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BIBLIOMETRIC REVIEW OF RESEARCH ON GREEN BUILDING ASSESSMENT METHOD BY CITESPACE AND HISTCITE

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Abstract. Numerous qualitative review studies have been conducted to enhance the understanding of current research status of green buildings (GBs). Green building assessment methods (GBAMs) are crucial to the development of GBs and relevant research works has received wide attention. However, there are very few reviews to quantitively explore these studies. Therefore, this paper aims to systematically review literatures on GBAMs, and visually analyzes them through CiteSpace and HistCite. The article identified the most influential journals, contributors, representative institutions and regions. The knowledge bases of this area focus on "triple bottom line", "indicator", "building design", "life cycle costing", "life cycle sustainability assessment", "tropical climate", "building information modelling" and "Chinese green building label". Through citation analysis, "updating existing GBAMs by scheme comparison", "updating existing GBAMs by GB case analysis", "establishment of new GBAMs" and "incorporation of BIM in GBAMs" were found as the main research themes. "Design", "LCA", "model", "energy", "management", "residential buildings" and "office buildings" are high-frequency keywords. Future research directions were finally proposed as "more investigation on the other types of GBs", "incorporation of cost-related criteria", "enhancing health-related indicators" and "integrating with BIM technology". The results could provide a useful reference to industry practitioners and scholars interested in GBAMs.

Keywords: green building, assessment method, review, CiteSpace, HistCite, construction industry, current topics, future directions.

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1. Introduction

Global warming and environment deterioration, caused by excessive utilization of fossil fuel, is becoming increasingly serious with frequent extreme weather events, like rare drought and storm (Hamdan et al., 2021). The construction industry consumes approximate 40% of energy and produces 33% of carbon emission in the world (Lu et al., 2020). Sustainability of construction industry, including mitigating carbon emission, have become a necessity to alleviate the negative environmental impacts. Green building (GB) refers to an environmental-friendly structure that makes full use of natural resources in the life cycle of buildings with low carbon emission (Darko et al., 2019). It has become an inevitable trend of global building development due to its proven environmental, economic and social benefits (Li et al., 2014). Green building assessment systems (GBAMs) usually consist of a series of labelling standards that could evaluate the environmental performance of buildings and structures. Numerous GBSMs have been increasing developed across the world which can also effectively and efficiently guide stakeholders to make appropriate decisions (Zhang et al., 2019), promote environmental protection, as well as enhance the comfort and health of residents (Kim et al., 2020). The earliest green building assessment method (GBAM) was BREEAM, released in the UK in 1990, and it was widely used in European countries. LEED of the US was first introduced in 1998. Considering its high applicability and operability, it has been the most employed GBSM in the world. Green Star in Australia was developed in 2002 as a well-known GBAM in the southern hemisphere. Green Mark of Singapore, as a successful tool for tropical climate, was launched in 2005 and has been commonly applied in southeast Asia. Despite ASGB of China was issued in 2006, later than that of many developed countries, the number of green buildings (GBs) increased dramatically in the last few years owing to the mandatory requirements of some local government. DGNB in German, released in 2007, was considered as the second generation of GBSM, which emphasizes not only environmental and social performance, but also economic performance of buildings.

GBAM has always been a long-lasting topic in GB field. For example, many researchers concentrated on developing new GBAMs adapting to different structures, different national or regional weather and social conditions (Wu et al., 2019). In addition, the existing assessment methods are updated at least once every two or three years to effectively improve environmental performance of GBs due to the development of innovative technologies and further understanding of sustainability (Li et al., 2017). Darko and Chan (2016) concluded that 31% of publications in GB area devoted to GBAMs and stated that it will continue to be a hot topic in the future. Considering the explosive growth of research efforts in this area, a systematic and comprehensive literature review will facilitate the understanding of current and future research directions to derive strategies for further improvement.

In fact, numerous reviews articles have been published in the last ten years in this area (Ascione et al., 2022), as listed in Table 1. Zuo and Zhao (2014) was the first to review GB related publications qualitatively and proposed future development directions. Darko and Chan (2016) analyzed 61 articles published in 10 well-known construction management journals in GB field qualitatively and uncovered the hot topics involving GB project delivery methods, GB rating systems, energy performance and related technologies. With the increasing number of studies on GBs, many scholars began to summarize literature with the assistance of bibliometric analysis, which has been commonly utilized to analyze a large number of studies quantitatively and objectively in a variety of fields. As shown in Table 1, most of these review papers in GB area highlighted that GBAM is an important research topic and there are extensive papers focusing on it. Furthermore, many qualitative review articles were published on some specific and limited aspects of GBs, such as GB cost premium (Darko & Chan, 2016), GB incentives (Olubunmi et al., 2016), GB development barriers (Darko & Chan, 2017) and drivers (Darko et al., 2017), also listed in Table 1. Although these qualitative review studies could enhance our understanding of GB research, they were usually based on researchers' knowledge and experience, which may reduce the reliability and be criticized for the subjective biases (Wu et al., 2021). Based on the above analysis, there are still some limitations that need to be improved. (1) With the increasing number of GB related papers, it is essential to review the studies on some specific aspects of GBs. However, although many studies have been conducted on GBAM, there are few papers to review them. (2) In recent years, more and more papers employed bibliometric analysis to review literatures quantitatively and objectively. Nevertheless, no research attempt has been made to review studies of GBAM quantitatively. Thus, this paper is an attempt at filling the gaps by using CiteSpace and HistCite. The main objectives of this review include: (1) identifying more active authors, institutions, and regions, and their cooperations; (2) exploring current research hotspots and trends; (3) recognizing future research directions in the current GBAM research area. This paper initially presents how the relevant literature was collected, which will determine the quality of data source. Then, influential authors, institutions, regions as well as the collaborations between them are identified to provide a brief review on the research works in this area. Furthermore, knowledge bases and current hotspots are subsequently explored through cluster analysis, citation analysis and keywords analysis. Finally, possible future directions are proposed to enrich knowledge in this emerging field. The findings of this paper could provide guidance

Table 1. List of previous reviews on GB related publications

Scope	Authors	Number of articles	Data type	Tools	Findings
Reviews on GBs	Zuo and Zhao (2014)	——	Qualitative	——	Common research themes in GB area include "quantification of cost and benefits of GB", "measures to achieve GB" and "coverage and definition of GB". GBAMs was emphasized as an important topic and there were extensive studies on it
	Darko and Chan (2016)	61	Qualitative	——	This paper classified selected articles into four areas: "GB project delivery and developments" (44%), "GB certifications" (31%), "energy performance" (18%), and "advanced technologies" (7%)
	Huo and Yu (2017)	226	Qualitative	——	There are five main research themes: "GB management in general", "the benefits and barriers to GB development", "GB performance", "stakeholder behavior with regard to GBs", and "GB strategies"
	Zhao et al. (2018)	2980	Quantitative	CiteSpace	The hot research topics are: "green and cool roof", "vertical greening systems", "water efficiency", "occupants' comfort and satisfaction", "financial benefits of GB", "life cycle assessment and rating systems", "green retrofit", "GB project delivery", and "information and communication technologies in GB"
	Darko et al. (2019)	6867	Quantitative	VOSviewer, Gephi, CiteSpace	The authors highlighted future studies should focus more on "social and economic performance", "project management issues", "more specific GB rating systems", and "green technologies"
	Shi and Liu (2019)	6905	Quantitative	CiteSpace	Five major research topics are: "the GB technologies adoption", "materials selection"," panel data approach", "GB project management", and "GBAM"

Continue of Table 1

Scope	Authors	Number of articles	Data type	Tools	Findings
	Wuni et al. (2019)	1147	Quantitative	CiteSpace	The research in GB areas grouped into "GB adoption and implementation:", "attitude assessment and post-occupancy evaluation", "project delivery and management", "stakeholder management and impact analysis", "GB codes, regulations and policies", "sustainability performance assessment", "GB design, materials and products", "energy performance assessment", "GB rating and certification", and "optimization and advanced technologies"
	Ahmad et al. (2019)	77	Qualitative	——	GB development research mainly includes six paradigms: "project delivery attributes", "critical success factors", "barriers", "drivers", "risks", and "benefits"
	Li et al. (2020a)	3060	Quantitative	CiteSpace	12 research hotspots in GB area were identified. GBAM related research was one of them
	Li et al. (2021)	5246	Quantitative	Pajek, CiteSpace, Loglet Lab 4	Three hotspots were detected: "GBs", "sustainability", and "energy efficiency"
Reviews on sub-fields of GBs	Dwaikat and Ali (2016)	17	Qualitative	——	There is no conclusive empirical evidence that the GB tends to cost more. Significant gap exists in the quantified cost premium range
	Olubunmi et al. (2016)	65	Qualitative	——	GB incentives include "incentive categorization", "its effectiveness on promoting GB development", "criticism of current green incentive implementation" and "strategies for improving GB incentives"
	Thome et al. (2016)	1769	Quantitative	HistCite, Scimat, Pajek	The main research streams in sustainable infrastructure are "green infrastructure", "sustainable buildings", and "assessment methods". Emerging and prevailing research themes include methodological issues of "cost-effectiveness", "project management" and "assessment tools"
	Tan et al. (2016)	123	Qualitative	——	Three critical areas for the success of sustainable urbanization in China are summarized as: "evaluation", "innovative solutions", and "engagement of all stakeholders"
	Li et al. (2017)	57	Qualitative	——	Four-level assessment method comparisons were presented: "general comparison", "category comparison", "criterion comparison", and "indicator comparison"
	Darko and Chan (2017)	36	Qualitative	——	The main barriers to GB adoption were reviewed: "lack of information", "cost", "lack of incentives", "lack of interest and demand", and "lack of GB codes and regulations"
	Darko et al. (2017)	42	Qualitative	——	Five key categories of GB drivers are: external, corporate-level, property-level, project-level, and individual-level drivers
	Lu et al. (2017)	92	Qualitative	——	Green BIM were classified into three aspects, namely "contributions and applications of BIM in the lifecycle of GBs", "various functions of environmental sustainability analyses provided by BIM programs", and "integration of GB assessment with BIM"
	Jagarajan et al. (2017)	——	Qualitative	——	The obstacles affecting stakeholders from engaging in green retrofit projects implementation are: "financial resources", "GB professionals", "policy support", "green development quantification", "green awareness", "communication internal leadership", "green material and technology"
	Tayyab and Ayodeji (2017)	20	Qualitative	——	The previous research on GB project delivery attributes focused on: "exploring differences in project performance resulting from different project methods", "reconciling and relating different project methods with GB projects", "determining state of practice for delivery methods of GBs", "determining key processes for GB delivery" and "relating project delivery attributes with performance outcomes of sustainable buildings
	Aarseth et al. (2017)	68	Qualitative	——	Sustainability strategies adopted by project organizations include: "setting strategic and tactical sustainability goals", "developing sustainable supplier practices", "emphasizing sustainability in project design". Sustainability strategies adopted by project hosts are: "setting sustainability policies", "influencing sustainability of project practices". Mutual sustainability strategies contain: "inclusion of sustainability-promoting actors in project organization", "Developing sustainability competencies", "sustainability-emphasis in project portfolio management"

