GREEN BUILDING: CONCEPTS, IMPLEMENTATION TOOLS, AND POTENTIALS BENEFITS TOWARD SUSTAINABLE CONSTRUCTION IN VIETNAM

Le Thi Kim Oanh, Ho Thi Kieu Oanh

University of Science and Technology – The University of Danang;
ltkoanh@dut.udn.vn, hothikieuoanh@dut.udn.vn

Abstract - Green building has been exposing the attractive contributions to the triple bottom line of every construction project. It is currently the imperative global trend due to its balance of economics, society, and environment.However, the green movement in Vietnam is still at the initial stage of its development. Derived from the growing concerns on the friendly environmental development, developing the green in the construction industry in Vietnam is still the gap for the construction industry. In order to reduce this gap,this research aims to fill up and to extend the knowledge of green building and its implementation to Vietnam context through reviewing the green building concepts, the global development, and then displaying its striking benefits through a practical case study in Vietnam. This research will pinpoint the benefits of green buildings in both theoretical and practical sides. Its outcome can be a reference for stakeholders to going to green in their project decisions.

Key words - green building; green benefits; triple bottom line; "going to green" for construction; Vietnam.

1. Introduction

As two sides of a coin, the construction industry on the one hand is the main contributors to the national economic growth through its contribution to the annual GDP and the employment rate. On the other hand, it has caused the urgent issues of pollution and the unexpected global climate change. The building emission accounts for 10.3% of total emissions [1] and negatively affects human health, environment and living conditions. In order to maintain the environment and improve human living condition, the green in building projects is the globally imperative trend recently. Green construction contributes to the balance of economic, social and environmental benefits by the human approach in the community capital.

Compared with some typical countries and the world, Viet Nam has the high percentage of polluted emissions. It leads to the target of reduction of greenhouse gas emissions with 2.5% - 3% (per unit GDP) until 2020 and 2-3% from 2020 to 2030 [2]. This target stimulates the implementation of the green in the construction industry promptly. Based on this, the green building tool as the name of LOTUS is unveiled in 2010 but currently the green building is still at the initial stage of its development [2]. One of the main barriers to this development in Vietnam is the low awareness of the green in the concerned sector [3].

This research aims to over this barrier by an extensive review of the green building concepts and its benefits in literatures and then an analysis of the case study to illustrate the consitence of green benefits between the theory and the practice. This research will be the transparent reference for promoting the green development in Vietnam's construction industry.

2. Literature review on green construction, its benefits, and tools for "green" implementation

2.1. Green construction

The definition of green construction has been changed during its 40-year development to get the full identification and definitions through all phases of a construction project [4]. The green construction can be known in different names such as green building(s), ecological construction, smart building, and sustainable building. However, generally the green building is defined as the integration of enviroment in every phase of a project from the design to the demolition (see Table 1)

The main concentration of a green project is the healthy environment, living conditions and productivity improvement based on the savings from the energy and water efficiency, toxic elimination and natural protection. In other words, the green building can be understood as the satisfaction of environmental, economic and social conditions in every construction project to improve and maintain the human life quality and to protect the nature.

Table 1. *The definition of Sustainable and Green Construction [4]*

Terms	Definition	Quoted source
Sustainable design	A design philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating negative impacts to the natural environment.	McLennan (2004), The philosophy of Sustainable Design
Green buildings	Buildings that are designed, constructed, and operated to boost environmental, economic, health, and productivity performance over conventional building.	U.S. Green Building Council (2003), Building momentum
Green building	The careful design, construction, operation, and reuse of removal of the built environment in an environmentally, energy-efficient, and sustainable manner, may be used interchangeably with high performance building, green construction, whole building design,	McGraw-Hill Construction (2006), Green building smart market report

