



Environmental Rehabilitation Techniques of Existing Buildings

تقنيات إعادة التأهيل البيئي للمباني القائمة

Ghada Essam Galfon, *Sherief Ahmed Sheta* and Mohamed Ali Khalil

KEYWORDS:

Existing buildings, Environmental, Rehabilitation, Techniques

المخلص العربي: يزيد النمو العمراني المطرد للمدن القائمة - وخاصة في الدول النامية - من التأثيرات البيئية للعمران والتي تؤدي إلى تغير المناخ، الأمر الذي يستلزم طرح مجموعة من الاستراتيجيات التي تزيد من كفاءة استهلاك المبني للموارد وتحسين جودة البيئة الداخلية ليس فقط في المباني الجديدة، ولكن أيضاً في المباني القائمة والتي تمثل النسبة الأكبر من البيئات المبنية مما يمنحها أهمية أكبر. يناقش البحث تقنيات إعادة تأهيل المباني القائمة لتحسين كفاءة استهلاك الموارد وتحسين جودة البيئة الداخلية للوصول إلى مبني صديق للبيئة وذلك من خلال تحليل أمثلة عالمية لمبان قائمة حاصلة على اعتماد بيئي، ومن ثم استخلاص التقنيات القابلة للتكرار والتي يمكن الاستفادة منها في التطبيقات المحلية. ويخلص البحث إلى مجموعة من تلك التقنيات التي يتم تصنيفها من حيث أسلوب التطبيق إلى ثلاث مجموعات؛ أولاً: تطوير أو استبدال بعض مواد المبني بمواد أكثر كفاءة، ثانياً: تطوير أنظمة المبني لزيادة كفاءتها، وثالثاً: إضافة أنظمة جديدة للمبني لتحسين كفاءته البيئية.

Abstract—Rapid urban growth of existing cities -especially in developing countries- increases the environmental impacts of urbanization that lead to climate change. This requires a set of strategies to increase the resource management efficiency of buildings and improve indoor environmental quality (IEQ) not only for new constructions but also - and more important - for existing buildings which represent the major percentage of the built environment. The paper discusses the environmental rehabilitation techniques of existing buildings to improve the resource management efficiency of IEQ, and thus, achieve an environmentally friendly building. The research analyses examples of environmentally certified existing buildings to recognize techniques that could be reused in other buildings on the local scale. The paper concludes a set of such techniques that are classified based on application method into three groups; first, by developing or replacing some of the existing building materials with new, more efficient ones; second, by developing the building systems to enhance their performance; and third, by adding new systems to the building to improve its overall environmental efficiency

Received: (15 March, 2016) - revised: (26 April, 2016) - accepted: (13 July, 2016)

Ghada Essam Galfon, Demonstrator - Architecture Department - Faculty of Engineering - Mansoura University

Sherief Ahmed Sheta, Assistant Professor - Architecture Department - Faculty of Engineering - Mansoura University.

Mohamed Ali Khalil, Teacher - Architecture Department - Faculty of Engineering - Mansoura University

I. INTRODUCTION

ENVIRONMENTAL degradation has led to the emergence a lot of global problems. According to the U.S. Green Building Council, buildings are one of the biggest consumers of natural resources and energy, thereby creating an important part of the emissions that affect climate change. ⁽¹⁾ Figure (1) present Egypt's total GHG emissions by sector for the year 2005 and figure (2) present details of emissions within fuel combustion sector for the base year 2005/06. Residential and Commercial utilities share in 9% of these emissions. ⁽²⁾

