

Research on the Benefits and Barrier of Green Building

Zhekun Zhu

The Department of Civil and Environmental Engineering, Carleton University, Ottawa, Ontario,
Canada

kevinzhu5@cmail.carleton.ca

Abstract. Many researches have pointed out that human activities around the world are producing too much pollution and that something must be done immediately. The concept of green civil engineering takes this traditional field in a new direction. Green building (GB), also known as sustainable building, is the best way to overcome the extensive damage to the environment caused by waste materials and mitigate the negative impact of buildings throughout their life cycle, not only providing more suitable indoor conditions, but also being economically sustainable in the long term. Therefore, this paper presents the economic, social, and environmental benefits of GB, respectively. Moreover, the obstacles that currently exist are introduced and the proposes solutions to overcome them are also listed in the end of this paper. Results show that GB can develop better real-world applications for the construction industry while acting as a major driver of solutions to help save the planet from even worse pollution.

Keywords: Economic benefits, social benefits, environmentally friendly, barriers, solutions.

1. Introduction

Architecture has a great environmental, social and economic impact on society. However, on the other hand, it has also had adverse effects on the environment and natural resources, which is well known. Negative effects include noise, water pollution, waste and energy consumption [1]. Therefore, the civil engineering industry is facing huge environmental pressure, and there is an urgent need to change the traditional building model. Finding suitable and effective environmental protection methods has been the focus of many engineers and researchers. The concept of green building (GB) was born. GB is often associated with better air quality, lower energy and water consumption, and higher property values [2]. With the continuous development of new technologies and new materials in engineering, more environmentally friendly structures and buildings can be constructed and developed. However, at the same time, owners and real estate companies do not like the additional construction costs of GB and feel that GB is not a necessary step they have to take. Therefore, this study aims to raise awareness of GB by providing benefits and current barriers that exist.

2. GB overview

The concepts of GB and sustainable building are substitutable ideas in sustainable development that offer a balanced way to overlap the environment, economy, and society, as shown in Fig. 1 [3].

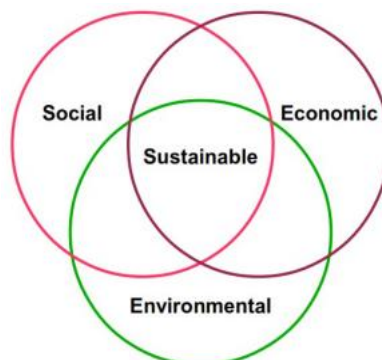


Figure 1. Concept of sustainability [4]

As a growing concept, GB is relatively new in the construction and civil engineering industry and has been appearing as a symbol of sustainable and high-performance building. GB Canada pointed out "GB is a resource-efficient method of construction that produces healthier buildings which have less impact on the environment and cost less to maintain" [5]. The alternative goal of GB's design is to minimize its environmental impact, including energy efficiency, water conservation, environmentally friendly materials, and waste reduction [6]. All these factors make GB outperform traditional (non-green) buildings and contribute to the overall well-being of the planet. Although GB has been elevated as a high-potential solution to decrease the unfavorable environmental effects of the construction industry, there is still no measurable and globally recognized definition for the term. Several countries worldwide have created their assessment tools and standards to evaluate the performance of GBs. The well-known rating systems are LEED (Leadership in Energy and Environmental Design), The Living Building Challenge certification, Green Globes Certification, BREEAM (BRE Environmental Assessment Method), etc. [7]. These rating systems help GB establish a more sustainable development system, thus making GB's benefits tangible and visible to the public. However, GBs still have a vague and confusing image nowadays. Buyers and builders see GBs as an extra cost and expensive technique, such barriers prevent people from seeing the long term advantage of GB.

3. Benefits of GB

3.1. Economic Benefits

Researches show GB provides some economic benefits that traditionally constructed buildings do not, and one of the biggest advantages is energy consumption [8]. GB's abilities in energy saving come from the improved thermal protection system and reduced energy purchase and demand. On average, GBs are approximately 28% more energy efficient than traditional constructed buildings as shown in Table 1. Furthermore, if PV (photovoltaics) are installed, GBs have the ability to generate 2% of power on site [9].

Water efficiency is the term that describes the use of freshwater. Due to GB's water-saving strategies, it can reduce water usage by almost 25% compared to traditionally constructed buildings [10]. Some GBs can collect water from their roofs or have a water treatment system to treat collected wastewater to achieve even higher water efficiency. Maintaining cost savings in GB involves a strategic and ongoing commitment to sustainable practices throughout the building's lifecycle, and with lower energy and water costs, emissions savings, operation savings and maintenance savings, GB can save a significant amount of money in the long term, as shown in Table 2.