	sustainable building, and sustainable design.	
Green building	The practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials and (2) reducing impacts on human health and the environment through better siting, design, construction, operation, maintenance, and removal- the complete building life cycle.	Cassidy (2003), quoting the Office of the Federal Environmental Executive White Paper on Sustainability
Green building	The process of building that incorporates environmental considerations into every phase of the homebuilding process. That means that during the design, construction, and operation of a home, energy and water efficiency, lot development, resource-efficient building design and materials, indoor environmental quality, homeowner maintenance, and the home's overall impact on the environment are all taken into account	National Association of Homebuilders (2006), Model green homebuilding guidelines
Sustainable construction	The goal of sustainable construction is to create and operate a healthy built environment based on resource efficiency, and ecological design with an emphasis on seven core principles across the building's life cycle: reducing resource consumption, reusing resources, using recyclable resources, protecting nature, eliminating toxics, applying life cycle costing, and focusing on quality	Kibert (2005), quoting the Conseil Internaltional du Batiment (CIB), Sustainable construction: Green Building Delivery and Design.

2.2. Benefits of green construction toward the triple bottom line

For a green construction project, the emphasis is not only on the three constraints of time, cost and quality but it is the focus of the three strands of society, environment and economics. This new focus requires a project to satisfy the new requirements of the green in order to ensure the project performance and quality as shown in Figure 1.

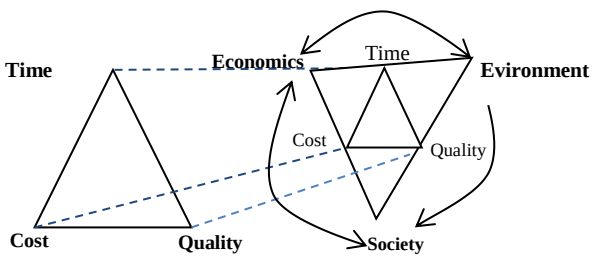

Figure 1. *The change of the sustainability in construction*

The change of the project focus can bring the below benefits:

2.2.1. Green benefits for the environment

The main priority of green building is the environment purpose with the integration of eco-technologies, green technologies, and green attributes to getting the reduction of greenhouse gas emissions, energy use and the efficient use of recyclable and reused materials. According to Beradi et al. (2014), it is repeatedly documented that construction buildings emit the higher proportion of greenhouse gas and consume a large account of worldwide energy [5]. Environmental problems caused by the increase of pollutants, land use, solid waste disposal, and greenhouse effects from the construction industry have been increasing significantly [6]. It is, therefore, essential to move to "green" in the construction industry to resolve these problems.

To solve the environmental issues, the variety of sustainable approaches and environment-efficient technologies have been innovated and implemented to construct the green buildings. These approaches aim to saving energy and water as well as to improving the indoor environment quality and to reducing the emissions and contaminant elements. These approaches can be the green design with the implementation of natural light, natural ventilation, thermal system, green roofing, and low-emitting materials. Also, these approaches can be the green material selection or green construction products such as the recycled materials or renewable materials. These approaches may lessen the building impacts on the environment as well as the scarity of natural materials.

Compared with a traditional building following the building code requirements, the performance of a green building uses all resources more efficiently and effectively. It also provides the better building environment for working and living. It reduces the greenhouse gas emissions, carbon footprint and wastes as well [4]. These buildings are an efficient measure to promise the protection of the environment for both the current and future generations from the perspective of the construction industry.

2.2.2. Green benefits for the society

As mentioned above, another triple bottom line of green buildings is the social benefits (see Figure 1). The social benefits are the benefits related to the human, who spend more than 90 per cent of their time in the buildings [7]. The benefits can be examined by the occupational health, living quality, productivity, and further opportunities for the professional development in the one side [8]. In the other side, the benefits can be the efficiency of the social relationships and community development such as the positive attitudes and the frequent communication [9].

Green buildings create the sustainable working environment as the healthy workplace to improve the satisfaction and wellbeing amongst occupants. The green buildings reduce the effects of sick building syndrome caused by the poor ventilation and poor indoor environment quality [8]. Green buildings basically have the efficient indoor environment quality that eliminates

the negative health contaminants and decrease the rate of absenteeism as well as reduce the number of sick building syndrome [10]. Consequently, the occupants' performance and their working productivity improve dramatically.