End of Table 1

Scope	Authors	Number of articles	Data type	Tools	Findings
	Zhang et al. (2018b)	——	Qualitative	——	Key obstacles hindering the adoption of GB practices include "overestimates of initial costs", "cost-benefit mismatch caused by information asymmetry", "split incentives caused by contract structure" and "energy pricing", and "a lack of attention to energy costs"
	Li et al. (2019)	36	Qualitative	——	The CSFs for GB projects include "communication and cooperation between project participants", "effective project planning and control", "owner's involvement and commitment", "clear goals and objectives" and "project manager's performance"
	Sfakianaki (2019)	31	Qualitative and quantitative	VOSviewer	Five categories of factors for sustainable construction are: "economic factors", "social factors", "design and techniques", "environmental factors" and "implementation, policy and regulation issues"
	Lazar and Chithra (2021a)	80	Quantitative	Bibliometrix	The main research themes in building sustainability assessment systems fields include "sustainability", "GB", "AHP", "rating system", "MCDM", "environment", "rating systems" and "assessment"
	Nguyen and Macchion (2023)	64	Qualitative	——	The main themes of GB risk studies were classified into: "identifying risk factors in implementing GB projects, "creating risk assessment models for GB projects", Studying according to specific types of GB risks", and "investigating risks in green retrofit projects"
	Debrah et al. (2022)	28	Qualitative	——	Seven distinct Green finance (GF)-in-GBs research themes were summerized, namely "GF-in-GBs policy guide and performance", "obstacles and drivers of GF-in-GBs", "GF-in-GBs solutions and trends", "financing building energy efficiency and retrofits", "financing green affordable housing and real estate", "GF-in-GBs knowledge sharing and counselling", and "case examples of GF-in-GB". Future research directions were suggested "green incentives for GF-in-GBs", "GF-in-GBs rating software", "AI-enabled GF-in-GBs performance assessment software", and "intelligent GF-in-GBs cost-benefit analysis framework"
	Li et al. (2022b)	630	Quantitative	CiteSpace, HistCite, VOSviewer	Literature on stakeholders' studies of GBs mainly concentrated on the following themes: "risks, drivers and obstacles of GB stakeholders", "occupants' satisfaction and willingness to pay for GBs", and "decision-making process of GB stakeholders"

for researchers, practitioners, and journal editors who are interested in this field. It can assist these stakeholders to have a detailed understanding of the status quo and trend of this area and make further contributions to developing more accurate and comprehensive GBAMs.

2. Research methodology

Bibliometric could review literatures screened from database in a quantitative and objective way (Li et al., 2022a). It could extract important information and free people from time-consuming and laborious burdens through computer algorithms and interactive visualization. It has been extensively employed in previous review studies to analyze a large number of documents (Debrah et al., 2023; Li et al., 2022a).

2.1. Software selection

Recently, the development of knowledge mapping and visualization tools further drives bibliometric analysis. CiteSpace could analyze huge amounts of sample data and generate visual knowledge graphs by exploring the main authors, institutions, countries, research hotspots and frontiers. HistCite is another citation analysis tool to identify groundbreaking papers and map the research evolution of a specific field. Currently, CiteSpace and HistCite have been applied in numerous reviews in GB related field (Lu et al., 2017; Thome et al., 2016; Zuo & Zhao, 2014). In this study, CiteSpace (6.1.R2) and HistCite (Pro 2.1) were chosen for further bibliometric analysis.

2.2. Database selection and paper retrieval

This paper aims to systematically review studies on GBAMs. Web of Science (WoS) contains multidisciplinary literatures on engineering, management, and social sciences, and covers most GB related journals. It has been employed as the main search database in many bibliometric analysis with CiteSpace and HistCite (Li et al., 2021; Li et al., 2022a). Thus, we used WoS to search articles from 2007 to 2022. The search keywords include two categories as listed in Table 2. One category comprises terms that can be used interchangeable with GBAMs and the other consists of specific well-known GBAMs. To ensure the quality of the data analysis, selected papers only limited to journal papers and conference papers were not included.

Table 2. Keywords for searching

Concepts	Keywords
GBAM	green building/sustainable building/ high-performance building/ecological building assessment method/rating system/certification/evaluation/ labeling method/guideline/benchmark/ assessment standard/measurement
Specific well-known GBAM	LEED, CASBEE, DGNB, BREEAM, Green Star, Green Mark, ESGB, GBL, EcoEffect, EcoProfile, ESCALE, HK-BEAM, BEAM^{Plus}, GB Tool, SB Tool

Manual screening was carried out by three researchers. Two researchers firstly filtrate literatures based on the objective of this study. If they have different opinions, they will consult the third researcher and group discussion was conducted. Finally, 568 articles were screened.

2.3. Quantity analysis

Number of the selected publications per year was analyzed, as indicated in Figure 1. Overall, it reflected an upward trend. Before 2014, the publications on GBAMs were growing slowly but steady. After 2017, the number rises greatly and heated 79 in 2020. In 2022, it peaked at 90 articles. Because of the increased awareness of environmental protection and the progress of society, especially in developing countries, more appropriate GBAMs are needed and the number of studies in this area are expected to continually increase.

The selected 568 papers published in 159 internationally renowned journals, demonstrating that GBAMs is a widely concerned topic. The top 10 journals (Table 3) published more than 50% of the papers, reflecting that journals in this field are more concentrated. The citation frequency of journals could well explore high-quality journals in an area (Li et al., 2022a). As shown in Figure 2, the top co-citation journals involve *Building and Environment* (frequency = 365), *Energy and Buildings* (frequency = 325), and *Renewable & Sustainable Energy Reviews* (frequency = 246). Journals with high literature count and

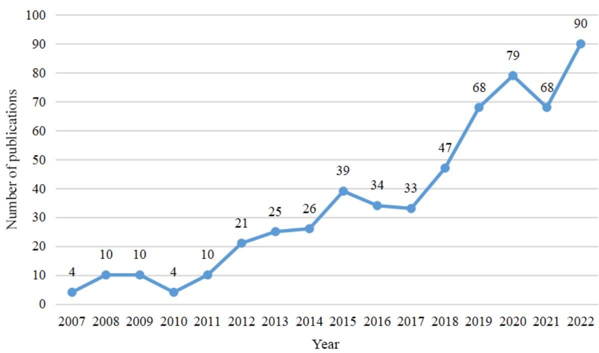


Figure 1. Annual literatures on GBAMs from 2007 to 2022

Table 3. Major journals

No.	Journal	Count	Percent
1	*Sustainability*	84	14.7%
2	*Building and Environment*	53	9.3%
3	*Journal of Cleaner Production*	34	6.0%
4	*Energy and Buildings*	32	5.6%
5	*Sustainable Cities and Society*	28	4.9%
6	*Journal of Building Engineering*	18	3.2%
7	*Buildings*	15	2.6%
8	*Energies*	14	2.5%
9	*Building Research and Information*	13	2.3%
10	*Journal of Asian Architecture and Building Engineering*	9	1.6%
	Total	300	52.8%

Figure 2. Journal co-citation analysis network

co-citation frequency are *Building and Environment*, *Energy and Buildings* and *Building Research and Information*. Researchers interesting in this area could pay more attention to these journals.

3. Author analysis

Major contributing authors was explored through co-authorship analysis and author co-citation analysis. Co-authorship analysis could identify the most active authors of the selected articles and reveal their relationships. While in author co-citation analysis part, main authors of the co-cited documents are explored (Xiao et al., 2017).

3.1. Co-authorship analysis

The co-authorship analysis network is shown in Figure 3. There are a total of 1596 authors. Luis Braganca (frequency = 7) has the highest number of publications, followed by Chithra Kurukkanari (frequency = 5), Nina Lazar

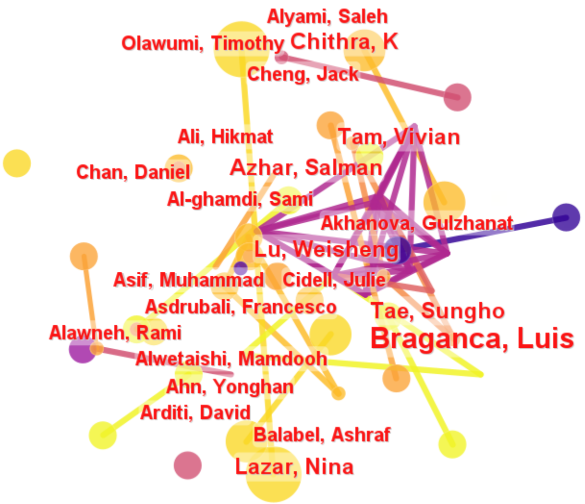


Figure 3. Co-authorship network

(frequency = 5) and Zhonghua Gou (frequency = 5). The betweenness centrality of the authors is relatively low. It reveals this research topic is still pristine and there are no active contributors. As for the burst strength, Chithra Kurukkanari (burst strength = 2.39, 2021–2022) and Nina Lazar (burst strength = 2.39, 2021–2022) are at the top. All these authors promote the advancement of research in this direction and are worth following.

As shown in Figure 3, Cinzia Buratti, Francesco Asdrubali, Franco Cotana, Francesco Bianchi and Catia Baldassarri formed the largest research group. Besides, Hikmat Ali, Rami Alawneh, and Muhammad Alawneh formed another research group around Hikmat Ali. Although there are several small groups, most authors are not very closely linked. It means most authors haven't been working for a long time on this topic.

3.2. Author co-citation analysis

The co-cited document network with 659 nodes and 3312 links was obtained (Figure 4). The top three authors are Roni Cole (frequency = 85), Appu Haapio (frequency = 66) and Woochan Lee (frequency = 65). As for betweenness centrality, Roni Cole (centrality = 0.23) has the highest value, followed by Ge Ding (centrality = 0.14) and Gursah Kats (centrality = 0.11). They are all influential authors in this area.

Through comparing co-authorship with author co-citation analysis, Roni Cole and Hikmat Ali were detected to be the most contributing authors. Their research works have great effects on other authors in this area. Woochan Lee had high co-cited frequency and betweenness centrality. It is worth tracking their articles.

4. Institution analysis

The institution analysis network (Figure 5) illustrates that 659 institutions are involved. The density was 0.004. It indicates that the institutions did not cooperate closely. As seen from the top ranked institutions (Table 4), seven are from China. The Hong Kong polytechnic university is the most productive institution with higher records, total local citation score (*TLCS*) and total global citation score (*TGCS*), reflecting its great influence in this area.

