GREEN BUILDINGS: TOWARDS A SUSTAINABLE BUILDING TRANSFORMATION

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Abstract- The high growth in population, the rapid urbanization, and the prompt evolution in construction sector, are making green building nowadays more essential than ever. Current efforts to apply water and energy efficient features in buildings are crucial and should be seen as the first important phase towards promoting the green sustainable practices.
The study proposes the building renovation and transformation based on green sustainable practices as an important strategy to overcome the environmental challenges in Jordan. It can be used to avoid the impacts of demolishing old structure or rebuilding a new one. The case of the Dutch embassy in Amman/Jordan is discussed in details to present a successful example based on remodeling and extending an existing structure in inspiration from local architecture, where energy and water problems are solved, and the construction waste and the consumption of raw materials are minimized.

Keywords- Green buildings, Sustainable design, building transformation, LEED.

I. INTRODUCTION

According to the United States Green Building Council, buildings are one of the heaviest consumers of natural resources and account for a major portion of greenhouse gas emissions. Buildings consume 25% of water resources, and 40% of energy worldwide, moreover, about 11% of deaths result from poor internal environment [1]. This is where the importance of green buildings arises, as they characterized with increased energy efficiency, reduced amount of resource consumption, and improvement of health and environment. Minimizing energy and water consumption over building's life time is essential to achieving a sustainable transformation of the building sector [2].
A World Green Building Trends report published in 2018 states that in addition to being motivated by environmental concerns, companies across the world are increasingly turning to green building practices out of business imperative and market demand, according to them, during the last decade, implementing green building practices has picked up momentum, with the value of the global green building market about $260 billion in 2013, while the global average is expected to increase from 27% to 47% between 2018 and 2021 [3]. Greening of the building sector has a huge implication on other relevant industries, such as: construction, materials, transportation, energy, waste management, and wastewater treatment. Therefore, dealing with a comprehensive approach that integrates these sectors would help in creating some opportunities for greening the overall economy. Green building practice provides a cost-effective strategy to decrease solid waste, electricity consumption and conserve water. Likewise, improving energy performance of building is among the most cost-effective methods of contesting climate change, based on projection for greenhouse gas (GHG) abatement costs for key economic sectors [2].
"Green architecture" includes green building and green construction. It concerns both natural environment and human comfort [2]. "Sustainability", however, comprises natural environment, human comfort, and economic development. The difference among these terms is a matter of emphasis on particular social and environmental aspects, as well as methods of minimizing negative environmental impacts [4]. A sustainable building should also be economically viable and socially equitable achieving some vital factors, such as: environment, economy and equity. Accordingly, architectural approaches can be distinguished as striving to balance the unique concerns for a specific building, site and client. Architecture is uniquely placed as a profession to grasp the overall complexity inherent in sustainable transformation [5].

II. GREEN TRANSFORMATION

To transform or renovate a building is considered a sustainable strategy in itself. The act of not demolishing and not rebuilding is typically considered a minor impact approach, with lesser energy and materials use [6]. Therefore, renovating an existing structure and transforming it into a new building can be considered as a sustainable practice.

The sustainable renovation or the green transformation are incorporating a balanced and multi-faceted building specific approach to environmental-energy, social-architectural and economic-appropriate contexts [7]. The theoretical concept of the green transformation can be discussed in many contemporary successful examples.

Sometimes, this can be understood as re-exploring the layers of history, by removing poor quality renovations or additions [8]. The work of architects Durot, Lacaton and Vassal advocate focuses on additive transformations, rather than demolishing, subtracting or replacing elements focusing on adding, transforming, and utilizing these elements [9]. The architects see potentials in architectural transformation to achieve "generosity" and "simplicity" and they strive for a balance between social, economic and environmental concepts in their design.