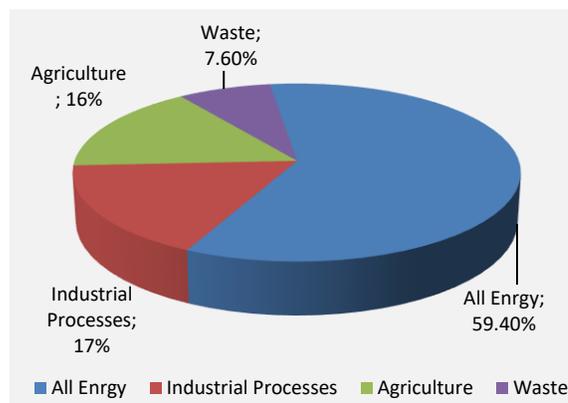


Figure 1: GHG emissions by sectors for 2005.²

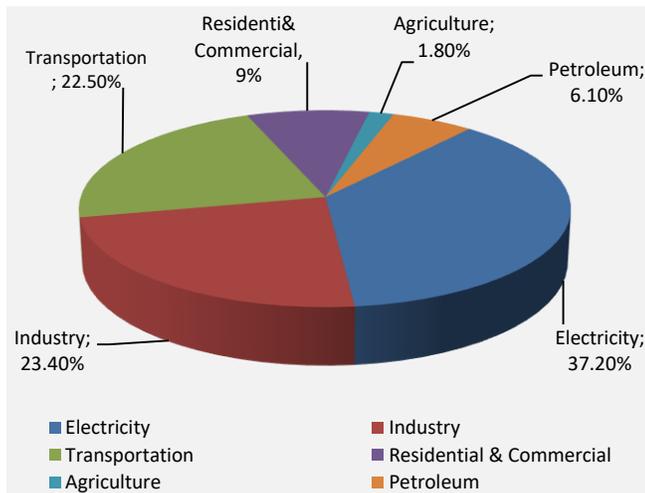


Figure 2: GHG emissions within the fuel combustion sector.²

Creating more green and sustainable buildings is an important issue. Existing buildings, however, form the main bulk of the building stock of our cities. In response to this demand and other factors that we will discuss, the real estate industry will have to start converting existing buildings into energy-efficient properties.

1. Environmental Impacts of Existing Buildings:

The environmental impact of building design, construction, and operations industry in Egypt is enormous, as they according to the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS)⁽³⁾

- consume more than 7.6% of total energy;
- consume more 58% of electricity.
- use 13.55% of potable water in flush toilets;
- use 40% of raw materials globally.
- produce up to 60% of the municipal solid waste stream;
- cause emission CO₂ and greenhouse gases;
- cause heat island impact on microclimates, human and wildlife habitats; and have a significant impact on human health, as indoor air typically contains between double and 5 times -and occasionally greater than 100 times- more pollutants than outdoor air. As a result, poor indoor air quality in buildings has been linked to significant health problems such as cancers, asthma, Legionnaires' disease and hypersensitivity pneumonitis.

The environmental impacts of buildings can be measured, monitored, and improved. Improving the efficiency of building systems can be implemented by reducing water consumption, choosing healthier indoor materials. This in turn will make our existing buildings more sustainable and reduce their environmental impacts. In addition, this will help in meeting the ambitious government targets to reduce greenhouse gas emissions by 2050.⁽⁴⁾

II. CONVERTING EXISTING BUILDING INTO GREEN

Converting existing buildings into sustainable buildings will make them healthier to live in, more economical, save energy and water, and reduce carbon missions.

To illustrate the benefits of adopting green concepts in building design, construction and operation, two cases of green buildings are studied. Analyzing these cases help to highlight the technologies of converting existing buildings into sustainable buildings. All the selected buildings have achieved the LEED for Existing Buildings certification, and thus have been certified as green buildings.

2.1 Dubai Chamber of Commerce and Industry (DCCI), Dubai, UAE.

Dubai Chamber of Commerce and Industry was established in 1965. It is a private non-profit organization whose mission is to represent, support and protect the interests of the business community in Dubai.⁽⁵⁾

Since 1998, the Chamber has been working hard to improve the environmental performance of their head office. Earlier efforts focused on energy and water efficiency. In 2007, the Chamber began focusing on waste management and recycling, and in 2008 the organization had added green transportation, (Figure 3).⁽⁶⁾



Figure 3: Dubai Chamber of Commerce and Industry.⁽⁷⁾

By adopting green strategies, Dubai Chamber succeeded in reducing energy and potable water consumption per person by 63% and 92% respectively, accumulating an estimated AED 21.2 million (USD 5.8 million) in savings, including AED 17.7 million in energy and AED 3.5 million in water between 1998 and 2013, and that leading to significant carbon emission reductions. The majority of these gains came from simple low cost initiatives.⁽⁸⁾

