Comparative Review of Global and Malaysian Green Building Rating Systems: Literature Review

Yousif Mohammed, Gasim Hayder, and Sivadass Thiruchelvam

Abstract

Environmental assessment and carbon footprint have recently become popular research topics due to their significant impact on greenhouse gas (GHG) and building life cycle (BLC), both of which have an impact on human life all over the world. Thus, the issue of developing a more sustainable society through creative methods has opened up a significant research area for officials and environmental specialists to increase building efficiency, cut carbon dioxide CO_2 emissions, and boost human welfare throughout this industrial rapid transition. The goal was to create an environmental rating system that would have a substantial impact on the industry. Comparing international rating systems such as LEED, BREEAM, and CASBEE, as well as local rating systems such as GBI and MyCREST, establishing criteria for the suggested rating system, and conducting a thorough examination. As a result, a new interface might be designed that includes the system's criteria and measurements. Then it may be put to the test and compared to other rating systems. It is expected to have a profound impact on the sustainability dimensions (economy, society, and environment). BIM is associated with tools for collaboration between modeling and extra analysis. Limitations, as well as the future route of a sustainable planet, are highlighted.

Keywords

Sustainable • Carbon footprint • Green building • BLC • BIM

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1 Introduction

Designation of green building (GB) returns in specific to building designed to be echo efficient during its life service. This involves the whole construction process, from planning to demolition (Liu et al. 2019). This could be accomplished using sustainability indicators or rating systems, which are useful because they summarize trends and correlations in a concise manner (Khanh 2012). Their diversity among countries makes it difficult to grasp for international businesses (Yusoff and Wen 2014), complicated by the fact that few systems are well-known and set a long-term development standard (Nguyen and Altan 2011).

Buildings or the building sector are responsible for 30–40% of worldwide environmental impact (Liu et al. 2019), as well as 30% of raw material utilization, 50% of landfill wastes, around 40% of pollution detected in drinking water, generates around 23% of air pollution, consumes 40% of energy, huge part of it in the operating phase and emits a significant quantity of GHG (CIDB 2018; Khahro et al. 2021). Indeed, because of their high operational energy besides water consumption, raw material employment and land use, buildings have proved to be the largest CO_2 emitters and contribute significantly to world's climate (CIDB 2018). Thus, countries all around the globe have set long-term carbon emission reduction objectives in order to help prevent climate change. Malaysia has actually committed to reducing emissions throughout the country by up to 45% by the year 2030 as part of a worldwide initiative (Abdullah 2017).

According to United States Green Building Council (USGBC), green construction can save 30% on energy, 30–50% on water, 50–90% on construction waste, and 20–35% on GHG (CIDB 2018). As a result, technologies such as sustainability rating systems (SRS) and life cycle assessment (LCA) have been developed. LEED and BREEAM are global Sustainability assessment systems, while Malaysia's GBI and MyCREST are local, both of whch has been

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initiated for assessing buildings with its environments in Malaysia. Several research regarding BIM and energy efficiency (EE) has set frame for implementing BIM to minimize energy and emissions of the related buildings (Petri et al. 2017), because of their powerful mechanism to sustainability analyses and project management along construction stage (Khahro et al. 2021; Marrero et al. 2020). It enables designers to create constructive components while also defining their qualities or parameters during the project's current life cycle stage (Marrero et al. 2020).

This research reviewed both global and Malaysian SRS and has selected three international rating systems LEED, BREEAM, and CASBEE together with two Malaysian rating systems GBI and MyCREST as samples to represent as per their data information and assessment tools.

2 Methodology

This research technique, which was conducted by employing global content analysis of materials that were published in the form of articles, procedures, or other guidelines from the SBRS (Yusoff and Wen 2014). A systematic review strategy is required to gain a deeper knowledge of the peculiarities and distinctiveness of each existing Malaysian sustainability rating tool. The review criteria chosen for examining the similarities and differences of sustainability rating tools were inspired by the BRE (2004) study (CIDB 2018). This study is review of the previous literature of the international rating systems based on their influence and the Malaysian rating systems as well. Comparative review among both is highlighted. The methodology flowchart of this study is illustrated in Fig. 1.