Table 1. Reduced Energy Used in GBs as Compared with Conventional Buildings [9]

Item	Certified	Silver	Gold	Average
Energy Efficiency (above standard code)	18%	30%	37%	28%
On-site Renewable Energy	0%	0%	4%	2%
Green Power	10%	0%	7%	6%
Total	28%	30%	48%	36%

Table 2. Financial Benefits of GBs Summary of Findings (per ft2) [9]

Category	20-year Net Present Value
Energy Savings	\$5.80
Emissions Savings	\$1.20
Water Savings	\$0.50
Operations and Maintenance Savings	\$8.50
Productivity and Health Benefits	\$36.90 to \$55.30
Subtotal	\$52.90 to \$71.30
Average Extra Cost of Building Green	(-3.00 to -\$5.00)
Total 20-year Net Benefit	\$50 to \$65

Compared to traditionally constructed buildings, GBs favor choosing durable materials with a long lifespan and low maintenance requirements according to the principle of "healthy constructions" [11]. The chance of a failed building structure is much smaller. Although the starting price to construct these durable building materials is higher, the cost for this material during its service life is lower than that of conventional materials. GBs are often designed to minimize waste generation, and they often come with effective waste separation systems to recycle materials such as paper, plastics, glass, and metal. Constructing GB for landowners and real estate companies will help increase property prices. Properties that can be recognized by green rating systems, such as LEED, are often perceived as higher in quality and performance. Green-certified buildings (GB) provide third-party verification of a building's sustainability features, resulting in faster rental and selling, which can increase its market value. In some regions, governments offer GB incentives, tax credits, or rebates. Property owners can also benefit financially from these incentives, indirectly adding to the property's overall value [12].

3.2. Social Benefits

According to studies, people often spend 90% of their time indoors, making indoor quality particularly noteworthy [13]. Indoor environment plays an important role in occupants' physical and mental health and productivity. The most famous "unhealthy" indoor condition can be Sick building syndrome (SBS). The term refers to a series of symptoms experienced by the occupants of a building. The National Institute of Health defines SBS as "a situation in which the occupants of a building experience acute health- or comfort-related effects that seem to be linked directly to the time spent in the building" [14]. Symptoms include but are not limited to headache, eye irritation, difficulty concentrating, etc., which can be caused by poor ventilation, the release of toxic chemicals, biological contaminants, etc. With the sustainable materials used in GB construction, humidity control and indoor air pollution can be measured and improved. GB often comes with effective ventilation systems that refresh the indoor polluted air with outdoor air. Usage of low-emission and non-toxic materials in GB enhances indoor air quality. GB also often contains HVAC systems, which are systems that allow for temperature and humidity control. Compared to traditional structured buildings, GB can maintain consistent environmental conditions that provide the occupant with a more comfortable indoor environment, and directly provide a positive impact on the health and productivity of occupants.

3.3. Environmental Benefits

The main idea of having GB is to reduce the energy used and limit carbon dioxide during operation to help the earth on global warming [15]. Energy-efficient technologies and renewable energy sources are often practiced in GB, and the application of these can reduce the carbon footprint. Sustainable materials lower the environmental impact during their lifetime; some examples are cork, recycled glass, recycled plastic, etc. Consuming energy and water efficiently can lower greenhouse gas emissions associated with energy production and local water supplies. GB can also help minimize the negative impacts of construction and operation of buildings.

4. Barriers and Possible Solutions

Many barriers exist between the public and the idea of GB, and they can be due to many different reasons. According to the study done by Amos Darko and Albert P.C. Chan they researched 36 published articles and listed a table for the barriers that appear in at least two articles. This section is going to talk about the top 3 barriers mentioned out of 36 articles and what they are [16].

(1) Lack of information and education

The study showed that the most mentioned barrier out of the 36 articles is "lack of information about GB". The knowledge about GBs is vague to the public. People might say GBs are environmentally friendly, but they often do not know what it means and what it does. Studies found

that lack of information and research about GB causes individuals in the industry not to know what the correct information to use as guidance is, resulting in decreased public awareness about the GB concept.

(2) Cost

Cost is the second most common barrier. The price for GB-related materials and equipment, such as energy-efficient systems, renewable energy sources, and sustainable materials, can be higher than for traditional materials. For GB projects, securing the finance can sometimes be challenging because institutions may not fully understand the benefits or risks associated with GB. Developers and owners sometimes want immediate cost savings over long-term sustainability. Since GB is still a relatively new concept, skilled labour for implementing GB practice may also cost more.