Generaly speaking, green buildings generate the better indoor environment quality to reduce the sick building syndrome and absenteeism. Based on these, the productivity and working performance of building occupants escalate significantly leading to the business satisfaction of the organizational aims and expectations. Besides, green buildings emphasize the community activities. These buildings often have community areas for communication and interaction. Such areas open the community development and shorten the distance amongst occupants. It is necessary for the development of a community in every building for strengthening the social relationship and improving the cooperation in the working environment.

2.2.3. Green benefits for the economics

The majority of previous studies of green building have mainly examined the environmental and social benefits. One of other important aspects of the green building needed to be concerned is the economic contribution. This benefits can be presented by the cost premiums and savings awarded during the operational and maintenance phases.

First of all, most stakeholders believe that green benefits should require the additional cost- as known as cost premium. Most previous studies prove that the higher initial cost is the main barrier to the green development in the construction industry [10]. However, other studies noted that no difference of the cost is between green buildings and traditional counterparts [11]. Thus, the findings of the initial cost in green building is still inconsitent and controversal.

The cost premium of green building varies significantly from neutral to high rates depending on the green features and green technologies. According to Matthiessen and Morris (2004), there was no difference in the cost of the green and conventional buildings [11]. In that study, these authors undertook the comparison of actual construction cost between 45 LEED buildings (including academic building, laboratories and libraries) and 93 similar standard buildings. These buildings were assessed under six categories of LEED requirements, namely sustainable site, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation, and design. These categories were evaluated by point evaluation of 69 elective points and the surveys were analysed by T-test to conclude that the cost premium of the green building compared with green building was insignificant. Otherwise, Kats et. al (2003) summarised the range of cost premiums in different green building certifications. The premium percentages were increased with the increase of green ratings but basically, the average of these buildings was 1.84% corresponding with $4 per square foot [12].

However, the savings of the total project costs are mainly in the operational and maintenance phases. In the operation, the reduction is from the energy savings (such as electricity and gas) as well as the reduction of internal and external water consumption (including water use and sewerage) [13]. Green buildings make the efficiency of energy use and water conservation, as a result,the decrease in the utility bills of building operation. In terms of maintenance, the savings are from the material selections and the designs. These create the longer lifetime services and the reduction in the frequency of equipment replacement or equipment fixing [13].

Based on the analysis of green building benefits toward the tripple bottom line, it can be concluded that green buildings provide the benefits by minimising the impact of the construction project on the environment, especially natural resources, energy, water, and waste. Green buildings also emphasize the benefits of humans and human community by the higher indoor environment quality, the improvement of productivity and the reduction of absenteeism as well as the community spaces and social development. Lastly, the economic savings during the operational and maintenance phases are one of its outstanding achievements. These savings and benefits can capture the amazed image of green building in the construction. With these benefits, the green building should be the attempted trend for the construction sector.

2.3. Green tools in the world and in Vietnam

There are many different tools of sustainability that can be implemented in the world. In US Green Building Council, the tool is the Leadership in Energy and Environmental Design (LEED) and the building green certificate is dependent definitely on the points that buildings award. The higher points the building gains, the higher level of LEED certification it can obsesses. The certifications are available in USA and Canada.

In UK, the certification rating is the Building Research Establishment Environment Assessment Method (BREEAM). This tool is used in the European countries such as England, Netherlands and Sweden. This tool is the best practice in the sustainable design and description of the building environmental performance.

In Australia, the Green Star Rating tool is applied to evaluate the green construction project. This tool assesses the project during its life cycle from the phase of design to the phase of project ending. The green certification relies on the independent assessment of the sustainable project outcomes compared to the key criteria. There are included Green Star certifications of communities, design and as built, interior, and performance.