Table 4. Major institutions

No.	Institution	Records	*TLCS*	*TGCS*
1	Hong Kong Polytech University	21	73	654
2	Chongqing University	12	41	262
3	Hanyang University	10	4	90
4	National University of Singapore	10	30	305
5	University Hong Kong	10	29	273
6	Tsinghua University	8	4	106
7	China Academy of Building Research	7	17	102
8	Nazarbayev University	7	0	58
9	Shenzhen University	7	39	216
10	Tianjin University	7	0	48

Note: *TGCS* (Total global citation score); *TLCS* (Total local citation score).

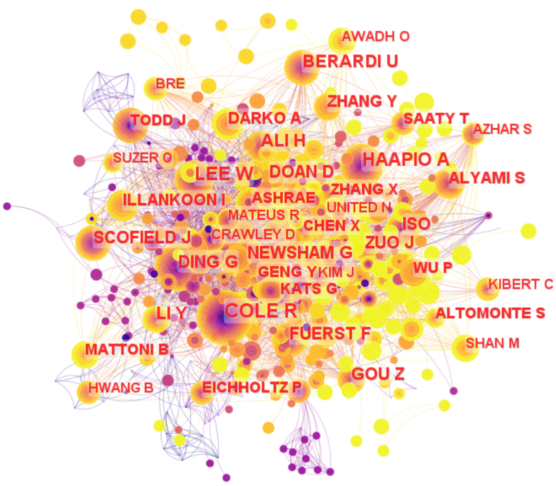


Figure 4. Author co-citation analysis network

Figure 5. Co-institution network

5. Region analysis

The top regions are shown in Table 5 and Figure 6. China published the largest number of articles, followed by the US and South Korea. Most are the developed countries with high level of economy, indicating a large obvious regional imbalance for the research in this area. The GBAMs in the developing areas, like West Asia and Africa, should get much more attention in the future. For the value of TGCS/N, Australia, the US and Canada hold the first three spots, which reveals that the quality of the publications in these regions is relatively high.

Table 5. Major countries

No.	Country	*N*	*TLCS*	*TGCS*	*TGCS/N*
1	Peoples R China	152	205	2062	14
2	USA	105	254	2900	28
3	South Korea	40	45	345	9
4	UK	37	113	920	25
5	Australia	36	130	1477	41
6	Canada	27	89	768	28
7	Malaysia	25	20	358	14
8	Taiwan	22	29	422	19
9	Italy	18	35	426	24
10	Saudi Arabia	18	10	132	7

Note: *N* (total number of publications); *TLCS* (total local citation score); *TGCS* (total global citation score).

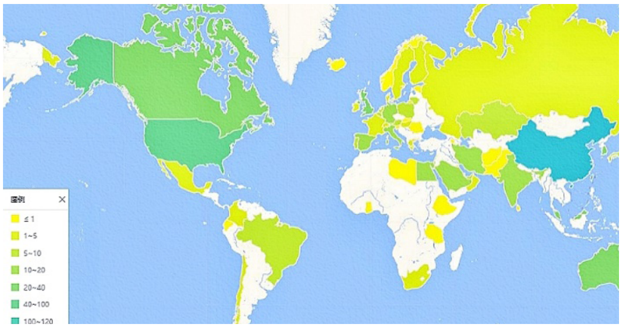


Figure 6. Publication distribution map by regions

6. Knowledge base analysis

Cluster analysis of the co-cited references was produced (Figure 7) to unveil the knowledge bases (Li et al., 2022b). Modularity value (Q value) of the cluster is 0.7893, reflecting the structure is very significant. Profile coefficient (S) of this cluster is 0.9201, indicating the clustering has high reliability. The clusters, which are duplicated with retrieval words and unrelated ones, were removed.

(1) Triple bottom line

Cluster 2, "triple bottom line", refers to the three aspects of sustainability: environmental, economic and social performance. GBs should be evaluated by environmental protection, occupant wellbeing and economic benefits. At present, construction industry consumes massive natural resources and results in environmental degradation (Illankoon et al., 2017a). Most GBAMs focus more on environment performance (Park et al., 2017). For example, the proportion of environment related criteria is 54% in LEED. How to update environmental criteria is also the main research topics (López et al., 2019). Asdrubali et al. (2015) compared the environmental indicators of LEED and ITACA, and proposed suggestions on updating indicators of site protection, water resources and energy consumption. Ding (2008) reviewed 20 GBAMs in the world and emphasized that conventional single dimension evaluation solely on environment aspect is not adequate. Many scholars' attention shifted to social related criteria. For example, Atanda (2019) established a model to assess the social performance of buildings, which could enhance the indoor environment quality (IEQ) and promote end-users' satisfaction. Cost analysis of GBs is also an interesting topic. Many studies reached consensus that the GB initial cost is often 10–20% higher (Alawam & Alshamrani, 2021; Hwang et al., 2017). DGNB is the first to incorporate economic indicators, accounting for 22.5% of points, to balance the cost and environment performance of buildings. "Demonstrating Cost Effective Design" became an important criterion of Green Mark 2015 version to evaluate GBs. However, most GBAMs still lack economic related criteria. How to enhance the sociality and affordability of GBs through the guidance of GBAMs will be meaning research topics.

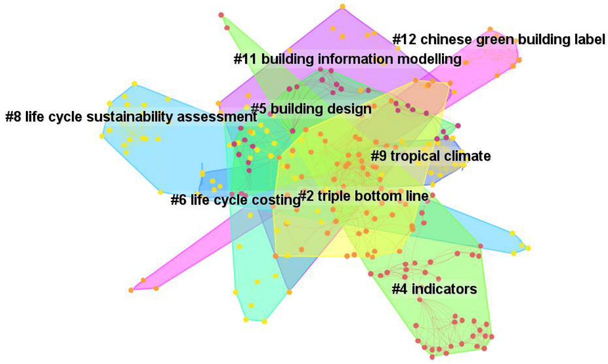


Figure 7. Document co-citation cluster network

(2) Indicator

Cluster 4 is "indicator". There are usually three levels of hierarchy for GBAMs: categories, criteria, and indicators. Indicator is the lowest and detailed level of the hierarchy to measure the sustainability of buildings quantitatively or qualitatively (Li et al., 2017). The scientificity and accuracy of indicators play a decisive role to achieve the sustainable goals. However, the indicators differ greatly among GBAMs. For example, BREEAM has 114 indicators; CASBEE has only 50 indicators (Lee, 2012). Some same criteria may be assessed by different indicators (Chen et al., 2015). Because of the importance of energy indicators, they are mostly studied

(Illankoon et al., 2017b). Srinivasan et al. (2014) compared the energy indicators in GBAMs and found that the relevant indicators at operation, renovation and demolition phases are relatively lacking. "IEQ" related indicators, affecting occupants' health, are often discussed. Kamaruzzaman et al. (2010) investigated IEQ of renovated buildings in Malaysia and proposed to adjust the related indicators. Moreover, Wu and Low (2010) compared three well-known GBAMs (LEED, Green Globes and Green Mark) and highlighted the importance of project management indicators in implementing GBs. In contrast, the "water", "material" and "waste" related indicators are rarely studied (Mattoni et al., 2018). Besides, the association between indicators, like energy and occupants' satisfaction related indicators, deserve more attention.

(3) Building design

Cluster 5 is "building design". Excellent architectural design could greatly improve the energy efficiency, enhance the indoor environment, and reduce waste without increasing construction cost (Cang et al., 2020). Chen et al. (2015) concluded that passive design method is an effective way to cut energy consumption and budget during the operation stage. Ding et al. (2016) found that deconstruction-oriented design could reduce negative environmental impacts by at least 50% compared with conventional design. Basbagill et al. (2013) proposed life cycle assessment (LCA) in the early decision-making stage helps designers to improve the environment performance by 20% to 37% through material selection. Although the effectiveness of many building design measures has been proven, how to incorporate them into the GBAMs is an urgent issue to address.

(4) Life cycle costing (LCC)

Cluster 6, LCC is defined as "cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements". It can be used to compare alternatives and facilitate decision-makings. The LCC of GB refers to the cost generated throughout the design, bidding, construction, use and demolition stages of buildings. Optimizing LCC is conducive to achieving the sustainable goals, including minimizing energy, reducing water consumption without increasing costs (Abdallah et al., 2016). The main potential weakness of GBAMs is lack of cost related criteria. Many scholars began to investigate how to immerge LCC into GBAMs (Mahmoud et al., 2022), such as the incorporation between LCC and Green Star (Illankoon et al., 2018), Green Mark (Li et al., 2020b) and BEAMPlus (Abdallah et al., 2016). Two suggestions were proposed: increasing the weighting of LCC and removing criteria with high economic impacts. But, it is a challenging work to balance LCC and environment performance of buildings (König & De Cristofaro, 2012) and more efficient evaluation tools on LCC of GBs should be established.

(5) Life Cycle Sustainability Assessment (LCSA)

Cluster 8 (LCSA), comprising LCA, LCC and social life cycle assessment (S-LCA), could evaluate environmental, economic and social performance of GBs. Many scholars pointed out that GBAMs should utilize LCSA to conduct comprehensive evaluation. Srivastava et al. (2022) developed a framework that not only incorporates LCSA into GB assessment but also rates the interactions between socio-economic well-being and environmental pressures. In fact, many studies have been made to integrate LCA and LCC with GBAMs (Marzouk & Azab, 2017). SLCA is an extension of LCA. Fan et al. (2018) utilized SLCA to develop a green quantitative rating method to evaluate social and humanistic needs of buildings. Although many studies have been conducted in these aspects, only LCA has been explicitly incorporated into numerous GBAMs, such as BREEAM, LEED, Green Star, DNGB, CASBEE, the Green Globes and GB tool (Sartori et al., 2021). The trade-offs between environmental, economic, and social aspects through LCSA is still one major task (Dong et al., 2023).

(6) Tropical climate

Cluster 9, "tropical climate", refers to the climate type in the lower latitudes of the Earth. Frequent extreme weather events are particularly prominent in tropical climates (Lazar & Chithra, 2021b). However, most GBAMs are highly regional and climate-adaptable in line with different national conditions to ensure accurate evaluation (Lazar & Chithra, 2021c). Many scholars concentrated on the establishment of GBAMs in tropical areas. For instance, Lazar and Chithra (2022) stressed the necessity of regional-oriented standards and established several GBAMs adapted to India's tropical climate (Lazar & Chithra, 2021c). How to update GBAMs in Malaysia (Esfandiari et al., 2021) and Sri Lanka (Ravindu et al., 2015) was also investigated. However, the studies on GBAMs in tropical climate areas are still limited in some building types, such as hotels and hospitals. More studies should be carried out under the pressure of global warming.

