An applied methodology for advancing sustainable development within the construction sector via the utilization of the LOTUS-Vietnamese green-building evaluation instrument

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Abstract

Amid the global effort to address climate change, architects and industry practitioners often grapple with a critical concern: how to select a building design that optimally manages energy and financial resources throughout its lifecycle. Researchers worldwide are advancing building optimization models to minimize energy consumption and greenhouse gas emissions. Vietnam's government employs rigorous enforcement of laws, clear green construction regulations, and diverse strategies to promote sustainable development.

The aim is to encourage construction firms to use environmentally friendly materials in current and future projects. This study identifies several influential factors, such as experience, credentials, and talent, in assessing green buildings. These factors encompass motivation for economic optimization, energy and water conservation, material management, and market strategy enhancement. Efficient energy management is crucial for evaluating sustainable construction approaches. It will also influence future assessments, including life cycle cost and environmental impact evaluations during project implementation. Prioritizing influential components in green building development is essential. This resource offers scholars, designers, and professionals precise methodologies for project development.

Keywords: *Green building rating systems (GBRSs), life-cycle assessment, life-cycle energy consumption, life-cycle greenhouse-gas emissions, life-cycle cost, LOTUS.*

1. INTRODUCTION

Environmental pollution poses a significant threat to global well-being, with the construction sector being a significant contributor to air pollution and non-industrial waste generation. The Sustainable Development Goals (SDGs) play a crucial role in addressing these issues, as buildings contribute to 38% of carbon dioxide emissions, 71% of electricity consumption, 39% of overall energy usage, 12% of water consumption, and 40% of non-industrial waste generation.

The construction industry has adopted green building practices to mitigate environmental impacts and enhance human well-being. Governments worldwide are encouraging citizens to devise innovative approaches to mitigate environmental impacts on urban areas, aligning with ecological principles. The United Nations' 17 Sustainable Development Goals (SDGs) are recognized for their importance in tackling global challenges and inequalities.

Green building legislation is increasingly popular due to the goal of achieving the SDGs. Green construction involves a comprehensive approach that includes design, construction, equipment manufacturing, technology, materials, policy, and finance (Ahmed et al. 2022;

Pham & Nguyen 2021). Benefits of green building include environmental efficiency, social advantages, and economic gains (Islam et al. 2022; Munir, Lean & Smyth 2020).

Incorporating green building practices into construction management allows investors to promote investments aligned with green building standards. Green building rating systems (GBRSs) have been used for over twenty years to advance sustainable development and provide a comprehensive assessment of sustainability across all stages of a building's lifespan. The Building Research Establishment Environmental Assessment Method (BREEAM) and the Leadership in Energy and Environmental Design (LEED) certification have gained recognition for their widespread adoption and successful completion of projects. Vietnam, a developing nation in the Southeast Asian region, has introduced the Local Operation Towards Urban Sustainability (LOTUS) rating system in 2007 to evaluate green buildings in the country.

2. RESEARCH FRAMEWORK

This research investigates the correlation between green building evaluation criteria and Vietnam's political and economic attributes. The study aims to investigate the LOTUS approach and its potential effectiveness in sustainable development in the construction industry. The research involves a thorough review of green building standards worldwide and a comparative analysis of the LOTUS standard and other prominent assessment standards. The findings can help improve project management procedures and promote sustainable building practices in Vietnam and other developing nations. The paper provides an introduction to global green building rating systems, outlines the research methodology, examines key factors influencing green building advancement, compares the LOTUS rating system with other tools, discusses the application and effects of the LOTUS standard in promoting sustainable development in Vietnam, and summarizes the contributions and limitations encountered throughout the study.
Sustainability is a constantly evolving field, and green building certifications aim to verify that a building meets specific criteria and offers an ecological advantage. These certifications use multi-attribute approaches, including energy consumption, recycled ratio, and air and water emissions. Some programs focus on specific attributes, such as water usage, energy consumption, or chemical emissions, which directly affect Indoor Environmental Quality (IEQ). This study analyzes the evolution and current state of green building standards in the construction industry, including energy efficiency, indoor environmental quality, materials and resources, water efficiency, site and land use, emissions, and pollution (Chegut, Eichholtz & Kok 2014). The research methodology involves a systematic approach to gather and analyze data on green building standards and rating systems worldwide, identifying best practices and areas for improvement.

3. LITERATURE REVIEW

Table 1 shows the most widely used green-building rating tools globally, with LEED being the most widely used. The latest version, LEED v4.1, was released in 2018 and builds upon previous versions, offering updated requirements and credits for high-performance, sustainable buildings. These evaluation systems are widely used in many countries to assess green-building projects.
Over 70 countries use BREEAM, with several European nations establishing their own schemes run by National Scheme Operators (NSOs). These NSOs include BREEAM DE,

BREEAM ES, BREEAM NL, BREEAM NOR, and BREEAM SE. Miljöbyggnad (MB) is the most prevalent system for environmental certification of buildings in Sweden, developed as a voluntary environmental rating tool to evaluate all new buildings. The VERDE Environmental Certificate from Green Building Council España (GBCe) also shows that buildings have less environmental impact than standard reference buildings. The WELL Building Standard is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being.