In Vietnam, the green tool is LOTUS, which started in the year of 2008 [3]. This tool mainly focuses on the measurement and assessment of environmental effects, energy efficiency and impact on occupants. This tool has been changed and developed noticeably from 2008 until now. This tool is the later generation of various international green building tools like LEED, BREEAM

and Green Star. LOTUS is the national tool for Vietnam while these other tools have become the international tools employed and adopted in the most international countries.

Briefly, these tools may have different category requirements to award the green certification but the main aims of these tools are to encourage the leadership in the green construction, improve the internal environment for occupants to protect their health, to enhance productivity and to increase the savings through the energy and water efficiency, and the waste minimization. Moreover, all these tools support each other to get the most important aims in the green construction.

3. A case study in Vietnam: The Moc Bai Project

3.1. Overview of the Moc Bai Project

In 2013, Vietnam has 21 LEED projects and 9 LOTUS projects in the total of 41 projects certified as Green buildings. Until now, this number increases to 34 LEED projects and 14 LOTUS projects [14]. These increased numbers illustrate the slow movement of green buildings in Vietnam, especially about LOTUS as the national green tool. Compared with other countries in the same continent like Indonesia (23 LEED projects and 105 GREENSHIP projects) and Philippines (142 LEED projects), the progress of green buildings in Vietnam should be motivated alarmingly.

One of the first challenges that Vietnam should focus on is the knowledge of green building, particularly its benefits. These benefits would be shown obviously by the case study of Moc Bai project, one of the first projects gained both LOTUS and LEED certificates (see Figure2).

Moc Bai project includes the office and factory that are located in Tay Ninh province, the home of Nike production facility. This project got LEED Silver in November 2008 and LOTUS certified in December 2012.

Some of the major construction features of this project briefly described as follows:

a. For the office building:

- Status: Renovated of an existing building
- Number of Storeys: 2
- Gloss Floor Area: 16.500 m^2

Figure 2. *The image of the project*
Source:[14]

b. For the factory

- Status: New
- Number of Storeys: 2
- Gloss Floor Area: 10.270 m^2
- The factory project includes a set of eight factory buildings and service areas.
- The factories share the same water recycling system with the office building.
- Construction structure: steel building

The office building is the first LOTUS NR Pilot certified project and the factory is the second one, achieving certified level with a score of 79 points.

3.2. Benefits of green building from the project

3.2.1. For the environmental benefits

- Using environmentally friendly materials
- Roof system: roof materials with highest solar reflectivity (SRI=84)
- Mainframe: steel plates, recycled content up to 28%
- Skylight: using a double skin translucent sheets for the roof
- Innovation and design process: Reducing energy consumption by the skylight and window, high-energy performance roof ventilation and windows, high performance building exterior wall with improved insulation.

With these special features, this project shows all the main requirements of green buildings: materials (with the successful implementation of recycled materials, using the natural light and thermal system and the increase of internal environment).

3.2.2. For the economic benefits

- Cost premium: 2% of construction cost, which is for:
  - Increased waste water treatment plant capacity.
  - Improved landscaping design
  - Improved daylighting and artificial lighting
  - Improved ventilation and accessibility
  - Added solar hot water heating.

Cost premium as 2% is in the permitted range of cost premium in the world. This percentage is acceptable for the development of design, lighting, and ventilation system.

The most pivotal benefits of this green buiding is the long-term returns as can be shown below:

Energy cost saving: $118.000 per year – 18% reduction of energy use for factory and about 14.07% compared to the baseline model of ASHRAE 90.1

- Water cost saving: $46.474 per year
- Time of payback: 2.5 years at today's rate.
- 35% of site area vegetated.
- 100% of construction waste was recycled and reused.

3.2.3. For the social benefits:

Conductive working environment to improve the efficiency of working productivity.

- 60% daylighting,
- 89% view outdoor connection for the office while for the factory, 100% view outdoor connection [14]

Based on these distinct features compared with a conventional building, Moc Bai green buildings got undeniable achievements of savings in long term and benefits for the internal occupants.