(7) Building information modelling (BIM)

BIM (Cluster 11) is an intelligent model with rich digital information (Xia et al., 2022). It could optimize building design to reduce the negative environment impacts in the life cycle of buildings. The combination between BIM and GBAMs has become a hot topic (Solla et al., 2022), such as the incorporation of BIM in GBI of Malaysia (Solla et al., 2022), LEED of the US (Jalaei et al., 2020), and BREEAM of the UK (Carvalho et al., 2020). Many researchers established new BIM models to evaluate GBs. Lee et al. (2015) developed a green BIM template for evaluating the environmental influence of buildings through LCA. Marzouk et al. (2022) tried to improve GBs assessment by developing a unified digital technology framework. However, due to lack of relevant information exchange technology, the combination between BIM and GBAMs in different stages (Shukra & Zhou, 2021) and different aspects of buildings is a challenging work (Abdelaal & Guo, 2022).

(8) Chinese Green Building Label

Cluster 12, "Chinese Green Building Label", refers to the GB rating system in China. The national assessment tool in China is ESGB, launched by the Ministry of Housing and

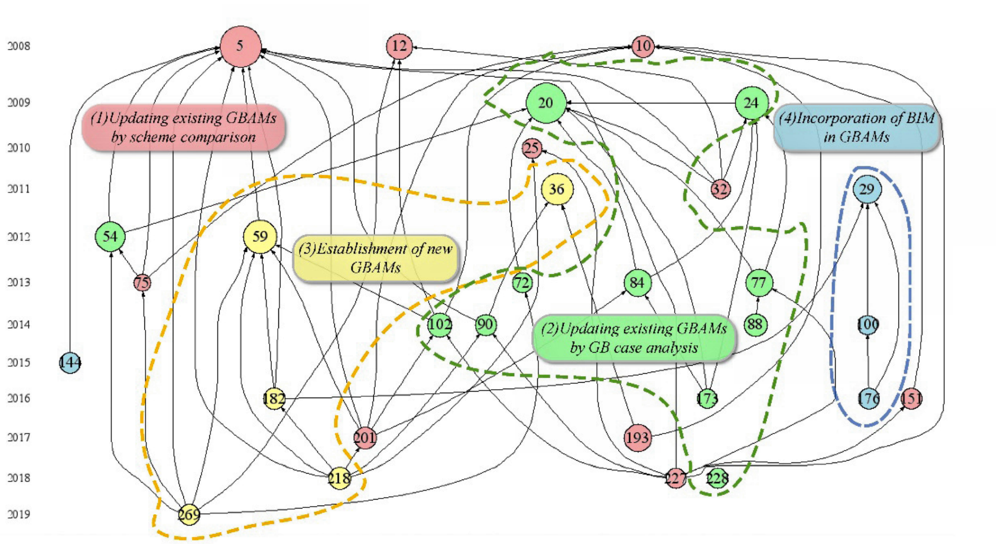
Urban-Rural Development in 2006 (Zhang et al., 2018a). GB has become a dominant trend in China (Zhang et al., 2017). In this context, an increasing number of studies on refining Chinese Green Building Label have been made and many suggestions were proposed. For instance, qualified GB professionals are still scarce in China compared to LEED-certified professionals, and their participation should be encouraged in ESGB (Zhang et al., 2018a). Carbon-related indicators should be added (Liu & Leng, 2021). Regional differences in renewable energy sources should be considered. The indicators related to the living experience and thermal comfort of occupants should be enhanced (Xu et al., 2023). Based on the statics analysis of GBs in China, it was found that there are 4,246 design labels, accounting for 94%, and 269 operation labels, accounting for only 6%. The lagging development of operation labels reflects that the real environmental performance of GBs may be not as expected, which will finally hinder the promotion of GBs (Ye et al., 2013). In 2019, the labelling rules in China changed and GBs should be evaluated at completion stage, which could ensure their quality. Although studies on GBAMs have been extensively conducted in recent years, most focused on indicators improvement. Other aspects that affect the efficiency, fairness and scientifically of GB standards in China have been neglected, including certification process and organizations, integration of GB rating system with other building standards, as well as databases establishment.

7. Current research topic analysis

(1) Citation analysis

Citation analysis could explore the main themes of an area by detecting the most influential articles and mapping the citation correlation visually by HistCite (Li et al., 2022b). The historiography, as a chronological citation network showing citation links between the most cited articles, was generated (Figure 8). Circles represent articles. The size of a circle indicates the times it has been cited. The arrow reflects the citation relationships. Four main research themes were identified, marked with different colors.

Updating existing GBAMs by scheme comparison. With the development of technology and society, updating existing GBAMs is currently one of the most mainstream research themes in this area, marked as red. Comparative analysis of well-known GBAMs is commonly used method to identify the shortcomings of the assessment criteria and make recommendations for improvement. Article 5 is the prominent node in Figure 8, with the highest LCS value of 52. It means that 52 articles in this area cited this paper, which illustrates its high impact. This paper compared 20 GBAMs and proposed a new sustainability framework on design selection by using a multi-dimensional approach. Articles 12 reviewed BREEAM, LEED and HK-BEAM and established a benchmark to update the schemes on energy performance assessment for designers. Article 10, appeared early in this area, is a starting point for examining GBAMs in the planning stage. A framework, the planners could utilize to select the most suitable assessment tool to meet the local sustainability, was suggested by comparing nine different famous GBAMs. Article 193 compared LEED, BREEAM, GSAS and Estidama, and also stressed the potential areas of improvement in climate change adaptability, life cycle design and computer modelling. To sum up, the significance of the plan and design stages in achieving GBs has long been agreed by scholars. In 2010, paper 25 began to emphasize the



5 (Ding, 2008), 10 (Retzlaff, 2008), 12 (Lee & Burnett, 2008), 20 (Newsham et al., 2009), 24 (Scofield, 2009), 25 (Wu & Low, 2010), 29 (Azhar et al., 2011), 32 (Kajikawa et al., 2011), 36 (Mateus & Bragança, 2011), 54 (Berardi, 2012), 59 (Alyami & Rezgui, 2012), 72 (Schwartz & Raslan, 2013), 75 (Chandratilake & Dias, 2013), 77 (Altomonte & Schiavon, 2013), 84 (Scofield, 2013), 88 (Liang et al., 2014), 90 (Ferreira et al., 2014), 100 (Wong & Kuan, 2014), 102 (Gou & Lau, 2014), 144 (Jalaei & Jrade, 2015), 151 (Wu et al., 2016), 173 (Jeong et al., 2016), 176 (Ilhan & Yaman, 2016), 182 (Vyas & Jha, 2016), 193 (Awadh, 2017), 201 (Gou & Xie, 2017), 218 (Zarghami et al., 2018), 227 (He et al., 2018), 228 (Ding et al., 2018), 269 (Mahmoud et al., 2019)

Figure 8. Historiograph of the most-cited articles

significance of project management by comparing related criteria of Green Globes, LEED and Green Mark. This paper recommended that project management should not be neglected for the evolution of GBAMs. The construction waste management criteria of five GBAMs was compared in paper 151 and suggestions for further improvements in 3Rs principle (reduce, reuse and recycle) were proposed. It is demonstrated that technology is not the major obstacle that hinder the promotion of GBs and management related criteria should be more incorporated into the development of the next generation of GBAMs, which is also confirmed in paper 201. Paper 227 in 2018, also criticized that most GBAMs overemphasized the energy performance of buildings, like LEED, and didn't put enough attention on project management practice. This paper suggested that performance-based criteria, which rely on complete database, are more beneficial than measure-based criteria. Therefore, the trade-offs between social, environment and economic performance, technical and managerial issues, as well as performance-based and measure-based criteria throughout a building's design, construction and operation stages should be carefully considered for updating GBAMs.

Updating existing GBAMs by GB case analysis. The studies in this theme (labelled in green) thoroughly examined the real performance of GBs in operation stage and proposed suggestions for refining GBAMs. In 2009, two influential papers explored whether LEED-certified buildings are energy efficient and came to different views. Based on 35 office buildings in the US, paper 24 concluded that LEED-certified buildings could consume 18–39% less energy per unit of floor space than traditional buildings. However, LEED-certification process still needs to be updated so that inefficient buildings will not be certified, especially for large scale buildings. While, in paper 20, it is concluded that the link between certification levels and energy performance is not obvious through measuring 100 LEED-certified institutional and commercial buildings. 28–35% of GBs in the US even consumed more energy than traditional ones. Therefore, energy baseline and credits of LEED were suggested to be redefined to ensure reliable energy performance of GBs. Some subsequent research works also criticized the effectiveness of GBAMs since no positive effects were ensured. For example, 490 LEED certified buildings were investigated in paper 54 and the findings indicated that energy performance is obviously below expected probably hindered by costly energy saving technologies. Based on 455 multi-family structures in South Korea, paper 173 revealed that it is the house characteristics, not the green certification, that determine whether Green Standard for Energy and Environmental Design (G-SEED) and LEED-certified houses could save energy or not, compared to non-certified ones. Paper 84 also illustrated that on reduction has not been made on energy expenditure and carbon emission of the LEED-certified buildings compared with traditional ones. Furthermore, in paper 77, no obvious impact on occupant satisfaction was found by analyzing 144 buildings of LEED and non-LEED rated buildings. LEED is the most widely recognized scheme that is often used as reference for standard establishment in many countries. The deficiencies of LEED will weaken the recognition on the positive influence of GBs. In addition, most current research concentrated on the validity of energy and IEQ related indicators. The criteria in other aspects should be actively evaluated to provide more comprehensive suggestions on GBAM update.

Establishment of new GBAMs. Many researchers criticized the adaptability of the existing GBAMs. The third theme, marked in yellow, focuses on establishing new GB standards adapting to different local geographical and economic conditions, especially for some developing countries, such as Saudi Arabia (paper 59), Portuguese (paper 36), Iranian (paper 218) and India (paper 182). A global GBAM for existing structures, considering the regional variations by a multi-level weight model, was established in paper 269. With the deeper understanding of regional conditions and technological development, these GBAMs incorporated more innovative indicators (like waterscape, biophilic design, ventilation and light simulation) and could release the pressure of environmental degradation effectively.

Incorporation of BIM in GBAMs. The development of BIM presents an opportunity to evaluate GBs and implement certification efficiently and accurately, such as energy simulation, lighting optimization and documentation. The incorporation of BIM in GBAMs became a vital theme, marked in blue. Paper 29 was the first to build a theoretical framework to guide designers and planners to integrate BIM for sustainability analysis in the US. Paper 100 explored the potential ways to use BIM in obtaining $\text{BEAM}^{\text{Plus}}$ certification in Hong Kong and 26 out of 80 credits could be achieved with the assistant of BIM. An IFC-based model, incorporating BIM with sustainable data, was produced in Paper 176, which could aid designers to conduct relevant simulations and documentation for BREEAM certification application. Paper 144 proposed a tool for designers to integrate BIM in the application of the Canadian LEED certification at the conceptual stage. This model simplified the documentation process and was the first attempt to connect certification levels and cost estimation. At present, BIM is mainly used in pre-construction stage, which could optimize architectural designs effectively. However, the flexibility, operability and versatility of the developed frameworks should be further verified and improved. Besides, previous studies only focused on a few widely known GBAMs, like LEED, BREEAM and BEAMPlus. More efforts and attempts are needed to investigate the integration of BIM and other GBAMs.