During the last decade, the green building movement is gaining more momentum worldwide. This includes certification schemes for green buildings such as Leadership for Energy Environment and Design (LEED) [10]. The LEED set out a strong set of criteria for the adoption of greening practices starting with the design stage through to the operation stage [8]. These practices aims at lowering energy use, improving efficiency and creating a more comfortable environment inside the building, however, LEED use criteria that neglect the social aspects of sustainability, which considers as a key aspect in the renovation process.

III. GREEN BUILDINGS IN JORDAN

The construction sector in Jordan has contributed to 4.3 % of the GDP in 2011 and had a value added in the same year of 888 million JD. 14. The building sector in Jordan has evolved without considering the environmental and social aspects into account. Buildings lack of proper insulation for walls, windows and roofs [1]. Moreover, the currently installed systems of heating, ventilation and air-conditioning have the lowest energy efficiency performance among available options. This is mainly because applying cheaper systems is preferred over the more efficient ones.

In a country which is experiencing fast urbanization, the promotion of green building practices will have far reaching effects on sustainable transformation [2]. A number of local initiatives promote the use of renewable energy such as "Petra Solar" project that funded by JEDCO which installed solar panels for hundreds of houses in the Tafileh Governorate to save electricity costs. Likewise, the established engineering companies have integrated sustainability into their operations as a cross cutting theme. Even NGOs and private sector companies assess the environmental impacts of their operations in the field of banking, telecom, industrial, and transportation [1]. Still, the current greening initiatives and policies in Jordan are fragmented as they have achieved very limited success in creating effective transformation in the construction sector.

On the other hand, there are various challenges facing the promotion of green buildings in Jordan, such as: the lack of local building code regulation; lack of incentives; high investment cost; lack of proper green education; lack of public awareness; lack of a comprehensive strategy to promote green building; lack of professional expertise and knowledge in design and construction. Greening the buildings and achieving sustainable transformation require inclusive, long-term strategies taking into consideration the structure of the construction industry. These strategies should be developed in coordination with other green activities in other sectors, such as, transport, energy, water and waste management.

IV. GREEN BUILDINGS IN AMMAN

The aim for any green building project, locally and internationally, is to be awarded a Leadership in Energy and Environmental Design (LEED) certification. In Jordan, specifically in Amman, there are only three LEED certified buildings: The World Health Organization-WHO- which was the first building in Jordan awarded the gold certificate; The Middle East Insurance Company building which was the second building to receive a LEED gold certificate; and the Dutch embassy that was the first building awarded the silver certificate. The following paragraphs summarize the best practices that were applied in the gold certified buildings, followed by a detailed discussion that covers the case of the Dutch embassy as it represents the case of green transformation and sustainable renovation for an existing building that this study focus on.

The World Health Organization regional headquarter building was built in 2011 (Fig. 1). It is the first building to be awarded a gold LEED rating for the entire Eastern Mediterranean region [11]. The building was constructed with local materials, and various Environmentally-friendly features were used to extremely reduce the building's contribution to carbon dioxide emissions and other greenhouse gases. The environmentally-friendly components aimed at improving energy efficiency by 22.5%, and saving water by 60% [11].



Fig. 1 The WHO building [12]

The Middle East Insurance Company was built in 2013 (Fig. 2). It was the second in Jordan after the

WHO regional headquarters to receive a gold LEED certification. The building was constructed using green architecture strategies, which included energy efficient designs and sourcing 20% of manufactured materials regionally [11]. Efficient technologies were used to increase the building efficiency, such as gray water reuse and rainwater harvesting, these technologies help the building to achieve a 50% reduction in potable landscape water use, a 40% reduction in indoor water use, and a 50% reduction in wastewater generation [11].