2.1.1. Highlights of Dubai Chamber green strategies:(9)

2.1.1.1. Saving water:

- Using water efficient plumbing fixtures and fittings.
- Using infrared detectors and faucet aerators in flushing urinals and taps.
- Collecting the condensate water from air conditioners, fountain and washroom systems.
- Using recycled water (gray water) for toilet flushing, landscaping and the drip irrigation system.
- Desert vegetation is preferred.

2.1.1.2. Saving energy:

- The building envelope and roof insulation already conformed with ASHRAE 2004 standards for thermal transmittance, solar heat reflectance and solar heat absorption properties.
- The white exterior reflective tiling and the double glazed windows keep the heat out while allowing daylight to reach all building users.
- Using an in-house designed half-chiller system, and reducing chilled water circulation requirements to 1 circulating pump instead of 4.
- Using the outdoor fountain as a heat exchanger to cool the server room.
- Using "free cooling" of outdoor air during the winter months.
- Using CFL and LED lights.

- High level lighting control for individual occupants, and turning of air-conditioning and lighting after office hours.

2.1.1.3. Another green strategies:

- Solid Waste Management Policy, recycling of paper, plastic and electronic waste.
- Using eco-friendly furniture and paintings.
- Using carbon dioxide monitors to observe the pollutants and ensure that building users have fresh air.
- VIP parking for staff and free valet parking for visitors using fuel efficient vehicles, and bicycle racks.
- Developing Education Program on Environmental and Human Health Benefits.

2.1.2. Certifications



Figure 4: Dubai Chamber's Green Features.⁽¹²⁾

1. Outdoor Fountain
2. CO2 monitors, eco-friendly furniture and paintings ensure building users have enough fresh air.
3. Double glazed windows keep the heat out while allowing daylight to reach all building users.
4. Recycling paper, plastic and electronic waste.
5. Water efficient plumbing fixtures and fittings, infra-red sensors on taps and flushes and filtering system for gray water that used for toilet systems.
6. CFL and LED lights, motion sensors and turning of air-conditioning and lighting after office hours.
7. Efficient Elevators and mechanical systems.
8. VIP parking for staff and free valet parking for visitors using fuel efficient vehicles, and bicycle racks.
9. Desert vegetation like date palm or cactus.
10. Using the outdoor fountain as a heat exchanger to cool the server room.

2.2 The Office Building at 1800 K St. in Washington, DC.

The 1800 K Street is a commercial office building located in Washington, DC. It is located on an area of 20166.46 m². The building consists of 11 stories and 4 levels underground parking, owned by Deutsche Asset & Wealth Management and managed by Transwestern. The building has been renovated as part of a market-driven portfolio improvement program, and to reactive leasing activity in the region. the renovation was being performed while the building remains fully occupied.⁽¹³⁾ In addition, CBRE, which provides landlord representation and leasing services for the owner, had announced, on 16 September 2014, \$40 million Trophy-class renovation for 1800 k St. This upgrading will be completed by the first quarter of 2016, Figure 5.⁽¹⁴⁾



Figure 5: 1800 k St. Office Building

As a result of the renovation, the building succeeded in achieving 81% in Energy Star; meaning that it performs better on energy and water measures than similar buildings, offsetting 27% of electrical usage with sustainable power, recycling 61% of office waste, and reducing potable water consumption.

2.2.1 Highlights of 1800 K St. green strategies:

2.2.1.1 Saving water:

- Upgrading all plumbing fixtures to meet WaterSense requirements.

2.2.1.2 Saving Energy:

- Renovating the central chiller plant. The two main chillers were replaced with new frictionless centrifugal units, which provide years of energy savings.
- All related pumps and piping for the chillers and cooling towers were changed.
- Using efficient heating system.
- Installation of MERV 13 filters at all outdoor air intake locations.
- Replacing the existing building envelope with a new high-performance building skin. the building's existing curtain



Figure 6: 1800 k St. New Glass façade.¹⁷

wall and precast concrete façade will be replaced by new floor-to-ceiling glass façade along both K Street and 18th Street. (Figure 6)

- Windows will be installed along the southern façade of each floor to add to the natural light inside.
- Upgrading Elevators and mechanical systems.