It can be seen that the benefits of Moc Bai Project are aligned with the theoretical benefits. There is no difference of green buildings between the theory and practice when the green is adopted and adapted into the construction buildings. These benefits meet all the requirements of the society, economics and environment as shown in Figure 1. Therefore, the movement to "green" in the construction industry is an convincing development.

4. Conclusions

The green building is the primary development in the construction industry. It satisfies the requirements of balancing the environment, society and economics. Such building brings the long-term benefits that are crucial for the long-term uses.

Compared with green buildings in different countries and in different green tools, the benefit features of green buildings in Vietnam are mostly aligned with the principal benefits in the world. Basically, there is the improvement of the indoor environment quality through the green adoption and adaptation. This ensures the improvement of occupants' health and productivity. Furthermore, there are also the higher financial returns during phases of operation and maintenance. These benefits would recoup the higher initial capital cost.

Relied heavily on these theoretical and practical studies, it is valuable to invest and to develop green buildings in Vietnam with the aim of long-term benefits and savings for project-related stakeholders. It is also the chance for the construction in Vietnam to catch up with the development and achievement of the global construction.

This research is one of theoretical contributions to the knowledge of the green building in Vietnam and it can be the foundation to stimulate the green movement in the construction industry. The further research will focus on the quantitative evaluation toward these contributions of green building performance to prove these benefits persuasively. Therefore, this study is valuable as the reference to encourage the project stakeholders "going to green" and to undertake further research in this field in Vietnam.

REFERENCES

[1] Kubba, S., Green Construction Project Management and Cost Oversight. 2010, Butterworth-Heinemann.

[2] Eco-Business. Is there a future for green buildings in Vietnam? 2016; Available from: http://www.eco-business.com/press-releases/is-there-a-future-for-green-buildings-in-vietnam/

[3] VGBC, S.A.,Is there a future for green buildings in Vietnam? 2013; Available from: http://www.solidiance.com/whitepaper/is-there-a-future-for-green-buildings-in-vietnam.pdf

[4] Robichaud, L.B. and V.S. Anantatmula, Greening Project Management Practices for Sustainable Construction. Journal of Management in Engineering, 2011. 27(1): p. 48-57.

[5] Berardi, U., A. GhaffarianHoseini, and A. GhaffarianHoseini, State-of-the-art analysis of the environmental benefits of green roofs. Applied Energy, 2014. 115, p. 411-428.

[6] Omer, A.M., Energy, environment and sustainable development. Renewable and Sustainable Energy Reviews, 2008. 12(9): p. 2265-2300.

[7] Kamaruzzaman, S.N., et al., The effect of indoor environmental quality on occupants' perception of performance: A case study of refurbished historic buildings in Malaysia. Energy and Buildings, 2011. 43(2–3): p. 407-413.

[8] Smith, A. and M. Pitt, Sustainable workplaces and building user comfort and satisfaction. Journal of Corporate Real Estate, 2011. 13(3): p. 144-156.

[9] Edwards, B.W. and E. Naboni, Green buildings pay: Design, productivity and ecology. 2013: Routledge.

[10] Yudelson, J., The green building revolution. 2010: Island Press.

[11] Matthiessen, L.F. and P. Morris, Costing green: A comprehensive cost database and budgeting methodology. Davis Langdon, July, 2004.

[12] Kats, G., L. Alevantis, and E. Capital, The costs and financial benefits of green buildings: a report to California's sustainable building task force. 2003: Capital E.

[13] Fletcher, L.K., Green Construction Costs and Benefits: Is National Regulation Warranted. Natural Resources & Envionmentt, 2009. 24: p. 18.

[14] VGBC,Busting the myth of costly green building, 2016; Available from: http://www.vgbc.org.vn/index.php/new/Busting-the-Myth-of-Costly-Green-Buildings-18

(The Board of Editors received the paper on 15/05/2017, its review was completed on 23/05/2017)