(2) Keywords co-occurrence analysis

Keywords could reflect the key content of a whole article (Li et al., 2022a). From the keywords co-occurrence

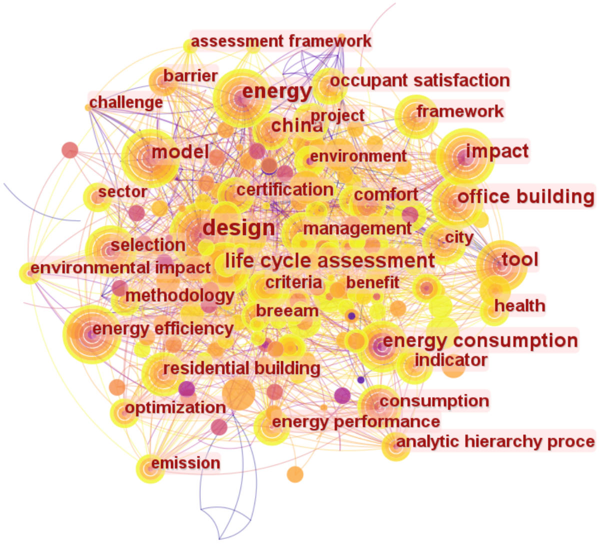


Figure 9. Keywords co-occurrence network

network (Figure 9), it can be seen that scholars concentrated more on "design" stage. "LCA" and "model" were the most commonly investigated methods in GBAMs. "Energy" and "management" related criteria of GBAMs were the main focuses. Furthermore, "residential buildings" and "office buildings" of GBAMs have attracted more attention in this area.

8. Keywords evolution analysis

Keywords evolution analysis from 2007 to 2022, as shown in Figure 10, depicts the evolution trend of literatures in this area. "Performance" was the most frequently used keyword appeared in 2007. It is not surprising given the close relationship between performance and GB evaluation, such as environment, thermal and energy performance. "Design" stage attracted the most attention in this area since 2008 because the decisions made during this stage have serious influence on the environment performance of GBs in the construction, operation and demolition stages. In fact, most criteria of GB standards are assessed during the design stage, which will, to some extent, decide the certified level that the building could achieve (Ding, 2008). "AHP" in 2007 and "LCA" in 2008 were widely used methods to quantify the environmental performance of structures. "Optimization" in 2016 and "BIM" in 2017 have been increasingly employed with the development of information technology. Criteria in GBAMs is commonly classified into five aspects: energy, water, IEQ, material consumption and waste management (Li et al., 2017). "Energy" performance has been the key issue discussed since 2008 due to its great influence on climate change worldwide. "Energy consumption" and "energy efficiency" in 2012, as well as "emission" in 2016 displayed energy will be a long-lasting topic in GB assessment area. However, at present, there is a clue that users' health related criteria have become main concern indicated through keywords: "comfort" in 2012, "occupant satisfaction" in 2018 and "health" in 2019. It is expected more health issues during the operation stage are worth of further investigation, considering its significance (Gong & Song, 2015). "China" is the most studied country, which is consistent with the results in country analysis above. Furthermore, "LEED" and "BREEAM" in 2016 revealed that they are the most popular standards to guide the development of GBAMs in other countries. Previous studies usually focused on both "city" and "project" levels. Research works on some specific building types has attracted attention in recent years, such as "office building" in 2016, which will improve the accuracy and effectiveness of GBAMs.

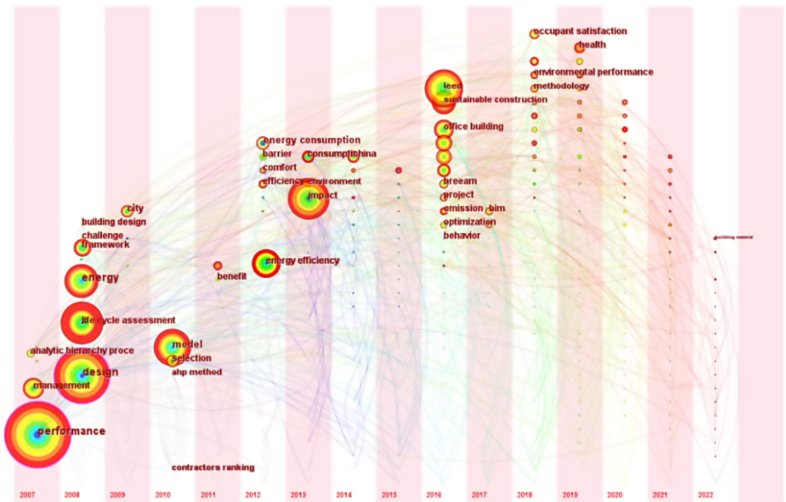


Figure 10. An evolution view of keyword co-occurrence network

9. Future directions

In the past decade, despite many achievements have been made on GBAMs, some limitations still exist and need further exploration.

(1) More investigation on the other types of GBs

The cluster analysis on "triple bottom line", "tropical climate" and "LCC" displays that researchers focus more on the GBAMs of residential buildings. The keyword, "residential buildings", reinforces this point. Since 2016, the studies on GBAMs of "office buildings" have attracted more attention. However, the performance of the other kinds of GBs, like commercial buildings, did not hit the anticipated targets (Newsham et al., 2009). With the growth of people's living standards, the demand for commercial buildings, medical care buildings and infrastructure is also growing (Jiang et al., 2013). Research on the assessment methods of these building types should be strengthened to improve their accuracy and effectiveness.

(2) Incorporation of cost-related criteria

Currently, the incremental cost remains a major obstacle to promote GBs (Tsai et al., 2014). The cluster of "triple bottom line" and the keyword "LCC" indicate that the research on cost of GBs have received much attention. But most GBAMs did not contain cost-related indicators. Future studies on how to incorporate cost indicators into GBAMs worth further investigation, which could finally improve the affordability of GBs.

(3) Enhancing health-related indicators

The keywords, "comfort", "occupant satisfaction" and "health", reflect that the IEQ and satisfaction of building occupants have become an increasing concern. In fact, healthy building has become an inevitable trend in the construction industry (Shao et al., 2023). More healthy-related indicators in GBAMs, such as air quality, mental health, and entertainment space, should be enhanced (Loftness et al., 2007).

(4) Integrating with BIM technology

The emergence of "BIM" in clusters and keywords shows that many scholars intended to integrate BIM technology into GBAMs. The BIM technique offers the possibility to solve many problems suffering by GBs, including facilitating the simulations (e.g. light, energy consumption, wind performance, acoustic environment and heat island effect) (Marzouk et al., 2022), optimizing LCC (Shukra & Zhou, 2021), balancing the cost and environmental performance of GBs (Jalaei et al., 2020), as well as simplifying cumbersome application process and documentation. The integration between BIM and GBAMs will be a challenging but unavoidable research problem.

10. Discussion

This paper aims to systematically and quantitively summarize research works in GBAM area by using CiteSpace and HistCite. The sub-aims contain (1) identifying more active authors, institutions, and regions, and their cooperations; (2) exploring current research hotspots and trends; (3) recognizing future research directions. Through co-authorship analysis, author co-citation analysis, co-institution analysis and region analysis, the active authors, institutions, and regions in this GBAM area were identified, which are the common approaches the researchers employed in their studies (Liu et al., 2022). Cluster analysis is the key and

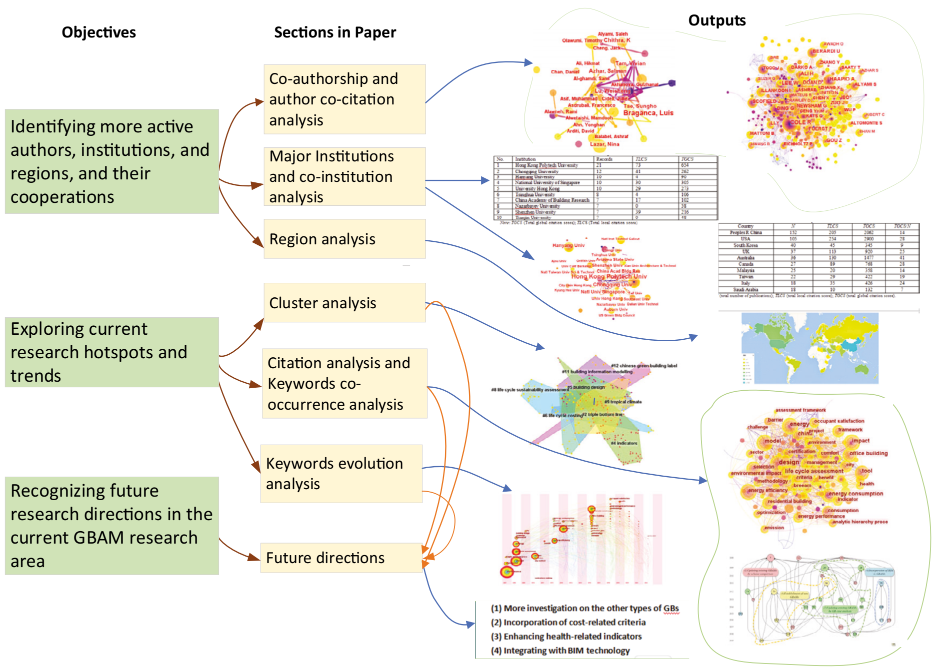


Figure 11. Knowledge graph of this paper

special function of CiteSpace (Song et al., 2019) and it was used to explore the main knowledge bases in this area. Citation analysis of HistCite and keywords co-occurrence analysis of CiteSpace assisted us to investigate the current hot topics in this study. The results indicated that "updating existing GBAMs by scheme comparison", "updating existing GBAMs by GB case analysis", "establishment of new GBAMs" and "incorporation of BIM in GBAMs" are the main research themes and "design", "LCA", "model", "energy", "management", "residential buildings" and "office buildings" have attracted more attention in this area. Based on the above analysis, future research directions in the field of GBAM were proposed. All the investigations and related processes were displayed in Figure 11.