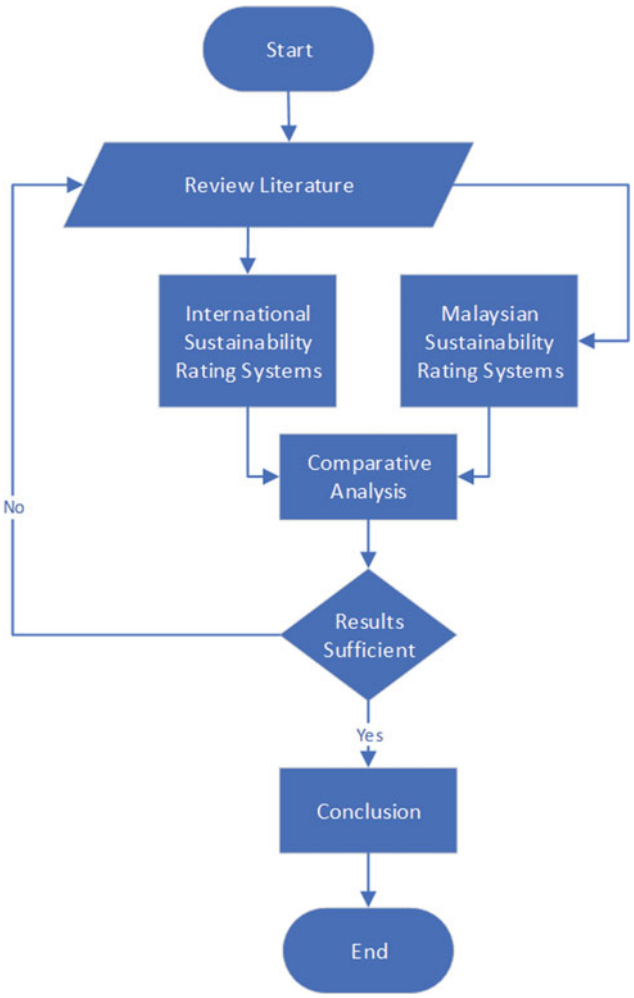

Fig. 1 Study methodology

3 Review Criteria

3.1 Sustainability Rating System

Due to climate threats besides the current global warming, understanding of sustainability is generally acknowledged (Lu et al. 2019). Actually, resilience of people has urged awareness toward the GB as a result of various negative environmental concerns that have arisen (Yusoff and Wen 2014). Sustainable building design in the construction field is defined by terms such as green design or energy-efficient structures (Wang and Adeli 2014). While the average global temperature has risen by around 2 °F (1.1 °C), this is mostly owing to increased greenhouse gas emissions (GHGs) into the atmosphere (Azharuddin 2019). Buildings utilized 40% of energy sources and resulted in 36% energy-related carbon emissions in developed countries, according to Intergovernmental Panel on Climate Change (Fu et al. 2014). To reduce environmental impacts during the life cycle of a building and to provide people with a suitable living environment, meaningful and significant adjustments are required (Xu and Daskalova Laura Franco Garcia 2018), to assess the effects of buildings, structures, infrastructure, urban-scale efforts, and community program (CIDB 2018). Figure 2 details the building entire life from planning to demolition (B icons 2021).

Rating systems are intended generally to assist projects in becoming more sustainable by offering specific frames that contain criteria that address various aspects of the project's environmental hazards. In 1990, sustainability importance has emerged (CIDB 2018). BREEAM was launched to be the pioneer of the industry, followed by LEED in 1993 and CASBEE in 2001 (CIDB 2018; Xu and Daskalova Laura Franco Garcia 2018). Those tools were followed by numerous of similar types over the world. In fact, other systems used their fundamentals, including their difference, to construct their tools. Thus, the line between "green" and

Fig. 2 Building entire life

"sustainable" has become increasingly blurred (Nguyen and Altan 2012). The rating systems listed intelligent system computing, sensor, and lifecycle cost optimization technologies as technologies that might aid in the building environment (Wang and Adeli 2014) and other greater challenges related to buildings sustainability, such as social elements, zero energy, living and regenerative building concepts (CIDB 2018).

3.2 Criteria Based

Majority of world SRS are criteria based. They're organized into categories, sub-categories, and issues. Issues are given points to determine their worth. Later scores are given to evaluate project parameters based on an assessor's satisfaction and the result is in rating levels. There are differences in their allocation points and methods of result presentation, but they share common criteria concept such as site planning and management, energy efficiency (EE), indoor environmental quality (IEQ), materials and resources, and water efficiency (WE), innovation, quality of services, health and comfort, transport, waste, land use and ecology and emissions (Khanh 2012; Yusoff and Wen 2014; CIDB 2018; Nguyen and Altan 2012; Yim et al. 2018).