Fig. 2 The Middle East Insurance Company [11]

V. THE CASE STUDY OF THE DUTCH EMBASSY IN AMMAN

The Dutch embassy was built in 2010 with a total Area of 1253 m2, including both existing and new areas for the main building and annexes [13]. It was the first building in Jordan to receive the prestigious international LEED-certification for green buildings with a silver rating. This environmentally-friendly building was constructed by transforming and renovating an old villa in Amman. The design based on transforming and extending the one-story villa in inspiration from Jordanian architecture [4]. The architect was inspired by traditional Jordanian building practices and used thick walls made from local materials to act as natural insulation thus increase the thermal mass and ensure a cool indoor climate. The designer retained the existing structure and used local materials for the building envelop, such as concrete and the yellow limestone known as 'Jerusalem Stone', for the extra story and for the arcade around the house [13]. The existing swimming pool was reused as a thermal buffer, especially in summer, when the cold night breeze is caught and pumped back into the building during the day as a natural cooling system. While in winter, solar panels warm the water inside which is then pumped into the central heating system [11].

Solar units were installed on the roof including photovoltaic panels and water heaters. According to the designer of the building, the total renewable energy generated about 2.5% out of the total energy consumption in the building and site. The photovoltaic panels that are used to supply power to all computers inside the office saves 4.3% from the total load. Therefore, the estimated savings for the running cost equals to JDs 1, 149 per year. Estimated annual energy produced from solar collectors equals 5,415 kWh/year, while the running cost for heating and cooling is about 7, 086 JDs/year, compared with the annual cost without green features that is about 10, 935 JDs/year [13](Fig. 3).

The existing basement and ground floor were retained with minor adjustments. A steel structure that carries a new glassy pavilion enclosing the new office spaces were added above the existing structure, and floating stone plates were fixed on the roof. Each plate is tilted in different direction so that there are enough spaces between them for natural ventilation and natural lighting. The skylights is designed to increase daylight inside the building [4]. Other green features were used such as the mechanical system for heating and cooling to retain the thermal comfort inside the building, the automatically controlled, movable canvas of adequate amount and certain glazing characteristics were erected on the first floor windows with manual overrides [13].

The garden is mainly rendered with hard landscaping features, while the applied materials are of high solar reduction impact value. Xeriscape garden that includes water efficient landscaping is used to reduce the water consumption by 50%. A plan for storm water management was implemented by harvesting the rain water from the roof and hardscape in winter, and from the condensate water from air conditioning units in summer, and stored in special tanks [13]. The project captures and treats 90% of the annual rain fall and the collected rain water is treated by a suitable filtration system then reused in toilets and flushing.

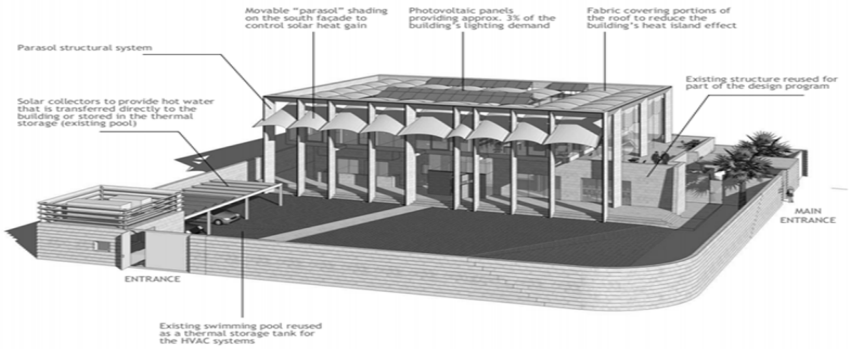


Fig. 3 the green features used at the Dutch embassy in Amman

CONCLUSIONS

Green buildings offer numerous advantages and response to the main environmental challenges in Jordan. Improving energy performance of buildings is one of the most cost-effective technique of reducing harmful emissions. Therefore, green buildings should be viewed as an element of a comprehensive and multi-disciplinary approach towards the environmental challenges. Green buildings have to be tackled within a wider strategy that supports sustainable development, as part of a package that contains renewable energy, social aspects, and green funding. This would reflect the integrated approach to sustainable development, and help strengthening the value chain for green buildings.

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