11. Conclusions

To guide and promote the development of GBs, many GBAMs have been established in different nations and a growing number of related works have been made. Systematically reviewing previous research could gain invaluable insights into the current status of knowledge and further directions in this area. In this paper, 568 articles on GBAMs from 2007–2022 were analyzed through CiteSpace and HistCite. The number of articles was only four in 2007 and peaked at 90 in 2022. Despite this topic is an attraction for lots of journals, the most influential journals are *Building and environment* and *Energy and buildings*. Based on co-authorship and author co-citation analysis, Roni Cole and Hikmat H. Ali were found as the major contributors. Their research works are worthy of tracking, especially for novices interesting in this area. Although many institutions have involved in this field, the Hong Kong Polytechnic University was the most outstanding one. China, the US and South Korea were found as the regions with the highest number of articles. Cluster analysis of the co-cited literature revealed that "triple bottom line", "indicator", "tropical climate", "BIM", "building design", "LCC", "LCSA" and "Chinese green building label" are the research basis in the field. The top 30 most cited articles in the database were analyzed and four main research topics were summarized: "updating existing GBAMs by scheme comparison", "updating existing GBAMs by GB case analysis", "establishment of new GBAMs" and "incorporation of BIM in GBAMs". Keywords co-occurrence analysis helps us understand more about the hot topics. Furthermore, the keywords evolution analysis shows the evolution trends from 2007 to 2022. Most scholars focused more on "office building", which has the largest floor area in most countries. "Energy consumption" and "energy efficiency" have always been a very active research area in GBAMs. "LEED" and "BREEAM" were the most influential assessment methods, which guided the development of GBAMs in other countries. GBAMs of "China" have attracted more attentions, to an extent, reflecting its commitment to sustainable development in construction industry. With the emerging of information technology, "optimization" and "BIM" were increasingly employed. At the same time, the research found that the earliest evaluation criteria were more concentrated, while the later research topics were more scattered and the research content was more, which reflects that scholars' attempts to establish and update the GBAMs from different perspectives. This paper finally summarized four development directions in this area: "more investigation on the other types of GBs", "incorporation of cost-related criteria", "enhancing health-related indicators" and "integrating with BIM technology". The results in this paper can provide effective guidance for various countries to formulate and update GBAMs, including the utilization of the BIM and incorporation of cost and social indicators. The discussion on knowledge bases, current and further research topics could provide useful information for researchers who are interested in this area.

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Author contributions

Yuanyuan Li wrote the first draft of the article. Ying Wang and Rui Wang were responsible for data collection and analysis. Chunlu Liu revised the article. Zhigang Zhang was responsible for funding acquisition.

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References

Aarseth, W., Ahola, T., Aaltonen, K., Okland, A., & Andersen, B. (2017). Project sustainability strategies: A systematic literature review. *International Journal of Project Management*, *35*(6), 1071–1083. https://doi.org/10.1016/j.ijproman.2016.11.006

Abdallah, M., El-Rayes, K., & Liu, L. (2016). Optimizing the selection of sustainability measures to minimize life-cycle cost of existing buildings. *Canadian Journal of Civil Engineering*, *43*(2), 151–163. https://doi.org/10.1139/cjce-2015-0179

Abdelaal, F., & Guo, B. H. W. (2022). Stakeholders' perspectives on BIM and LCA for green buildings. *Journal of Building Engineering*, *48*(11), Article 103931. https://doi.org/10.1016/j.jobe.2021.103931

Ahmad, T., Aibinu, A. A., & Stephan, A. (2019). Managing green building development – A review of current state of research and future directions. *Building and Environment*, *155*, 83–104. https://doi.org/10.1016/j.buildenv.2019.03.034

Alawam, Y. S., & Alshamrani, O. S. (2021). Initial cost assessment stochastic model for green buildings based on LEED score. *Energy and Buildings*, *245*(16), Article 111045. https://doi.org/10.1016/j.enbuild.2021.111045

Alyami, S. H., & Rezgui, Y. (2012). Sustainable building assessment tool development approach. *Sustainable Cities and Society*, *5*, 52–62. https://doi.org/10.1016/j.scs.2012.05.004

Altomonte, S., & Schiavon, S. (2013). Occupant satisfaction in LEED and non-LEED certified buildings. *Building and Environment*, *68*, 66–76. https://doi.org/10.1016/j.buildenv.2013.06.008

Ascione, F., De Masi, R. F., Mastellone, M., & Vanoli, G. P. (2022). Building rating systems: A novel review about capabilities, current limits and open issues. *Sustainable Cities and Society*, *76*, Article 103498. https://doi.org/10.1016/j.scs.2021.103498

Asdrubali, F., Baldinelli, G., Bianchi, F., & Sambuco, S. (2015). A comparison between environmental sustainability rating systems LEED and ITACA for residential buildings. *Building and Environment*, *86*, 98–108. https://doi.org/10.1016/j.buildenv.2015.01.001

Atanda, J. O. (2019). Developing a social sustainability assessment framework. *Sustainable Cities and Society*, *44*, 237–252. https://doi.org/10.1016/j.scs.2018.09.023

Awadh, O. (2017). Sustainability and green building rating systems: LEED, BREEAM, GSAS and Estidama critical analysis. *Journal of Building Engineering*, *11*, 25–29. https://doi.org/10.1016/j.jobe.2017.03.010

Azhar, S., Carlton, W. A., Olsen, D., & Ahmad, I. (2011). Building information modeling for sustainable design and LEED® rating analysis. *Automation in Construction*, *20*(2), 217–224. https://doi.org/10.1016/j.autcon.2010.09.019

Basbagill, J., Flager, F., Lepech, M., & Fischer, M. (2013). Application of life-cycle assessment to early stage building design for reduced embodied environmental impacts. *Building and Environment*, *60*, 81–92. https://doi.org/10.1016/j.buildenv.2012.11.009

Berardi, U. (2012). Sustainability assessment in the construction sector: Rating systems and rated buildings. *Sustainable Development*, *20*(6), 411–424. https://doi.org/10.1002/sd.532

Cang, Y. J., Luo, Z. X., Yang, L., & Han, B. (2020). A new method for calculating the embodied carbon emissions from buildings in schematic design: Taking "building element" as basic unit. *Building and Environment*, *185*(14), Article 107306. https://doi.org/10.1016/j.buildenv.2020.107306

Carvalho, J. P., Bragança, L., & Mateus, R. (2020). A systematic review of the role of BIM in building sustainability assessment methods. *Applied Sciences*, *10*(13), Article 4444. https://doi.org/10.3390/app10134444

Chandratilake, S. R., & Dias, W. P. S. (2013). Sustainability rating systems for buildings: Comparisons and correlations. *Energy*, *59*, 22–28. https://doi.org/10.1016/j.energy.2013.07.026

Chen, X., Yang, H. X., & Lu, L. (2015). A comprehensive review on passive design approaches in green building rating tools. *Renewable & Sustainable Energy Reviews*, *50*, 1425–1436. https://doi.org/10.1016/j.rser.2015.06.003

Darko, A., & Chan, A. P. C. (2016). Critical analysis of green building research trend in construction journals. *Habitat International*, *57*, 53–63. https://doi.org/10.1016/j.habitatint.2016.07.001

Darko, A., & Chan, A. P. C. (2017). Review of barriers to green building adoption. *Sustainable Development*, *25*(3), 167–179. https://doi.org/10.1002/sd.1651

Darko, A., Chan, A. P. C., Huo, X. S., & Owusu-Manu, D. (2019). A scientometric analysis and visualization of global green building research. *Building and Environment*, *149*, 501–511. https://doi.org/10.1016/j.buildenv.2018.12.059

Darko, A., Zhang, C. Z., & Chan, A. P. C. (2017). Drivers for green building: A review of empirical studies. *Habitat International*, *60*, 34–49. https://doi.org/10.1016/j.habitatint.2016.12.007

Debrah, C., Chan, A. P. C., & Darko, A. (2022). Green finance gap in green buildings: A scoping review and future research needs. *Building and Environment*, *207*, Article 108443. https://doi.org/10.1016/j.buildenv.2021.108443

Debrah, C., Darko, A., & Chan, A. P. C. (2023). A bibliometric-qualitative literature review of green finance gap and future research directions. *Climate and Development*, *15*(5), 432–455. https://doi.org/10.1080/17565529.2022.2095331

Ding, G. K. C. (2008). Sustainable construction – The role of environmental assessment tools. *Journal of Environmental Management*, *86*(3), 451–464. https://doi.org/10.1016/j.jenvman.2006.12.025

Ding, Z. K., Fan, Z., Tam, V. W. Y., Bian, Y., Li, S. H., Illankoon, I., & Moon, S. (2018). Green building evaluation system implementation. *Building and Environment*, *133*, 32–40. https://doi.org/10.1016/j.buildenv.2018.02.012

Ding, Z. K., Wang, Y. F., & Zou, P. X. W. (2016). An agent based environmental impact assessment of building demolition waste management: Conventional versus green management. *Journal of Cleaner Production*, *133*, 1136–1153. https://doi.org/10.1016/j.jclepro.2016.06.054

Dong, Y. H., Ng, S. T., & Liu, P. (2023). Towards the principles of life cycle sustainability assessment: An integrative review for the construction and building industry. *Sustainable Cities and Society*, *95*, Article 104604. https://doi.org/10.1016/j.scs.2023.104604

Dwaikat, L. N., & Ali, K. N. (2016). Green buildings cost premium: A review of empirical evidence. *Energy and Buildings*, *110*, 396–403. https://doi.org/10.1016/j.enbuild.2015.11.021

Esfandiari, M., Zaid, S. M., Ismail, M. A., Hafezi, M. R., Asadi, I., Mohammadi, S., Vaisi, S., & Aflaki, A. (2021). Occupants' satisfaction toward indoor environment quality of platinum green-certified office buildings in tropical climate. *Energies*, *14*(8), Article 2264. https://doi.org/10.3390/en14082264

Fan, L., Pang, B., Zhang, Y. R., Zhang, X. J., Sun, Y. W., & Wang, Y. F. (2018). Evaluation for social and humanity demand on green residential districts in China based on SLCA. *International Journal of Life Cycle Assessment*, *23*(3), 640–650. https://doi.org/10.1007/s11367-016-1166-x

Ferreira, J., Pinheiro, M. D., & De Brito, J. (2014). Portuguese sustainable construction assessment tools benchmarked with BREEAM and LEED: An energy analysis. *Energy and Buildings*, *69*, 451–463. https://doi.org/10.1016/j.enbuild.2013.11.039

Gong, Y. Y., & Song, D. Y. (2015). Life on cycle building carbon emissions assessment and driving factors decomposition analysis based LMDI – A case study of Wuhan city in China. *Sustainability*, *7*(12), 16670–16686. https://doi.org/10.3390/su71215838

Gou, Z. H., & Lau, S. S. Y. (2014). Contextualizing green building rating systems: Case study of Hong Kong. *Habitat International*, *44*, 282–289. https://doi.org/10.1016/j.habitatint.2014.07.008

Gou, Z. H., & Xie, X. H. (2017). Evolving green building: Triple bottom line or regenerative design? *Journal of Cleaner Production*, *153*(1), 600–607. https://doi.org/10.1016/j.jclepro.2016.02.077

Hamdan, H. A. M., Andersen, P. H., & De Boer, L. (2021). Stakeholder collaboration in sustainable neighborhood projects – A review and research agenda. *Sustainable Cities and Society*, *68*, Article 102776. https://doi.org/10.1016/j.scs.2021.102776

He, Y., Kvan, T., Liu, M., & Li, B. Z. (2018). How green building rating systems affect designing green. *Building and Environment*, *133*, 19–31. https://doi.org/10.1016/j.buildenv.2018.02.007