3.3 Carbon Emission Calculation

Regardless of the reality that many sustainability systems have taken steps to minimize CO_2 from construction activities, there is still a limited amount of comprehensive research and analysis of buildings' (GHG), particularly in densely populated areas (Roh et al. 2018). LCA is a method to assess environmental loads (Lu et al. 2019), of CO_2 and other impacts during a building's entire life span (Roh et al. 2018), when calculating and measuring GHG emissions from buildings, they are frequently defined as building's life cycle (Kaspersen et al. 2016). Although a building can be built to promote sustainability, quantitative evaluation of its performance is required (Wang and Adeli 2014), therefore, carbon dioxide is the predominant greenhouse gas (GHG) produced from a number of different sources including transportation, on-campus stationary sources, purchased energy, refrigerants, and solid waste among others, that should be quantified (Abdul-Azeez 2018). Estimated CO_2 between 2000 and 2010 increased by 1.0 giga ton annually, compared to 0.4 giga ton per year from 1970 to 2000, and overall anthropogenic GHG peaked at 49.0 giga ton in 2010 (Roh et al. 2018), thus, buildings' sustainability initiators at national and international levels, where they high concern to buildings' impact (Solís-Guzmán et al. 2018). They confirmed that increasing in green construction growth might result in a 35% lowering in carbon emissions (Klufallah et al. 2014). Carbon computation techniques are enhanced by the existing rating systems, such as the current international edition of BREEAM, which rewards points for calculating and lowering embodied CO_2 (Abdullah 2017). While the USGBC recently released an alternative compliance strategy that allows LEED credit measures to include CO_2 metrics (Drew and Quintanilla 2017). MyCREST has introduced carbon emission calculation for the Malaysian rating systems (CIDB 2018).

3.4 Global Environmental Rating System

Disparity in approaches among existing SRS systems like BREEAM (UK), LEED (USA), GBTool (International), and CASBEE (Japan) has perplexed developers and business owners (Nguyen and Altan 2012). That has enforced other countries developing their own system benefiting from the experience of leading tools. A basic introduction of SRS examples can be found in the paragraph below.

Introducing BREEAM, which was founded by the BBRE in 1990, is the pioneer of the SRS (Liu et al. 2019). BREEAM objectives were reducing energy emissions while assuring building safety and comfort (Xu and Daskalova Laura Franco Garcia 2018). Rating levels are Excellent for (70–100)% score, Very Good for (55–69)% score, Good for (40–54)% score, and Pass for (25–39)% score. Management, health, energy, materials, and land were considered at the design and construction phase, while transportation, water, waste and pollutions at the operation. These are the primary assessment criteria that can be evaluated over the course of a building's lifespan (Khanh 2012).

LEED was deployed by USGBC in 1994, and then LEED V1 was launched in 2000. It is highly influencing building assessment over the world, where million plus eight hundred and fifty square feet is the estimated assessed area for a day

(Liu et al. 2019; Xu and Daskalova Laura Franco Garcia 2018; Mohamed 2019). The LEED methodology works for all sorts of buildings, from existing structures to those still in the design and planning stages. Energy efficiency, environmental development, and water conservation have all received recent attention (Liu et al. 2019). Sustainable buildings can save within 24–50% on energy, 30% on CO_2 emissions, 40% on water, and 70% on solid waste, to the USGBC evaluation (Wang and Adeli 2014). LEED rating levels for buildings range within Platinum for (80–100) points score, Gold for (60–79) points score, Silver for (50–59) points score, and certified for (40–49) points score while its assessment criteria range within sustainable sites, water efficiency, energy, and others (Khanh 2012).

CASBEE the official SRS of Japan (Abdullah 2017) was launched by Japan Sustainable Building Consortium (JSBC) (Wang and Adeli 2014). It is designed to assess building with its environment (Wallhagen 2010). In 2003, 2004, and 2005, it was enhanced to include additional capabilities for newly constructed buildings, existing buildings, and renovation projects, respectively (Liu et al. 2019). CASBEE rating levels are; *S* for score (BEE = 3 − 5), A for score (BEE = 1.5 − 3), B+ for score (BEE = 1 − 1.5), B for score (BEE = 0.5 − 1), and C for score (BEE = 0 − 0.5). Its major assessment criteria range within IEQ, quality of services, site, energy, resources and materials and off-site environment (Khanh 2012).

