

The Future of Green Architecture in Saudi Arabia

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Abstract

Architecture plays an important role in the Environment sustainability. Through the time with the development of technology, new architecture techniques have emerged to improve the environment and limit pollution. In Saudi Arabia, the government is trying to improve the architecture sector by builds new green buildings that are suitable to the region. This research will explain the characteristic of green architecture, techniques to use for environmental sustainability, green techniques in Saudi Arabia, and the future of green architecture in Saudi Arabia.

Index terms— green architecture, sustainable buildings, sustainability, saudi architecture.

1 I. INTRODUCTION

he architectural sector in this day is no longer in isolation from the environmental pressing issues which they noticed it in the last few years, and it started threatening the world. Architecture Considered as one of the main consumers of natural materials such as land and materials, water, and energy. On the other hand, the large and complex construction industry operations produce large amounts of noise, pollution, and waste. However, the energy and water Consumption still the most prominent environmental-economic problems in the buildings due to its continuity throughout the period of the building operation. In the present era, the world began to recognize the close link between economic development and the environment. The traditional forms of economic development are restricted to overexploitation of natural resources and, at the same time, cause a lot of pressure on the environment, for the reason of the harmful pollutants and waste produced from it. Now a day, Architecture is facing the challenge of its ability to perform its developmental role towards the achievement of comprehensive sustainable development concepts. Architecture Sustainability and Environmental management and control became one of the most important competitive standards in the twenty-first century. Several approaches emerged to protect the environment through architecture; the most prominent was Green Architecture. Green architecture is a global movement toward Environment. Sustainability is a global concern; all of the countries must take care of the environmental condition and deal with it without affecting negatively on it. Saudi Arabia is one of these countries that supported the architects in this approach. Saudi Arabia is a country locate in Southwest of Asia with 200 million square kilometers. It is the largest country in the Arabian Peninsula, and the secondlargest geographically in the world. It's capital city is Riyadh. The Geography of Saudi Arabia is diverse, with forests, grasslands, mountain ranges and, most of its terrain consists of arid inhospitable desert or barren landforms.

The climate varies from region to region. Temperatures can reach over 110 degrees Fahrenheit in the desert in the summer, while in the winter temperatures in the north and central parts of the country can drop below freezing. Saudi Arabia gets very little rain, only about four inches a year on average (Saudiembassy).

This research will introduce you to green architecture; explain the different techniques and rating systems in green architecture, Also how these techniques can be applied in-country like Saudi Arabia and what is the future of this approach in Saudi Arabia. adaptation to the environment, by using the local material, the way of using the material and dealing with the climate of the region. In Egypt, we can see how the ancient Egyptian civilizations used the local materials, mud, papyrus, timber, and bricks in labors homes while they used the natural stone and sculptured the mountains for their sacred architecture, such as temples. In Islamic architecture, many environmental processors used, for example, the use Almagaf, domes, vaults, and courtyard, as well as timber in the mashrabiyya. These techniques were in the context of human adaptation to its environment. This trend was prevalent through ages) Al-Zubaidi ??? Shahin A human never ignore the environment, but rather attempted to

cope with the environment elements until the beginning of the industrial revolution. Since the invention of the steam engine by James Watt in 1761, it caused a serious coup and severe impact on people's lives as a whole and urban planning. A new period of human history began with a new character different from all preceded periods. With this huge development in all majors, many different materials and methods appear in construction Architecture, for example Curtin walls, cement, Asphalt, and other oil derivatives. Using many of this material was responsible for the environmental pollution, and changes. Because the architecture has a major impact and reasonability toward the environment. The advanced industrial countries develop new concept and techniques in the designing and construction of architecture. One of these concepts is the green architecture, this concept reflects the growing interest among architectural and economic development under environmental protection to reduce energy consumption, optimum utilization of natural resources and greater reliance on renewable energy(?).????? Figure ??: First steam engine Green Architecture is an approach to architecture began in 1999, which aims to minimize the negative effects of human aims to, Energy and water conservation, minimize the waste, recycling, preserve the environment, the health of the population, and the economic benefit to provide operating expenses and long-term maintenance. Green Architecture is not only the construction of buildings according to certain environmental conditions or increase of green spaces, but rather, it intended to achieve compatibility between man, society, and the environment by linking three key elements (Efficient use of resources, Dealing with the prevalent climatic and geographical conditions and Response of the prevalent human, physical and social needs), While preserving the rights and needs of future generations ?).?????(? According to Architect Ken Yeang "the green and sustainable architecture must correspond to the needs of the present without losing sight of the right of future generations to meet their needs as well".