(3) Lack of Incentives

Lack of incentives in building is the third most mentioned barrier. Financial incentives are not worldwide for GB developers; therefore they might find it challenging to justify the upfront cost for GB project. Lack of clear policies, codes and regulations promoting GB cause stakeholders not have enough motivation to do a GB project.

The suggestions to overcome these barriers can be summarized as follows. Education about GB is essential, activities like campaigns and school lectures can help to inform the public, developers, and builders about the benefits of GB. More financial support programs, such as low-interest loans for GB projects, can make GB financially viable for developers to invest. Government and local authorities can also introduce more financial incentives, such as tax credits, grants, etc. Once developers and owners can see the long-term benefits and have financial and regulatory, GB will have a positive public image and motivate people to invest and be part of GB projects.

5. Conclusion

(1) GB's economic, social and environmental benefits have been studied. Economically, GB provides long-term benefits and lower operational costs. The social impact includes improved physical and mental well-being of the occupants. Environmentally, GB helps reduce greenhouse gas emissions and efficient resource use.

(2) Some of the barriers that exist are lack of information and education, high initial cost and lack of support; these can be overcome over time with the raised awareness of the public and government. GB becomes not only a responsible choice but a way that will provide a better tomorrow for us and our future generations.

(3) The GB project relies heavily on the development of technology and methodology used. Some ideal future GB can have self-energy support, zero-carbon buildings, and total solar power buildings, requiring more developed technology. The integration of advanced technologies, sustainable materials, changing environmental conditions, public social awareness and society's interest will be key drivers in shaping the future of GB.

References

- [1] Val Dusek. *Philosophy of Technology: An Introduction*. Blackwell Publishing, 2006, 33-35.
- [2] Xu X Y, Li X. Application Analysis of Green Building Materials in Civil Engineering Construction. *Adv Matl Sci Tech*, 2020, 2 (1): 12-16.
- [3] Kibert, Charles J. *Sustainable construction: green building design and delivery*. John Wiley & Sons, 2022, ISBN: 978-1-119-70645-8.
- [4] Behnam Neyestani. A Review on Sustainable Building (Green Building). *Science Research Network*, 2017, DOI:10.2139/ssrn.2968885.
- [5] Green Building Canada | green building guide “What is Green Building”. October 6 2020. Retrieved on December 24, 2023. Retrieved from: <https://greenbuildingcanada.ca/green-building-guide/what-is-green-building/>.

- [6] Widok A. Social Sustainability: Theories, Concepts, Practicability; Environmental Informatics and Industrial Environmental Protection: Concepts, Methods and Tools, EnviroInfo, 2009, ISBN: 978-3-8322-8397-1.
- [7] Jerry Yudelson. The green building revolution. Island Press, 2010, ISBN:9781597267632.
- [8] Tian W, Zhu C, de Wilde P, Shi J, Yin B. Sensitivity analysis of building energy performance based on polynomial chaos expansion. Journal of Green Building. 2020, 15 (4): 173–183.
- [9] Gregory H. Kats. Green Building Costs and Financial Benefits, Massachusetts Technology Collaborative, 2002, 3-7.
- [10] Scofield J H. Green Building technology, Environmental Science and technology, 2000, 34 (21): 448A.
- [11] Dergunova, Anna Vasilevna., Erofeev, Vladimir Trofimovich. Economic, environmental, and social benefits of Green building. Ogarev Mordovia State University, 2021, ISSN 2658-5553.
- [12] Echome | guides “Green Home Renovation Tax Credits Grants”, May 5 2021. Retrieved on December 25, 2023. Retrieved from: <https://www.ecohome.net/guides/2301/green-building-financial-incentives/>.
- [13] Klepeis N, Nelson W, Ott W et al. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. J Expo Sci Environ Epidemiol, 2001, (11): 231–252.
- [14] SumedhaM Joshi. The sick building syndrome, National Institute of Health, 2008, PMID: 20040980; PMCID: PMC2796751.
- [15] Khoshbakht M., Gou Z, Dupre K., Altan H. Thermal environments of an office building with double skin facade. Journal of Green Building, 2017, 12 (3): 3-22.
- [16] Amos Darko and Albert P. C. Chan. Review of Barriers to Green Building Adoption, Sustainable Development, John Wiley & Sons, Ltd., 2017, 25 (3): 167-179.