3.5 Malaysian Environmental Rating System

GB assessment tools began at 2009, when GBI was launched through PAM which is the abbreviation of Pertubuhan Arkitek Malaysia and translated to Malaysian Institute of Architects, together with ACEM that is briefed to Association of Consulting Engineers Malaysia. They were inspired by the sustainability assessment systems that were emerging at that period (Abdullah 2017). Then, other institutions were motivated to build up numerous systems such as GreenRE that was driven to the industry by REHDA, Melaka Green Seal which was deployed by the authority of Melaka. They were intended to assess buildings as well as township. GreenPASS, PHJKR, MyCREST, and CASBEE Iskandar were among the additional systems implemented for the same goal, whereas MyGHI was focused on infrastructure (Kamal et al. 2019). The advantages of having a shared base with LEED and BREEAM could help with the transition to a globally recognized rating system (CIDB 2018). From 2006 through 2010, the whole national energy demand is expected to expand at a rate of 6.3% per year, according to the Ninth Malaysia Plan (Klufallah et al. 2014), that has driven the officials encouraging sustainability projects.

The fact that PAM and ACEM have launched GBI for an environmental evaluation related to structures (Yim et al. 2018; GBI 2009), in addition to developing both structures and towns in order to enhance construction environmental sustainability. Furthermore, it was intended to enhance environmental awareness among construction stakeholders, to ensure a brighter and greener future (Tools 2016). It is influenced by LEED in its assessment approaches. GBI rating levels range within Platinum for (86 +) points score, Gold for (76–85) points score, Silver for (66–75) points score, and Bronze for (50–65) points score. Furthermore, the GBI's key building assessment criteria are energy, indoor, sustainable site, materials and resources and water, while climate, energy and water, ecology, community, transportation and connectivity, building and business are the criteria for a sustainable township (BSI).

In order to promote and manage building project echo systems, CIDB built MyCREST (Kamal et al. 2019), to assist in guiding, quantifying, and thereby eliminating building impact, while considering the performance of the building along its life span (MyCREST 2016). MyCREST rating levels range within 5 Stars for (80–100)% score, 4 Stars for (70–79)% score, 3 Stars for (60–69)% score, 2 Stars for (50–59)% score, and 1 Star for (40–49)% score (CIDB 2018). Pre-design, infrastructure, energy, occupant, embodied carbon, water, social and cultural, demolition and disposal and carbon initiatives are some of the major criteria (CIDB 2018; Tools 2016).

3.6 Comparative Analysis

Throughout existing buildings to those currently under planning and design, based on the examined literature. It was discovered that LEED standards are now frequently used to assess the sustainability of new construction and substantial renovations (Liu et al. 2019). It is used mostly in North America, Brazil, and India (Wang and Adeli 2014), while BREEAM has affected Europe and part of Asia. CASBEE started with building quality and environmental impact evaluation and upgraded to include new buildings and renovation project (Liu et al. 2019; Wallhagen 2010). Both BREEAM and LEED have continued to increase building LCA standards by modifying green building criteria, making LCA a fundamental component rather than an optional item (Roh et al. 2018). The three rating systems reflect the differences in their result presentation, rating levels, and in counter the similarity approach for their targeting assessment. LEED has allocated high scores toward site planning and management, while BREEAM and CASBEE concentrated on EE, as well as they have minimal or even neglected Innovation (Fig. 3).