Huo, X., & Yu, T. W. A. (2017). Analytical review of green building development studies. *Journal of Green Building*, *12*(2), 130–148. https://doi.org/10.3992/1943-4618.12.2.130

Hwang, B. G., Zhu, L., Wang, Y. L., & Cheong, X. Y. (2017). Green building construction projects in Singapore: Cost premiums and cost performance. *Project Management Journal*, *48*(4), 67–79. https://doi.org/10.1177/875697281704800406

Ye, L., Cheng, Z. J., Wang, Q. Q., Lin, W. S., & Ren, F. F. (2013). Overview on Green Building Label in China. *Renewable Energy*, *53*, 220–229. https://doi.org/10.1016/j.renene.2012.11.022

Ilhan, B., & Yaman, H. (2016). Green building assessment tool (GBAT) for integrated BIM-based design decisions. *Automation in Construction*, *70*, 26–37. https://doi.org/10.1016/j.autcon.2016.05.001

Illankoon, I., Tam, V. W. Y., & Le, K. N. (2017a). Environmental, economic, and social parameters in international green building rating tools. *Journal of Professional Issues in Engineering Education and Practice*, *143*(2), Article 05016010. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000313

Illankoon, I., Tam, V. W. Y., Le, K. N., & Shen, L. (2017b). Key credit criteria among international green building rating tools. *Journal of Cleaner Production*, *164*, 209–220. https://doi.org/10.1016/j.jclepro.2017.06.206

Illankoon, I., Tam, V. W. Y., Le, K. N., & Wang, J. Y. (2018). Life cycle costing for obtaining concrete credits in green star rating system in Australia. *Journal of Cleaner Production*, *172*, 4212–4219. https://doi.org/10.1016/j.jclepro.2017.11.202

Jagarajan, R., Asmoni, M., Mohammed, A. H., Jaafar, M. N., Mei, J. L. Y., & Baba, M. (2017). Green retrofitting – A review of current status, implementations and challenges. *Renewable & Sustainable Energy Reviews*, *67*, 1360–1368. https://doi.org/10.1016/j.rser.2016.09.091

Jalaei, F., & Jrade, A. (2015). Integrating building information modeling (BIM) and LEED system at the conceptual design stage of sustainable buildings. *Sustainable Cities and Society*, *18*, 95–107. https://doi.org/10.1016/j.scs.2015.06.007

Jalaei, F., Jalaei, F., & Mohammadi, S. (2020). An integrated BIM-LEED application to automate sustainable design assessment framework at the conceptual stage of building projects. *Sustainable Cities and Society*, *53*, Article 101979. https://doi.org/10.1016/j.scs.2019.101979

Jeong, J., Hong, T., Ji, C., Kim, J., Lee, M., & Jeong, K. (2016). Development of an evaluation process for green and non-green buildings focused on energy performance of G-SEED and LEED. *Building and Environment*, *105*, 172–184. https://doi.org/10.1016/j.buildenv.2016.05.041

Jiang, P., Dong, W. B., Kung, Y. H., & Geng, Y. (2013). Analysing co-benefits of the energy conservation and carbon reduction in China's large commercial buildings. *Journal of Cleaner Production*, *58*, 112–120. https://doi.org/10.1016/j.jclepro.2013.04.039

Kajikawa, Y., Inoue, T., & Goh, T. N. (2011). Analysis of building environment assessment frameworks and their implications for sustainability indicators. *Sustainability Science*, *6*(2), 233–246. https://doi.org/10.1007/s11625-011-0131-7

Kamaruzzaman, S. N., Zawawi, M. A. E., Pitt, M., & Don, Z. M. (2010). Occupant feedback on indoor environmental quality in refurbished historic buildings. *International Journal of the Physical Sciences*, *5*(3), 192–199. https://doi.org/10.1142/S021812741002623X

Kim, J. M., Son, K., & Son, S. (2020). Green benefits on educational buildings according to the LEED certification. *International Journal of Strategic Property Management*, *24*(2), 83–89. https://doi.org/10.3846/ijspm.2020.11097

König, H., & De Cristofaro, M. L. (2012). Benchmarks for life cycle costs and life cycle assessment of residential buildings. *Building Research and Information*, *40*(5), 558–580. https://doi.org/10.1080/09613218.2012.702017

Lazar, N., & Chithra, K. (2021a). Comprehensive bibliometric mapping of publication trends in the development of building sustainability assessment systems. *Environment Development and Sustainability*, *23*(4), 4899–4923. https://doi.org/10.1007/s10668-020-00796-w

Lazar, N., & Chithra, K. (2021b). Evaluation of sustainability criteria for residential buildings of tropical climate: The stakeholder perspective. *Energy and Buildings*, *232*, Article 110654. https://doi.org/10.1016/j.enbuild.2020.110654

Lazar, N., & Chithra, K. (2021c). Prioritization of sustainability dimensions and categories for residential buildings of tropical climate: A multi-criteria decision-making approach. *Journal of Building Engineering*, *39*, Article 102262. https://doi.org/10.1016/j.jobe.2021.102262

Lazar, N., & Chithra, K. (2022). Benchmarking critical criteria for assessing sustainability of residential buildings in tropical climate. *Journal of Building Engineering*, *45*, Article 103467. https://doi.org/10.1016/j.jobe.2021.103467

Lee, S., Tae, S., Roh, S., & Kim, T. (2015). Green template for life cycle assessment of buildings based on building information modeling: Focus on embodied environmental impact. *Sustainability*, *7*(12), 16498–16512. https://doi.org/10.3390/su71215830

Lee, W. L. (2012). Benchmarking energy use of building environmental assessment schemes. *Energy and Buildings*, *45*, 326–334. https://doi.org/10.1016/j.enbuild.2011.11.024

Lee, W. L., & Burnett, J. (2008). Benchmarking energy use assessment of HK-BEAM, BREEAM and LEED. *Building and Environment*, *43*(11), 1882–1891. https://doi.org/10.1016/j.buildenv.2007.11.007

Li, Y. A., Yang, L., He, B. J., & Zhao, D. D. (2014). Green building in China: Needs great promotion. *Sustainable Cities and Society*, *11*, 1–6. https://doi.org/10.1016/j.scs.2013.10.002

Li, Y. Y., Chen, X. C., Wang, X. Y., Xu, Y. Q., & Chen, P. H. (2017). A review of studies on green building assessment methods by comparative analysis. *Energy and Buildings*, *146*, 152–159. https://doi.org/10.1016/j.enbuild.2017.04.076

Li, Y. Y., Li, M., & Sang, P. D. (2022a). A bibliometric review of studies on construction and demolition waste management by using CiteSpace. *Energy and Buildings*, *258*, Article 111822. https://doi.org/10.1016/j.enbuild.2021.111822

Li, Y. Y., Li, M., Sang, P. D., Chen, P. H., & Li, C. C. (2022b). Stakeholder studies of green buildings: A literature review. *Journal of Building Engineering*, *54*, Article 104667. https://doi.org/10.1016/j.jobe.2022.104667

Li, Y. Y., Song, H. B., Sang, P. D., Chen, P. H., & Liu, X. M. (2019). Review of Critical Success Factors (CSFs) for green building projects. *Building and Environment*, *158*, 182–191. https://doi.org/10.1016/j.buildenv.2019.05.020

Li, Y., Rong, Y. Y., Ahmad, U. M., Wang, X. T., Zuo, J., & Mao, G. Z. (2021). A comprehensive review on green buildings research: Bibliometric analysis during 1998–2018. *Environmental Science and Pollution Research*, *28*(34), 46196–46214. https://doi.org/10.1007/s11356-021-12739-7

Li, Q. W., Long, R. Y., Chen, H., Chen, F. Y., & Wang, J. Q. (2020a). Visualized analysis of global green buildings: Development, barriers and future directions. *Journal of Cleaner Production*, *245*, Article 118775. https://doi.org/10.1016/j.jclepro.2019.118775

Li, S. P., Lu, Y. J., Kua, H. W., & Chang, R. D. (2020b). The economics of green buildings: A life cycle cost analysis of non-residential buildings in tropic climates. *Journal of Cleaner Production*, *252*, Article 119771. https://doi.org/10.1016/j.jclepro.2019.119771

Liang, H. H., Chen, C. P., Hwang, R. L., Shih, W. M., Lo, S. C., & Liao, H. Y. (2014). Satisfaction of occupants toward indoor environment quality of certified green office buildings in Taiwan. *Building and Environment*, 72, 232–242. https://doi.org/10.1016/j.buildenv.2013.11.007

Liu, C. L., Li, W. L., Xu, J., Zhou, H. K., Li, C. H., & Wang, W. Y. (2022). Global trends and characteristics of ecological security research in the early 21st century: A literature review and bibliometric analysis. *Ecological Indicators*, *137*, Article 108734. https://doi.org/10.1016/j.ecolind.2022.108734

Liu, K., & Leng, J. W. (2021). Quantified CO_2-related indicators for green building rating systems in China: Comparative study with Japan and Taiwan. *Indoor and Built Environment*, *30*(6), 763–776. https://doi.org/10.1177/1420326x19894370

Loftness, V., Hakkinen, B., Adan, O., & Nevalainen, A. (2007). Elements that contribute to healthy building design. *Environmental Health Perspectives*, *115*(6), 965–970. https://doi.org/10.1289/ehp.8988

López, C. D., Carpio, M., Martín-Morales, M., & Zamorano, M. (2019). A comparative analysis of sustainable building assessment methods. *Sustainable Cities and Society*, *49*, Article 101611. https://doi.org/10.1016/j.scs.2019.101611

Lu, Y. J., Wu, Z. L., Chang, R. D., & Li, Y. K. (2017). Building Information Modeling (BIM) for green buildings: A critical review and future directions. *Automation in Construction*, *83*, 134–148. https://doi.org/10.1016/j.autcon.2017.08.024

Lu, W., Tam, V. W. Y., Chen, H., & Du, L. (2020). A holistic review of research on carbon emissions of green building construction industry. *Engineering Construction and Architectural Management*, *27*(5), 1065–1092. https://doi.org/10.1108/ecam-06-2019-0283

Mahmoud, S., Hussein, M., Zayed, T., & Fahmy, M. (2022). Multiobjective optimization model for the life cycle cost-sustainability trade-off problem of building upgrading using a generic sustainability assessment tool. *Journal of Construction Engineering and Management*, *148*(7), Article 04022050. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002281

Mahmoud, S., Zayed, T., & Fahmy, M. (2019). Development of sustainability assessment tool for existing buildings. *Sustainable Cities and Society*, *44*, 99–119. https://doi.org/10.1016/j.scs.2018.09.024

Marzouk, M., & Azab, S. (2017). Analyzing sustainability in low-income housing projects using system dynamics. *Energy and Buildings*, *134*, 143–153. https://doi.org/10.1016/j.enbuild.2016.10.034