2.2.1.3 Another green strategy:

- Recycling office waste.
- Implementing a sustainable purchasing program for all cleaning products and equipment.
- The main lobby will be upgraded with new design.
- Renovating the rooftop terrace. (Figure 7)

2.2.2 Certifications:

- In October 2013, 1800 K St. achieved the Gold Certification of LEED-EBOM v2009, with 64 points.
- In May 2015, 1800 K St. achieved officially the Silver Certification of LEED-EBOM v4, with 52 points, after being the first building in the world to earn certification through LEED-EB operation and maintenance v4 just few days after its official launch by the end of 2013.⁽¹⁶⁾



Figure 7: 1800 k St. Rooftop Terrace.⁽¹⁷⁾

III. CONCLUSION AND RECOMMENDATIONS

3.1 Classify The Techniques and Technologies of Converting Existing Buildings into Sustainable Buildings:

Analyzing the previous examples, we can deduce a set of techniques and technologies that would achieve an environmentally friendly building. These techniques can be classified based on application method into three levels of application:

- Developing or replacing some of the existing building materials with new, more efficient ones.
- Developing the building systems to enhance their performance.

- Adding new systems to the building to improve its overall environmental efficiency. (Figure 8)

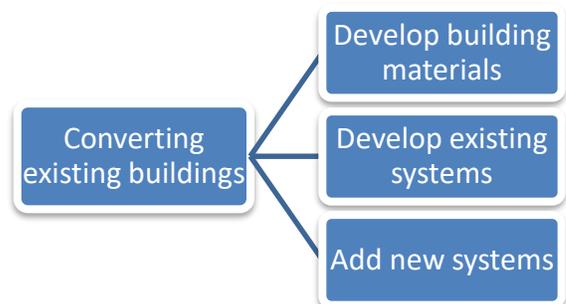


Figure 8: Classification of Environmental Techniques of Existing Buildings

3.2 Develop Building Material:

- Changing the color of external and interior material to proper color for climate region of the building to control solar radiation absorptance, daylight reflection. And thermal storage. To reduce the need of air condition and Industrial lighting and use eco-friendly painting.
- Using proper insulation material for the building to ensure no energy is wasted on heating or cooling.
- Using double glazed windows which keep the heat out while allowing daylight to reach all building users.
- Replacing the existing building envelope with a new high-performance building skin

3.3 Develop Existing Systems:

- Upgrading all plumbing fixtures and fittings with low-flow options and use dual-flush toilets to meet WaterSense requirements.
- Using infrared detectors and faucet aerators in flushing urinals and taps.
- Upgrading the chiller system, by replacing the chiller with new frictionless centrifugal units, which provide years of energy savings.
- Upgrading lighting system and use CFL and LED lights that reduces the lighting load.
- Upgrading Elevators and mechanical systems by using energy efficient technologies to reduce the overall energy usage with control strategies such as using sensors and software that automatically enter an idle or sleep mode, turning off lights, and ventilation when unoccupied.
- Using eco-friendly furniture.
- Desert/native plants preference as they need less watering, pesticides, and/or fertilizers, while being able to improve air quality and provide psychological and aesthetic benefits.

3.4 Add New Systems:

- Using high level lighting control, motion sensors and turning of air-conditioning and lighting after office hours.
- Applying rainwater collection system, recycled gray water reuse for toilet flushing and landscaping, and drip irrigation system for planting.
- Integrating an air conditioning condensate collection system for fountain and washroom feeding.
- Installing photovoltaic (PV) system to produce electricity. Such system can provide water heating potential using the sun's energy rather than electricity or gas.
- Integrating Green roofs; provide a number of important environmental benefits such as reducing heat island effect, storm water run-off from buildings, and the amount of carbon dioxide being emitted.
- Adopting sustainable policies for solid waste management and recycling of paper, plastic and electronic waste.