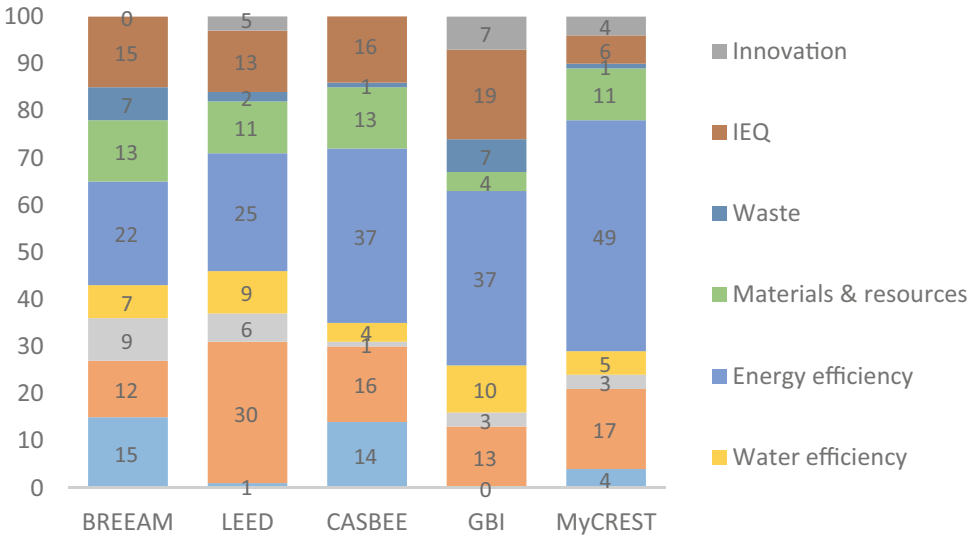

Fig. 3 International and Malaysian rating scores by categories

Concerning the local assessment system inside Malaysia, various similarities and differences could be remarked, their general trends can be identified as well. Among the existing rating tools for instance GBI that was launched to assess the buildings together with township. We can see that GreenRE uses the same approach while MyGHI is specialized in addressing highway. PHJKR involves health care while Melaka Green Seal for residential buildings. Also surveying the GB industry, we can realize that other system like Green Pass, CASBEE Iskandar, and LCCF are other progressing assessment tools. MyCREST is last deployed among all systems (CIDB 2018; Kamal et al. 2019). They are criteria checklist base except MyCREST that introduces carbon calculation and criteria checklist. According to a review of the local systems applications, PHJKR, Green Pass, and MyCREST are involved in construction, while SUSDUX and LCCF are used to assess townships. MyGHI is the only tool specialized to infrastructure assessment (CIDB 2018). Both GBI and MyCREST has allocated high score for EE (Fig. 3). GBI is more detailed than MyCREST for target assessment area.

4 Discussion

There is currently minimal public discussion about the requirements for a satisfactory rating system. However, it is widely acknowledged that the success of a voluntary plan is largely determined by how well it is received by profit-seeking building stakeholders (CIDB 2018). Using the LCA approach as part of a bigger plan to urge the building industry to reduce carbon emissions is crucial (Roh et al. 2018). Incorporating BIM-LCA, designers and engineers may get quick and accurate findings concerning a building's environmental performance (Lu et al. 2019). The trend for energy efficiency is increasing since the initiation of the environmental rating tools by BREEAM to the most recent one MyCREST, demonstrating the need for constant development and system updates to keep up with industry changes. The local rating tools are more competent to assess their environment, but they should be connected to the global to act as integrated system.

5 Conclusions

Observation through the study will end to regularly update the local systems learning from the global ones, to be valid to the industry revolution and maintain the world climate. The regional systems are developed to assess their local parameters, but they should be integrated into the global ones, for maximizing benefits and further research purposes. BIM-LCA should be enforced to have precise quantification and hence enhance building life cycle and reduce carbon footprint. Malaysian rating system could exchange their experience as well as strengthen their scaling to global rating systems, through comprehensive research projects.

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References

F. Abdullah, Potentials and challenges of MyCREST: a Malaysian initiative to assess carbon emissions from buildings (2017)

I.A. Abdul-Azeez, Development of carbon dioxide emission assessment tool towards pro-moting sustainability in UTM Malaysia. Open Journal of Energy Efficiency **7**, 53–73 (2018). https://doi.org/10.4236/ojee.2018.72004

M. Azharuddin, Integrated carbon emission management for the United Arab Emirates Construction Industry (2019)

B icons, Construction building icons—Bing images, https://www.bing.com/images/search?q=construction+building+icons&form=HDRSC3&first=1&tsc=ImageBasicHover. Accessed 21 Dec 2021

CIDB, Built-it-green-CIDB [Construction Industry Development Board] (2018)

N. Diyana Nizarudin, I. Tukiman, M. Ramzi Mohd, The application of the green building index (GBI) on sustainable site planning and management for residential new construction: prospects and future benefits architecture for autism view project ICoFA 2017 view project the application of the green building index (GBI) on sustainable site planning and management for residential new construction: prospects and future benefits (2010). [Online] Available: https://www.researchgate.net/publication/280730724

C. Drew, N. Quintanilla, The path to life cycle carbon neutrality in high rise buildings (2017)

F. Fu et al., Development of a carbon emission calculations system for optimizing building plan based on the LCA framework (2014)