2 II. LITERATURE REVIEW

Green architecture is a design process focused on the construction to be effective in terms of using resources, such as water and materials, reducing waste and environmental pollution. It is a High-efficiency system compatible with the vital surroundings with less negative effects. It is an invitation to deal with the environment in a better way to integrate with its determinants to Compensate for its deficiencies, repair its defects or take advantage of this environment and sources. This architecture term (Green) came from the plant that achieves success in its environment, taking full advantage of the surroundings to get its nutritional requirements. It did not creates with a full-fledged from its inception; rather as it increases in age it increases in length Until it reaches the phase stability. From this particular point, the green architecture coupled another term, which is (sustainable architecture and environmental architecture) these are two sides of the same coin. The first green building appears in china. It names TEDA H2 Low Carbon Building ?).???????"(? -BREEAM is the world's environmental evaluation method and rating system for buildings.

-Saudi Green Building Forum (SGBF), under the supervision of the General Presidency of Meteorology and Environmental Protection. (in progress) These rating systems provide special Codes for green building design. The most known rating system is LEED. It consist of different types of rating system; each one has requirements that address a specific needs of building types to the LEED certification. The project designers should choose a rating system to guide them (LEED).

3 Figure 7: LEED rating types

Each system is a combination of different categories. Within each category, there are specific prerequisites which the projects must satisfy it, to earn points. These points that earned will determine the level of LEED certification for the building (LEED).

4 a) Green building Techniques

The used techniques are differentiate from building to other depends on the type of the building and its users. The most important is to use a suitable technique to provide a very efficient green building. However, before deciding the method, the designer must take into consideration the microclimate of the area, site location, surroundings, environmental resources, building size, height, facilities, and the most important the occupancy of the building. However, There are some technology that can be used in any building (future) for example:

5 b) Green Architecture in Saudi Arabia

Saudi Arabia like other countries it environments have Contaminated as a result of the Pollutants resulting from industrial development. Recently they notice the effects of the pollution on human health, performance, and production. Although the government is trying to support the green building approach, but it still in the development stage toward this approach. However, there is many Government organization and regulations that emerged during the past few years which support the green architecture in the country. Moreover, there are many green projects in the design stages, some of them have been built, for example (KAUST), Establishment of the first solar plant and the use of alternative energy for lighting tunnels and streets in Jeddah. On the other hand, there are two organizations of green technologies and environmental sustainability. it aims to promote the green building initiatives in the kingdom by developing lows and regulation to support this approach, develop

green architecture criteria to be a guideline for designing the green building in Saudi Arabia, and do a workshop to educate the people ??Forum).

Although we still in the initial stage but the country is in the right way toward sustainability. It is changing, and the architecture green technologies will improve by time.

III.

Research Methodology

This research consist of the case study method; this method can be quantitative or qualitative. In this research, I will use the qualitative case study approach to examine in deeps different types of case studies to better understand the research. By analyzing some previews researches and observes information this research needs, to provide a will clear knowledge about the topic.

a) Case Studies

The research will clarify two case studies located in Saudi Arabia to show the developments of the green building approaches and techniques that suit Saudi Arabia's conditions. On the other hand, to give an idea about Government attention towards architecture and environment in the country. These two case studies are:

-The King Abdulla university (KAUST) very deep explanation of the green technology of the campus. -The King Fahd National Library in Riyadh. The site planning of the university campus was designed to respond directly to the climatic conditions and the surroundings. The buildings were arranged and grouped in particular places to improve and take full advantage of the microclimate and the site natural environment and to reduce the harmful effect of the sun and the heat of the climate (KAUST, Sustainable Site Planning, 2015).