Table 1. Common green-building rating tools worldwide (Alphabetical order)

Green-building rating tool	Country of Origin	Organisation	Lastest version	First Published year
Alta Qualidade Ambiental (AQUA)	Brazil	GBC Brazil		2007
BREEAM	UK	BRE	2016	1990
CASBEE	Japan	JSBC	2002	2015
DGNB (Deutsche Gesellschaft für Nachchaltiges Bauen)	Germany	DGNB - German Sustainable Building Council	2021	2009
Ecology, Energy Saving, Waste Reduction, and Health (EEWH)	Chinese Taipei	Taiwan GBC	2017	1999
EDGE		International Finance Corporation - World Bank Group	2015	2010
Green Mark	Singapore	Building and Construction Authority (BCA).	2010	2005
Green Star	Australia	GBC Australia		
LEED	US	USGBC	2018	1998
LOTUS	Vietnam	Vietnam Green Building Council (VGBC).	2020	2009
Miljöbyggnad	Sweden	Swedish Green Building Council (SGBC)	2022	2003
Nordic Swan Ecolabel	Nordic bodies	Nordic Swan Group	2022	1995
Selo Ambiental Colombiano para las Edificacionis (SACE) [Colombian Environmental Seal for Sustainable Building]	Columbia	Colombian Green Building Council (CCV)	2010	2010
VERDE	Spain	GCB España		
WELL	US	IWBI	2018	2014

Construction projects in Australia should be assessed consistently with the requirements of the Building Energy Analysis Software protocol in the Australian Building Code Board. Other green building tools used nationally are Building Sustainability Index (BASIX) and

Nationwide House Energy Rating Scheme (NatHERs), which are mandatory green building regulations. Both BASIX and NatHERs ratings can be used to earn credit points in the Green Star Environmental Rating System.

A few Asian nations, like Japan and Singapore, have created their own green building evaluation systems. The Green Mark system in Singapore promotes sustainable design and construction, while the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan is a green building rating system. In Vietnam, the Vietnam Green Building Council (VGBC) adopted LOTUS (Leadership in Energy and Environmental Design) as a tool for evaluating green buildings in 2009 (Vietnam Green Building Council 2019).

4. COMPARING LOTUS, A NEWLY DEVELOPED GREEN BUILDING RATING SYSTEM IN VIETNAM, TO OTHER AVAILABLE TOOLS IN THE SECTOR

Green building policies have become a crucial part of development policy reforms worldwide. Global evaluation methods, such as LEED, BREEAM, DGNB, and Green Star, have been developed to assess the value of green commercial buildings (Illankoon et al. 2019). Studies show that green buildings can achieve higher sales prices, higher rentals, and higher occupancy rates than those without certifications (Chegut et al. 2011; Leskinen, Vimpari & Junnila 2020). Industry validation of 'green value' is influencing property prices through reduced running costs, ease of sale and renting, and tenant retention.

Figure 1. Impact factors to green-building development

Factors influencing green building development include social, economic, and environmental impacts. Green certification is a primary factor, allowing real estate investors to assess property's future worth. Other factors affecting green office buildings include cost savings, occupancy rate, rental value, and market value (Ellis 2009; GBCA 2012; Pitts 2008). Other factors include available green building skills, market strategy benefits, business motivation, tax incentives, government interest, and green building certification policies.

Vietnam's urbanization is causing pressure on infrastructure, housing, and workplaces due to rising migrant influx. The country's metropolitan areas use 30-35% of its total energy, 60% of natural resources, 30% of clean water supplies, and 30% of CO and CO2 emissions. LOTUS, the first voluntary green building criteria system for the Vietnamese construction sector, combines the advantages of LEED and Green Mark systems. It aims to develop ecologically and health-friendly buildings with reduced running costs. However, high investment costs hinder green building development. Construction management must estimate and analyze construction investment costs throughout the project life cycle according to green building standards (Chegut, Eichholtz & Kok 2014; Diyana & Abidin 2013). Green building contributes to employee productivity, health, energy conservation, resource management, and operational expenses. The paper outlines the elements influencing office project investment choices based on cost assessments throughout the project's life cycle in accordance with green building standards in Vietnam.