GBI, GBI ASSESSmENT cRITERIA (2009). [Online] Available: www.greenbuildingindex.org (info@greenbuildingindex.org)

M.F.M. Kamal et al., Malaysian carbon reduction and environmental sustainability tool (MyCREST) qualified professional training assessment. Journal of Technical Education and Training **11**(4), 45–55 (2019). https://doi.org/10.30880/jtet.2019.11.04.006

B. Kaspersen, J. Lohne, R.A. Bohne, Exploring the CO_2-impact for building height; a study on technical building installations (2016)

S.H. Khahro, D. Kumar, F.H. Siddiqui, T.H. Ali, M.S. Raza, A.R. Khoso, Optimizing energy use, cost and carbon emission through building information modelling and a sustainability approach: A case-study of a hospital building. Sustainability (Switzerland) **13**(7) (2021). https://doi.org/10.3390/su13073675

B.N. Khanh, Developing a framework for assessing sustainability of tall-building projects volume I (2012)

M.M.A. Klufallah, M. Fadhil Nuruddin, M.F. Khamidi, N. Jamaludin, Assessment of carbon emission reduction for buildings projects in Malaysia—a comparative analysis (2014). https://doi.org/10.1051/e3sconf/20140301016

T.Y. Liu, P.H. Chen, N.N.S. Chou, Comparison of assessment systems for green building and green civil infrastructure. Sustainability **11** (7), 2117 (2019). https://doi.org/10.3390/su11072117

K. Lu et al., Development of a carbon emissions analysis framework using building information modeling and life cycle assessment for the construction of hospital projects. Sustainability (Switzerland) **11** (22) (2019). https://doi.org/10.3390/su11226274

M. Marrero, M. Wojtasiewicz, A. Martínez-Rocamora, J. Solís-Guzmán, M.D. Alba-Rodríguez, BIM-LCA integration for the environmental impact assessment of the urbanization process. Sustainability (Switzerland) **12**(10). MDPI (2020). https://doi.org/10.3390/su12104196

M. Mohamed, Green building rating systems as sustainability assessment tools: case study analysis (2019), [Online] Available: www.intechopen.com

MyCREST, Malaysian carbon reduction & environmental sustainability tool—version 1.0 (2016)

B.K. Nguyen, H. Altan, Comparative review of five sustainable rating systems. Procedia Engineering **21**, 376–386 (2011). https://doi.org/10.1016/j.proeng.2011.11.2029

B.K. Nguyen, H. Altan, Tall-building projects sustainability indicator (TPSI): a new design and environmental assessment tool for tall buildings. Buildings **2**(2), 43–62 (2012). https://doi.org/10.3390/buildings2020043

I. Petri et al., Optimizing energy efficiency in operating built environment assets through building information modeling a case study (2017)

S. Roh, S. Tae, R. Kim, Developing a green building index (GBI) certification system to effectively reduce carbon emissions in South Korea's building industry. Sustainability (Switzerland) **10** (6) (2018). https://doi.org/10.3390/su10061872

J. Solís-Guzmán, C. Rivero-Camacho, D. Alba-Rodríguez, A. Martínez-Rocamora, Carbon footprint estimation tool for residential buildings for non-specialized users: OERCO2 project. Sustainability (Switzerland) **10**(5) (2018). https://doi.org/10.3390/su10051359

G. Tools, Includes information on GBI (2016) [Online] Available: www.greenbuildingindex.org

M. Wallhagen, Environmental assessment of buildings and the influence on architectural design (2010)

N. Wang, H. Adeli, Sustainable building design. Journal of Civil Engineering and Management **20**(1), 1–10 (2014). https://doi.org/10.3846/13923730.2013.871330

J. Xu, V. Daskalova Laura Franco Garcia, Master thesis proposal research on the resident perception rating for green building through ESGB in China (2018)

S.Y.C. Yim, S.T. Ng, M.U. Hossain, J.M.W. Wong, Comprehensive evaluation of carbon emissions for the development of high-rise residential building. Buildings **8**(11) (2018). https://doi.org/10.3390/buildings8110147

W.Z.W. Yusoff, W.R. Wen, Analysis of the international sustainable building rating systems (SBRSs) for sustainable development with special focused on green building index (GBI) Malaysia. Journal of Environmental Conservation Research **2**(1), 11 (2014). https://doi.org/10.12966/jecr.02.02.2014