B. Orientation

The overall campus was oriented to reduce the heat of the sun from east to the west in the morning and afternoon especially in summer. However, the height of the building is relatively short to allow the daylight to enter the interior spaces (KAUST, Sustainable Site Planning, 2015).

C. Roofing System

The design team decides to ingrate the building roofing system of the buildings to provide a concoction and shades between the buildings. these roofs include over 12,000 square meters of solar photovoltaic panels, which produce 3,300-megawatt of energy annually, while protecting the building from the solar gain. On the other hand, the campus atriums and courtyards were integrated to enhance the natural light and ventilation into the interior spaces (KAUST, Sustainable Site Planning, 2015).

D. Paving color and use of Shade

The choosing of the color and the material of paving was very accurate to fit the harsh climate of the region. They use light-colored Local stone which reflects the heat instead of absorbing it. The Shades espaliers to reduce the heat and improves the comfort of the user (KAUST, Sustainable Site Planning, 2015).

E. Building material

Choosing Building materials for a large project like King Abdullah University Play an important in building sustainability. The designing team selected materials to limit the negative effects of and to the Environment. It includes, Local recyclable concrete and steel, Interior finishes and furniture with high levels of recycled content (carpet tile, ceiling tiles, gypsum board, paints, millwork, adhesives), all the wood is from sustainability managed forests and more than 75% of the construction waste was recycled. On the other hand, the university has made a sustainable recycle Program to guaranties that natural resources are not wasted. It will includes many materials for recycling like glass, metals, plastic, electronics, paper, compact fluorescent lights and more (KAUST, Building Materials, 2015).

F. Water conservation

Collecting storing the rainwater to be used in irrigation of green spaces in KAUST, which don't require additional water. Selected of native plants large amounts of water to survive, this will minimize the overall water Consumption. The wastewater (gray water and black water) will be recycled by the wastewater treatment the plant (WWTP) that located to the south side of the campus to be use in irrigation needs such as Golf Course Irrigation (KAUST, Water Conversation, 2015). With placing two iconic solar towers on the campus to create a difference in the passive pressure will create a by using the sun and the dominant winds conditions from the northwest and winds blowing in from the Red Sea, to provide a constant air waft along the shaded areas. The solar tower skin consists of two curtain wall layers, the outer layer is completely transparent to allow observation of a maximum amount of solar energy. Whereas the internal layer consists of a tinted glass that characterized with it extremely absorbent surface to gathers the solar energy for maximizing the hot air inside the tower, while

the hot air transfer to the top and move out of the tower through the shaft, it is replaced with cooler air from the courtyard. These effects of these techniques will provide a comfortable atmosphere for the occupancy of the campus (KAUST, Energy Efficiency and Renewable Energy, 2015).

14 Natural Daylight

Saudi Arabia Climate needs a dedicated balance to control the solar heat gain and at the same time allow enough light to enter into the occupied spaces, to ensure this in the campus they utilizes many different systems such as, dynamic exterior louvers, fixed exterior louvers, overhangs, skylights, mechanical shading systems, and atria to ensure that this balance is achieved.

15 Renewable Energy

The sun conditions in Saudi Arabia offer an opportunity to utilize solar power more than any other place. The huge roofing system of the campus buildings designed to contest of a large number of solar thermal arrays to provide the hot water to all buildings. Moreover, solar photovoltaic to produce electrical power to whole campus. On the other hand, these future arrays can be added to supply the increase of energy load. This energy production from clean energy sources will save almost 1,700 tons of carbon emissions per year (KAUST, Energy Efficiency and Renewable Energy, 2015).