Marzouk, M., Ayman, R., Alwan, Z., & Elshaboury, N. (2022). Green building system integration into project delivery utilising BIM. *Environment Development and Sustainability*, *24*(5), 6467–6480. https://doi.org/10.1007/s10668-021-01712-6

Mateus, R., & Bragança, L. (2011). Sustainability assessment and rating of buildings: Developing the methodology SBTool^{PT}-H. *Building and Environment*, *46*(10), 1962–1971. https://doi.org/10.1016/j.buildenv.2011.04.023

Mattoni, B., Guattari, C., Evangelisti, L., Bisegna, F., Gori, P., & Asdrubali, F. (2018). Critical review and methodological approach to evaluate the differences among international green building rating tools. *Renewable* & *Sustainable Energy Reviews*, *82*, 950–960. https://doi.org/10.1016/j.rser.2017.09.105

Newsham, G. R., Mancini, S., & Birt, B. J. (2009). Do LEED-certified buildings save energy? Yes, but. *Energy and Buildings*, *41*(8), 897–905. https://doi.org/10.1016/j.enbuild.2009.03.014

Nguyen, H. D., & Macchion, L. (2023). Risk management in green building: A review of the current state of research and future directions. *Environment Development and Sustainability*, *25*(3), 2136–2172. https://doi.org/10.1007/s10668-022-02168-y

Olubunmi, O. A., Xia, P. B., & Skitmore, M. (2016). Green building incentives: A review. *Renewable* & *Sustainable Energy Reviews*, *59*, 1611–1621. https://doi.org/10.1016/j.rser.2016.01.028

Park, J., Yoon, J., & Kim, K. H. (2017). Critical review of the material criteria of building sustainability assessment tools. *Sustainability*, *9*(2), Article 186. https://doi.org/10.3390/su9020186

Ravindu, S., Rameezdeen, R., Zuo, J., Zhou, Z. H., & Chandratilake, R. (2015). Indoor environment quality of green buildings: Case study of an LEED platinum certified factory in a warm humid tropical climate. *Building and Environment*, *84*, 105–113. https://doi.org/10.1016/j.buildenv.2014.11.001

Retzlaff, R. (2008). Green building assessment systems: A framework and comparison for planners. *Journal of the American Planning Association*, *74*(4), 505–519. https://doi.org/10.1080/01944360802380290

Sartori, T., Drogemuller, R., Omrani, S., & Lamari, F. (2021). A schematic framework for Life Cycle Assessment (LCA) and Green Building Rating System (GBRS). *Journal of Building Engineering*, *38*, Article 102180. https://doi.org/10.1016/j.jobe.2021.102180

Schwartz, Y., & Raslan, R. (2013). Variations in results of building energy simulation tools, and their impact on BREEAM and LEED ratings: A case study. *Energy and Buildings*, *62*, 350–359. https://doi.org/10.1016/j.enbuild.2013.03.022

Scofield, J. H. (2009). Do LEED-certified buildings save energy? Not really. *Energy and Buildings*, *41*(12), 1386–1390. https://doi.org/10.1016/j.enbuild.2009.08.006

Scofield, J. H. (2013). Efficacy of LEED-certification in reducing energy consumption and greenhouse gas emission for large New York City office buildings. *Energy and Buildings*, *67*, 517–524. https://doi.org/10.1016/j.enbuild.2013.08.032

Sfakianaki, E. (2019). Critical success factors for sustainable construction: A literature review. *Management of Environmental Quality*, *30*(1), 176–196. https://doi.org/10.1108/MEQ-02-2018-0043

Shao, W. C., Chen, J. W., Dong, Y. W., Lu, C. L., & Chiou, Y. T. (2023). Developing indicators for healthy building in Taiwan using fuzzy Delphi method and analytic hierarchy process. *Buildings*, *13*(7), Article 1860. https://doi.org/10.3390/buildings13071860

Shi, Y. L., & Liu, X. P. (2019). Research on the literature of green building based on the Web of Science: A scientometric analysis in CiteSpace (2002–2018). *Sustainability*, *11*(13), 1–22. https://doi.org/10.3390/su11133716

Shukra, Z. A., & Zhou, Y. (2021). Holistic green BIM: A scientometrics and mixed review. *Engineering Construction and Architectural Management*, *28*(9), 2273–2299. https://doi.org/10.1108/ecam-05-2020-0377

Solla, M., Elmesh, A., Memon, Z. A., Ismail, L. H., Al Kazee, M. F., Latif, Q., Yusoff, N. I. M., Alosta, M., & Milad, A. (2022). Analysis of BIM-based digitising of Green Building Index (GBI): Assessment method. *Buildings*, *12*(4), Article 429. https://doi.org/10.3390/buildings12040429

Song, J. B., Li, Y., Feng, Z., & Wang, H. M. (2019). Cluster analysis of the intellectual structure of PPP research. *Journal of Management in Engineering*, *35*(1), Article 04018053. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000664

Srinivasan, R. S., Ingwersen, W., Trucco, C., Ries, R., & Campbell, D. (2014). Comparison of energy-based indicators used in life cycle assessment tools for buildings. *Building and Environment*, *79*, 138–151. https://doi.org/10.1016/j.buildenv.2014.05.006

Srivastava, S., Raniga, U. I., & Misra, S. (2022). A methodological framework for life cycle sustainability assessment of construction projects incorporating TBL and decoupling principles. *Sustainability*, *14*(1), 1–52. https://doi.org/10.3390/su14010197

Tayyab, A., & Ayodeji, A. A. (2017). Project delivery attributes influencing green building project outcomes: A review and future research directions. *Built Environment Project and Asset Management*, *7*(5), 471–489. https://doi.org/10.1108/BEPAM-11-2016-0066

Tan, Y. T., Xu, H., & Zhang, X. L. (2016). Sustainable urbanization in China: A comprehensive literature review. *Cities*, *55*, 82–93. https://doi.org/10.1016/j.cities.2016.04.002

Thome, A. M. T., Ceryno, P. S., Scavarda, A., & Remmen, A. (2016). Sustainable infrastructure: A review and a research agenda. *Journal of Environmental Management*, *184*, 143–156. https://doi.org/10.1016/j.jenvman.2016.09.080

Tsai, W. H., Yang, C. H., Chang, J. C., & Lee, H. L. (2014). An activity-based costing decision model for life cycle assessment in green building projects. *European Journal of Operational Research*, *238*(2), 607–619. https://doi.org/10.1016/j.ejor.2014.03.024

Vyas, G. S., & Jha, K. N. (2016). Identification of green building attributes for the development of an assessment tool: A case study in India. *Civil Engineering and Environmental Systems*, *33*(4), 313–334. https://doi.org/10.1080/10286608.2016.1247832

Wong, J. K. W., & Kuan, K. L. (2014). Implementing 'BEAM Plus' for BIM-based sustainability analysis. *Automation in Construction*, *44*, 163–175. https://doi.org/10.1016/j.autcon.2014.04.003

Wu, P., & Low, S. P. (2010). Project management and green buildings: Lessons from the rating systems. *Journal of Professional Issues in Engineering Education and Practice*, *136*(2), 64–70. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000006

Wu, Z. Z., He, Q. F., Chen, Q. H., Xue, H., & Li, S. H. (2021). A topical network based analysis and visualization of global research trends on green building from 1990 to 2020. *Journal of Cleaner Production*, *320*, Article 128818. https://doi.org/10.1016/j.jclepro.2021.128818

Wu, Z. Z., Li, H., Feng, Y., Luo, X. C., & Chen, Q. H. (2019). Developing a green building evaluation standard for interior decoration: A case study of China. *Building and Environment*, *152*, 50–58. https://doi.org/10.1016/j.buildenv.2019.02.010

Wu, Z. Z., Shen, L. Y., Yu, A. T. W., & Zhang, X. L. (2016). A comparative analysis of waste management requirements between five green building rating systems for new residential buildings. *Journal of Cleaner Production*, *112*, 895–902. https://doi.org/10.1016/j.jclepro.2015.05.073

Wuni, I. Y., Shen, G. Q. P., & Osei, R. O. (2019). Scientometric review of global research trends on green buildings in construction journals from 1992 to 2018. *Energy and Buildings*, *190*, 69–85. https://doi.org/10.1016/j.enbuild.2019.02.010

Xia, H. S., Liu, Z. S., Efremochkina, M., Liu, X. T., & Lin, C. X. (2022). Study on city digital twin technologies for sustainable smart city design: A review and bibliometric analysis of geographic information system and building information modeling integration. *Sustainable Cities and Society*, *84*, Article 104009. https://doi.org/10.1016/j.scs.2022.104009

Xiao, F. J., Li, C. Z., Sun, J. M., & Zhang, L. J. (2017). Knowledge domain and emerging trends in organic photovoltaic technology: A scientometric review based on CiteSpace analysis. *Frontiers in Chemistry*, *5*, Article 67. https://doi.org/10.3389/fchem.2017.00067

Xu, Y., Luo, D., Qian, Q. K., & Chan, E. H. W. (2023). Are green buildings more liveable than conventional buildings? An examination from the perspective of occupants. *Journal of Housing and the Built Environment*, *38*(2), 1047–1066. https://doi.org/10.1007/s10901-022-09983-9

Zarghami, E., Azemati, H., Fatourehchi, D., & Karamloo, M. (2018). Customizing well-known sustainability assessment tools for Iranian residential buildings using Fuzzy Analytic Hierarchy Process. *Building and Environment*, *128*, 107–128. https://doi.org/10.1016/j.buildenv.2017.11.032

Zhang, C., Cui, C. L., Zhang, Y., Yuan, J. Q., Luo, Y. M., & Gang, W. J. (2019). A review of renewable energy assessment methods in green building and green neighborhood rating systems. *Energy and Buildings*, *195*, 68–81. https://doi.org/10.1016/j.enbuild.2019.04.040

Zhang, L., Liu, H. Y., & Wu, J. (2017). The price premium for green-labelled housing: Evidence from China. *Urban Studies*, *54*(15), 3524–3541. https://doi.org/10.1177/0042098016668288

Zhang, L., Wu, J., & Liu, H. Y. (2018a). Policies to enhance the drivers of green housing development in China. *Energy Policy*, *121*, 225–235. https://doi.org/10.1016/j.enpol.2018.06.029

Zhang, L., Wu, J., & Liu, H. Y. (2018b). Turning green into gold: A review on the economics of green buildings. *Journal of Cleaner Production*, *172*, 2234–2245. https://doi.org/10.1016/j.jclepro.2017.11.188

Zhao, X. B., Zuo, J., Wu, G. D., & Huang, C. (2018). A bibliometric review of green building research 2000–2016. *Architectural Science Review*, *62*(1), 74–88. https://doi.org/10.1080/00038628.2018.1485548

Zuo, J., & Zhao, Z. Y. (2014). Green building research-current status and future agenda: A review. *Renewable* & *Sustainable Energy Reviews*, *30*, 271–281. https://doi.org/10.1016/j.rser.2013.10.021