isch&ved=2ahUKEwiC7OmIy_juAhUKehQKHdSJAlIQ2-cCegQIABAA&oq=German+School+in+Dokki%2C+Cairo&gs_lcp=CgNpbWcQDFD0pwZY9KcGYO6-BmgAcAB4AIAB0gKIAdICkgEDMy0xmAEAoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=9hAxYIKZM4r0UdSTipAF&bih=625&biw=1280&rlz=1C1GCEU_enBH889BH889&hl=en

It consists of two arrays in two floors:

The first group has been installed on top of the main entrance of the school at its southern façade and it consists of two arrays in two floors, they contain monocrystalline silicon cells that are integrated into the façade as shades for the windows below.

The second group is installed on the roof of the main block of the school which is the administration block. Accordingly, the arrays are installed in a way that they are inclined towards the south in order to exploit the maximum possible amount of direct sun-rays. The group consist of five arrays, and it heats running water, provides lighting to the classrooms and operates computers and refrigerators.

The third group is located behind the second group on the same roof. It consists of two arrays, each of which consists of 5 solar panels. This group supplies the electricity needed to power the swimming pool's water pump, as well as the sprinklers for green areas in the playgrounds. As such, there are 145 photovoltaic panels that are able to produce most of the electricity required by the building.

A metal roof has been installed in zigzag pattern on the roof of the classrooms' block. There is a gap between the false roof and the concrete roof to reduce the impact of sun-rays on the concrete roof in order to provide thermal comfort to the empty spaces.

Figure (4) shows the photovoltaic system installed in the German School's building.

This project can be considered a model paving the way towards the use of such systems in Egypt. However, mass implementation of the project may not be possible because this project, in particular, was supported by two primary factors.

The first factor was foreign funding from the German embassy which covered the high costs of the project as it is easy to import photovoltaic cells from German companies at reasonable costs. This is because Germany is considered to be the very first-ranking country with this kind of progress in this field, as mentioned earlier.

The second factor was the foreign technical support that made it possible for engineers to be available for the maintenance of these systems.

5-4. Vocational Training Centre, Al-Mazallaat, Cairo

The Vocational Training Centre is a professional training centre located in Al-Mazallaat area of Cairo. The Centre was built in 1961 on a plot of land measuring 2150 m^2. The main building of the centre covers an area of 360 m^2 as seen in Figure (5). It consists of three main floors in addition to a large workshop in the rear built at a height of one floor. The Centre was developed using photovoltaic systems in 1996. The Production Efficiency Authority at the North Cairo Region Department had imported photovoltaic panels from a German company. The panels were installed and operated by a German company and were used exclusively to supply power to light up the large workshop during night hours. The photovoltaic system at the Centre, as seen in Figure (6), consists of 180 panels. Each arch contains 9 panels with the exception of the entrance pack where two arrays are installed on the top containing a total of 16 panels. Similarly, a solar energy plant was added between the outside panels that were installed on the south façade and the lighting units of the indoor workshop on the northern façade. This was in addition to several lighting poles in the Centre's courtyard with their own photovoltaic panels. As for the other rooms in the Centre, they drew electricity from the main electricity network of the area.

Figure (5) shows the Vocational Training Centre in Al-Mazallaat, Cairo
Photo source:
https://egyptindependent.com/green-architecture-egypt-sustainable-project/


System transformers at the Centre's solar energy plant - The main battery at the Centre's solar energy plant

Figure (6) shows the components of the photovoltaic system installed at the Vocational Training Centre in Cairo

The rest of the system components are housed in the solar energy plant in the workshop. In addition to artificial lighting using the photovoltaic system, the workshop is designed to receive natural light during daytime as seen in Figure (7). This is to reduce electric consumption to power the workshop's lights artificially. However, the complaints of managers and technicians are focused on the lack of specialized labour in the Centre to maintain the panels and the inability to repair them in the event of damage. This has been an issue especially due to the Company failing to periodically following up with the system since the expiry of the contract.


Figure (7) shows the interiors of the indoor workshop at the Vocational Training Centre in Cairo

Conclusion:

Having conducted a field study of these buildings which apply the principles of sustainability in Egypt, it is our conclusion that the Bank's building ranks first in achieving those principles. It is followed by the American University's building. As for the German school, it may be regarded as a model paving the way for using these systems in Egypt. The building that uses such systems in the least is the Training Centre's building, **which faces several problems. Accordingly, the following conclusions may be drawn:**

The need for using technologies that help the building achieve the principles of sustainability and help it to preserve the environment.

The failure to adhere to standards set by the Egyptian classification system for green architecture.

Many consulting firms do not have sufficient experience in green building.

A lack of environmentally friendly systems, tools and materials.

Lack of appreciation for people who take bold initiatives, and those with innovative ideas that adopt the principles of green buildings.

The green building concept has several benefits when perceived from the perspective of public interest. Green buildings contribute to saving 12% of water use. They reduce energy use by equivalent of 22% to 12%. They may also reduce construction and demolition waste equivalent to 12% through recycling and treatment of waste.

Green buildings are also beneficial from the private individual's perspective since they have health, thermal and environmental benefits.

From a financial perspective, green buildings are beneficial because they provide maintenance work. Similarly, they provide an increase in the return on investment due to higher rental yield. This is what is currently happening in the West where green buildings yield higher value, whether in rent or in sale.

Absence of labour that's specialized in buildings that apply some of the sustainable practices such as panel maintenance in addition to the inability to repair damaged units due to lack of periodic follow up systems.

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