LOTUS is a green building certification system developed by the Vietnam Green Building Council, an international non-profit organization. It includes seven assessment systems for various construction projects, including non-residential structures, condos, commercial buildings, houses, and interior spaces. LOTUS serves as a guideline and goal setting tool for creating environmentally friendly buildings with reduced running costs. It shares similarities with LEED, Green Mark, and Green Star. Vietnamese regulations and norms are also incorporated throughout LOTUS.

Credits encompass the same standards used to evaluate project performance. The LOTUS project will select and execute precise quantities and earn points for certification. Typically, the greater the number of points a project earns, the greater the benefits that LOTUS will offer. A higher grade signifies a structure that exhibits greater energy efficiency, reduced water consumption, less maintenance needs, and enhanced tenant comfort. The project will receive LOTUS Certification at one of several levels, depending on the final outcome. The minimum certification level is set at 40 percent of the overall score (referred to as LOTUS Certification). The LOTUS Silver, Gold, and Platinum certifications contribute 55 percent, 65 percent, and 75 percent, respectively, to the final score (Vietnam Green Building Council 2019).

5. THE DEVELOPMENT OF GREEN BUILDING EVALUATION SYSTEM IN VIETNAM

The recent yearly growth rate of the Vietnamese building industry, which has been approximately 9%, and the country's 40.5% urbanisation rate have put increasing pressure on energy usage. In 2020, Vietnam will have 743 commercial housing projects with a total of over 232,000 licenced flats; 288 of these projects will have been completed, resulting in over 57,000 units. More than 5.2 million square metres of affordable housing have been developed throughout 256 urban projects, totalling more than 104,200 units under construction. There are 264 active projects with about 11 million square feet of construction space. The typical home in 2020 will have 25 square metres of floor area for each occupant (General Statistics Office of Viet Nam 2022).

Vietnam now boasts slightly more than 200 green buildings, following more than ten years of growth since 2010. This quantity is far less than what is needed when considering the number of operational projects, as well as the possibilities and requirements for energy consumption, resource conservation, efficiency, and environmental protection.

Vietnam's green building market is expanding, with 201 certified green projects in the first three quarters of 2021. 53 projects received EDGE Green Building certifications, accounting for 26% and 58% of the total floor area. 113 projects received the LEED Green Building Certificate, accounting for 56% of the total floor area. 35 projects received LOTUS Green Building accreditation, accounting for 18% and 8% of the total floor area. However, Vietnam's LOTUS green building evaluation system is still inadequate compared to other systems. Life Cycle Cost Assessment (LCCA) is a method for evaluating an asset's total cost of ownership during its entire useful life, including procurement, use, maintenance, and disposal. Using a green building approach, life cycle costs can be calculated by adding up costs associated with the project's various phases and dividing them by the project's specified lifespan or time point.

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6. DISCUSSION AND CONCLUSIONS

The economic performance of a project life cycle in Vietnam is influenced by various factors. In Vietnam, financial management instruments, such as laws and standards, have been developed to improve quality assurance. However, there is a lack of legislation and corporate support mechanisms for green building certification. Most projects are funded by private or foreign capital, and state budget initiatives have not yet been implemented. Experience, qualifications, and skills play a crucial role in sustainable design and development principles (Waidyasekara & Silva 2014). Green building development requires a commitment to health and environmental concerns, integrating architectural ideas and landscaping to reduce energy consumption. Stakeholder training and certification examinations are necessary to promote energy-saving technology research and activities. Water saving is another important factor, with a coefficient of the effect of 0.29, highlighting the importance of reducing water consumption and protecting water quality in green buildings.

Green building laws and establish clear rules should be enforced by governments to promote environmentally friendly growth. Eco-friendly materials in building projects should be introduced to use on a regular basis. Green building evaluations are influenced by factors like experience, qualifications, skills, motivation to maximize project life cycle economic performance, energy and water saving, materials and resources, management, and market strategy promotion. Energy-saving management is the first criteria influencing green building approach and evaluation. Identifying and prioritizing these components will provide more precise project development approaches for academics, designers, and practitioners.

It can be seen that LOTUS is an energy-oriented environmental assessment tool and its highest weight

is given to the energy use index of the building. This results in LOTUS certified buildings focusing on the energy efficiency of the building at the expense of other environmental impacts. Design guidance programs are distinguished from performance-based rating systems. However, land ecological value, material life cycle assessment, and greenhouse gas emission reductions throughout the building life cycle, etc., should all be included in a project's green rating.

Therefore, to quantify the performance improvement of green buildings and score them, a robust database is needed. The performance-based approach to environmental impact assessment in LOTUS needs to be based on a comprehensive database built to suit the reality in Vietnam. Currently, to support its application, Vietnam is still in the early stages of development with much work to be done. At this level, measures-based green building assessment is regarded as a good technique for countries beginning to assess green buildings, such as Vietnam; however, in order to improve design results, a transition from measures-based to performance-based ratings is required for the next step.

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