- Installing CO2 monitors to ensure that building users have fresh air.
- Providing special parking lots for staff and free valet parking for visitors who use fuel efficient vehicles, and bicycle racks

REFERENCES

- [1] (USGBC) U.S. Green Building Council, Green Building by the Numbers, USGBC, April 2009, Accessed 24 December 2014. "<http://www.usgbc.org/Docs/Archive/General/Docs3340.doc>"
- [2] Ministry of Environment - Egyptian Environmental Affairs Agency (EEAA), Egypt Third National Communication, EEAA, March 2016.
- [3] Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS), Egypt in Numbers, CAPMAS, March 2016.
- [4] Susan Joy Hassol, Questions and Answers Emissions Reductions Needed to Stabilize Climate, Presidential Climate Action Project, 2007, p. 4.
- [5] Dubai Chamber (DC), About Dubai Chamber – Helping Business In Dubai, DC, Accessed 15 March 2015. "<http://www.dubaichamber.com/en/about-us/about-dubai-chamber>"
- [6] Luke Nicholls, First LEED green building in the Arab world, edie.net, 22 December 2009, Accessed 15 March 2015. "<http://www.edie.net/news/2/First-LEED-green-building-in-the-Arab-world/17451>"
- [7] Green Technologies, Dubai Chamber (DC), Green Technologies, Accessed 16 March 2015. "http://www.greentechno.com/leed_sustainability/view_details/29/dubai_chamber_dc_#."
- [8] Dubai Chamber (DC), Dubai Chamber Achieves LEED Platinum, DC, Accessed 16 March 2015. "<http://www.dubaichamber.com/en/news/dubai-chamber-achieves-leed-platinum>"
- [9] Dubai Chamber (DC), Dubai chamber LEED case study, DC., Accessed 16 March 2015.
- [10] USGBC, LEED Projects, Accessed 16 March 2015. "<http://www.usgbc.org/projects/dubai-chamber-commerce-and-industries>", "<http://www.usgbc.org/projects/dubai-chamber-commerce-and-industry>"
- [11] Dubai Chamber (DC), Dubai Chamber wins Best Sustainable Project of the Year Award, DC. 31st Dec. 2014, Accessed 16 March 2015. "<http://www.dubaichamber.com/en/news/dubai-chamber-wins-best-sustainable-project-of-the-year-award>"
- [12] Leighann Morris, 10 eco-friendly features of Dubai Creek's green landmark, Intelligent Building Today, 21 Oct 2014, Accessed 16 March 2015. "<http://www.intelligentbuildingtoday.com/2014/10/21/10-eco-friendly-features-of-dubai-creeks-green-landmark/>"
- [13] Transwestern, Transwestern-Managed Office Building Becomes First in The World to Earn Certification Under New LEED® V4, Transwestern, 25th Nov. 2013, Accessed 30 March 2015. "<http://www.transwestern.net/Media/News/Pages/Transwestern-Managed-Office-Building-Becomes-1st-To-Earn-Certification-Under-New-Leed-V4-Operations-And-Maintenance-Rating.aspx>"
- [14] CBRE group, CBRE Announces Multi-Million Dollar Trophy-Class Renovation for 1800 K Street in DC, CBRE, 16th Sep. 2014, Accessed 30 March 2015. "<http://www.cbre.us/o/washingtondcmarket/real-estate-news/Pages/CBRE-Announces-Multi-Million-Dollar-Trophy-Class-Renovation-for-1800-K-DC.aspx>"
- [15] <http://www.loopnet.com/Listing/16902455/1800-K-Street-NW-Washington-DC/>
- [16] USGBC, LEED Projects, Accessed 30 March 2015. "<http://www.usgbc.org/projects/1800-k-street>", "<http://www.usgbc.org/projects/1800-k-street-0>".
- [17] Todd Combs and Franck LeBousse, Details will elevate the repositioned 1800 K Street to trophy class, Level up, 17th December, 2014, Accessed 31 March 2015. "<http://www.voa.com/blog/level-up/>"