16 H. Ventilation and lighting

The designer takes into consideration the Natural daylight, natural ventilation, exterior views, and indoor air quality to ensure a comfortable, productive, and healthy environment for the campus occupancy. As result of the extremely sun heat in this region, the defuse daylight is preferred to minimize the sun heat in the entire campus. The exterior and interior spaces will consist of CO2 monitoring sensors to ensure the high quality of veneration, because of the increase of CO2 level cloud affects the production of the building users. The ventilation rates are more than 30% of the standards ventilation in the buildings to granite the good and fresh air all over the campus. Also, they use construction methods that reduce negative effects of the airborne, for example, the installation of MERV 13 and 14 filters (figure 18) in the heating ventilation air-conditioning (HVAC) systems to ensure removing the particles in the ventilation stream inside the buildings. Also, the Walk-off grates (figure 17) were installed to clean foot at all buildings entrances to ensure that the sand, dust and particles will not transfer from outside of the buildings(KAUST, Ventilation and Lighting, 2015). The design represented the national library as a new building to attract people to the central knowledge center. The most essential change was in the building façade, changing the classic façade of the stone dome and arches, to a new cubic modern attractive skin. This skin was carefully designed to fit the environment and culture conditions (Tobojini, 2014).

17 Year 2020

The Future of Green Architecture in Saudi Arabia Because the most majority problem is to provide natural daylight without entering the sun's heat to the spaces, so the use shading devices but in different forms. Also, the use of local materials which can be very helpful for the environment and, at the same time reducing the cost. Using the native plant can help in water conservation. For KAUST. They use more advanced techniques to increase energy-efficiency. However, all the buildings satisfied the user's needs and environmental sustainability from one side or more.

18 V. CONCLUSION

The world is always in constant evolution. This evolution brings new technologies and methods for humans. With this evolution, there are side effects that could harm humans. The people must take care of the new technologies and try to invent sustainable systems to granite a healthy life for the future generations.

Architecture plays a big role in this evolution, and it affects the sustainability of the world positively if it used in the right way, and vice versa. Architecture is improving, and new techniques discovered. Thus, the green architecture techniques will be improved. Although there will be several types of Green building technologies, but it doesn't matter, what matter is the result of using these techniques. Sometimes using these techniques in specific conditions could have a negative effect on the environment and the people living within this environment.

In Saudi Arabia, the future of green architecture is very bright due to the government financial and moral support. This will improve the green building and maximize the number of it in the country for the next years. The growth in this sector will provide environmental sustainability and guarantee a healthy life for the citizens and future generations.

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Figure 1: Figure 2 :

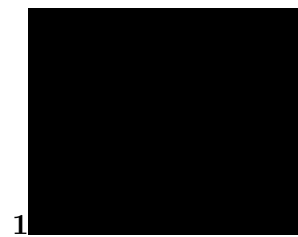


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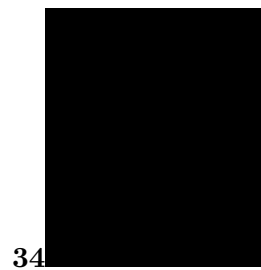


Figure 3: Figure 3 :Figure 4 :

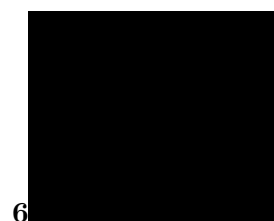


Figure 4: Figure 6 :



Figure 5: Figure 8 :



Figure 6: Figure 9 :



Figure 7: Figure 10 :

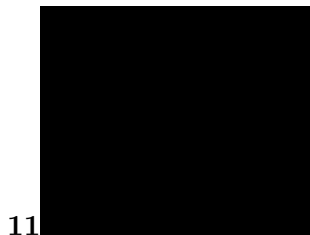


Figure 8: Figure 11 :

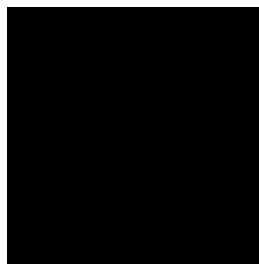


Figure 9:

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Figure 10: Figure 12 :

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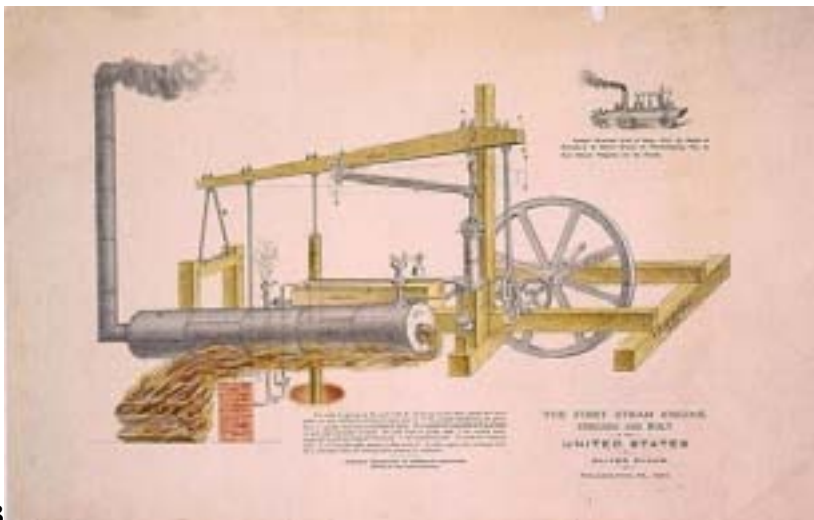


Figure 11: Figure 13 :

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Figure 12: Figure 14 :

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Figure 13: Figure 15 :

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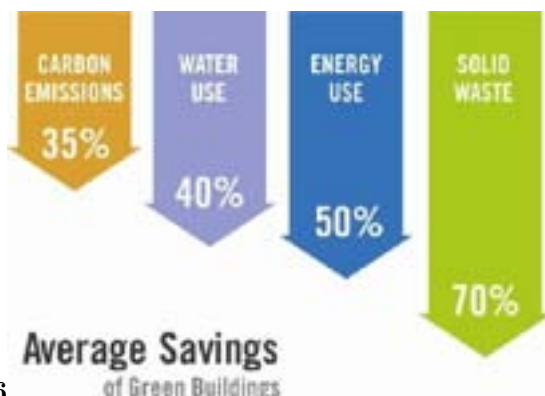


Figure 14: Figure 16 :

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Figure 15: Figure 18 :

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Figure 16: Figure 19 :



Figure 17: Figure 17 :



Figure 18: Figure 20 :

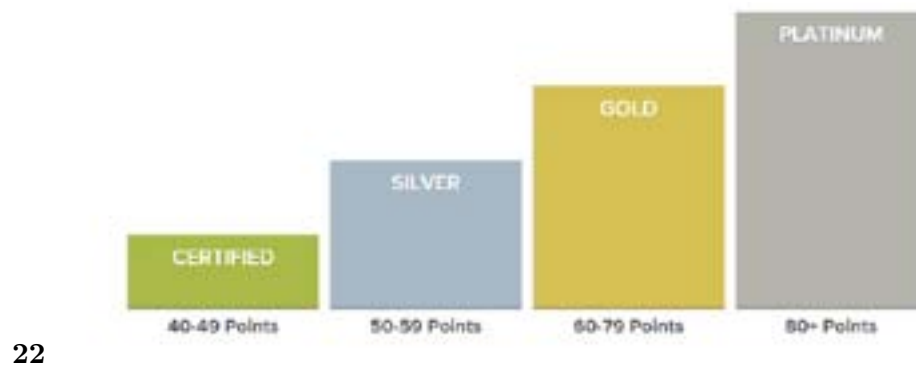


Figure 19: Figure 22 :



Figure 20: Figure 23 :



Figure 21: Figure 25 :



Figure 22:



Figure 23: Figure 21 :

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