

Review

Green and Sustainable Construction Industry: A Systematic Literature Review of the Contractor's Green Construction Capability

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Abstract: Contractors are the main implementers to achieve green construction, and the contractor's green construction capability (CGCC) is far-reaching for green construction. Research on CGCC exists in a number of disciplines, with major contributions in construction management, environment management, and sustainable management research. Despite the fact that CGCC is widely utilised in both research and practice, its formation and action mechanism remain obscure due to the multi-disciplinary nature of CGCC. This study is motivated by this research gap. This study conducted a comprehensive investigation of CGCC by using a systematic review covering 74 relevant publications published from 2005 to the first half of 2022. Five main research clusters were identified: (1) CGCC implementation; (2) CGCC performance; (3) CGCC profound impact; (4) CGCC and green building; and (5) CGCC and sustainability. Existing research collaborations on CGCC are infrequent, although this is an area of research that requires multi-disciplinary collaboration. Studies such as CGCC enhancement mechanisms and evaluation systems have received less attention. An integrative framework was proposed for future scholars to build upon as well as a guidance for executives.

Keywords: green construction; contractor; capability; contractor's green construction capability (CGCC); systematic mapping



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1. Introduction

Green construction refers to construction activities that maximize resource conservation and reduce the negative impact on the environment while ensuring quality, safety, and other basic requirements. Since the 1980s, a substantial amount of construction management research has focused on green construction [1]. Particularly, the question of how to achieve green construction more efficiently and quickly is currently receiving significant attention both in research and practice [2–5]. There is substantial evidence that the realization of green construction requires policy incentives [6–8], developer adoption [9,10], a mature supply chain [11,12], and excellent CGCC [13,14]; we use this result as the basis for our study.

Contractors are the main implementers of green construction, and CGCC directly affects the achievement of the project's green construction goals. The importance of CGCC is self-evident. In addition to this, the number of papers dealing with CGCC has increased dramatically over the past decade or so—but how much do we know about CGCC? The known answer is that we know a lot more now than we did before. However, CGCC and its role still need further clarification [15]. This is largely owing to the multi-disciplinary character of CGCC, which incorporates principles from several fields. Numerous publications from a variety of academic fields publish empirical and theoretical research on CGCC, resulting in a rich diversity of interpretations of CGCC from different perspectives by scholars in different fields such as enterprise management, construction management, environmental management, and sustainability. Thus, our new knowledge about CGCC is

fragmented. Most importantly, there is a lack of a systematic discussion in academia regarding the relationship between these discipline-isolated findings and a broader theoretical perspective on CGCC.

This study attempts to provide a comprehensive understanding of the current research in CGCC and their interactions with one another. Consequently, this study aims to: (1) review and critically analyse the current level of research in CGCC; (2) synthesise the findings into an integrated, multi-dimensional, and multi-disciplinary knowledge framework; and (3) identify any potential research gaps in order to suggest study options for the future.

Our review contributes to CGCC research and practice in multiple ways. First, we offer the first systematic review of the existing literature on CGCC. Second, we developed an integrated framework to organize the existing literature and provide a foundation for future researchers to further develop the field and practitioners they seek to direct. Third, we provide a potential future research agenda by identifying existing knowledge gaps, emerging topics, and research limitations.

This paper is structured as follows: First, we start by defining the conceptual boundaries of CGCC. Then, we provide a comprehensive overview of our systematic evaluation methodology. In the next part, we offer a descriptive overview of the current literature, followed by a systematic classification and synthesis of the existing literature based on keyword co-occurrence results, and present a synthesis framework. Afterwards, we highlight both the theoretical and practical contributions in our study. Finally, we discuss the limitations in this review and future research directions in CGCC.

2. Conceptual Boundaries

As recommended by Vrontis and Christofi [16], a massive and continually growing body of literature may unfocus the research themes; conceptual boundaries of the review are needed. We define the CGCC as the study of the set of: (1) CGCC in all segments of engineering construction, and (2) the contractor in CGCC include general contractors and subcontractors. Thus, other studies focusing on green construction capability beyond the contractor boundaries, such as researches on construction worker's green construction capability, are excluded [17]. Similarly, research on green construction capability from an industry perspective or from a national/regional perspective were also excluded [18]. Finally, in the analysis of CGCC, we included implementation, performance, profound impact, and relational variables that that explain the CGCC.

Although there have been efforts to undertake synthesis and review studies on many aspects of green construction in recent years, no review has attempted to unravel the green construction from the contractor perspective. Thus, we provide a deeper and more systematic understanding of CGCC through a systematic review of this field. Furthermore, our research establishes a research paradigm that researchers from different disciplines may use to do research on other corporate capabilities that are less developed, such as corporate innovation management capabilities [19] or corporate operation capabilities [20].

3. Methodology

A PRISMA systematic literature review allows for a rigorous, clear, and repeatable approach to screening, thematic segmentation, and critical review of the existing relevant literature in order to come to strong conclusions about the area under study [21]. Referring to the studies in Danese, Manfè [22] and Vrontis and Christofi [16], PRISMA systematic reviews appear to have several advantages over traditional narrative reviews, which include: (1) improving the systematic nature of the literature review process and effectively reducing subjective bias and errors in the literature review process [23]; (2) improving the rigor of the literature review process and providing some assurance of the quality of the literature review [24]; (3) improving the reproducibility of the literature review process and increasing the credibility of the study [25]; (4) enabling data synthesis and literature mapping of the literature within the research topic [26]; and (5) further integrating the

existing knowledge framework [27]. In addition, systematic literature reviews have been widely used in recent years in many high-impact journals, for example, safety management [28], smart construction [29], and technology innovation [30]. For the reasons stated above, we believe that using a PRISMA systematic literature review approach can help us better reveal the existing knowledge framework of CGCC, and as a result, this paper will use a PRISMA systematic literature review approach to conduct the relevant research.

3.1. Question Formulation

A comprehensive and well-developed literature review begins with a clear definition of the research question [31]. According to Adams, Jeanrenaud [32], the research question in this study is made clear by listening to experts in the field of green construction and having in-depth discussions among researchers. Based on our long-term research on green construction and the method described above, we came up with the research question “Examine the patterns and practices within the existing CGCC body of knowledge”.

3.2. Inclusion Criteria

Clear criteria may assist research in establishing which literature should be included in a systematic review, and this article followed Aramali, Sanboskani [33]’s method by using three inclusion criteria: (1) identifying the electronic databases searched; (2) identifying the terms searched; and (3) specifying the search time span.

First, electronic databases were used to define the search limits. Web of Science, Science Direct, and Google Scholar were chosen for our literature review due to their extensive journal coverage in the construction management area and their frequent use by other systematic reviews [34–36].

Second, following the lead of Hasan, Ghosh [37], we created a list of broad-coverage search terms, despite the fact that they yield a large number of non-relevant hits. This was done to reduce the likelihood of missing a search term that could lead to the discovery of pertinent literature.

Third, instead of limiting our search to a specific start date, we left it open until the conclusion of our research (June 2022), in order to capture all pertinent literature.

3.3. Search Strategy

The terms search scope in this paper for the aforesaid electronic database was set to title, abstract, and keywords, as it was in the case of Shi, Chen [38], Siraj and Fayek [39], and Yu, Chan [40], because this setting allows for the addition of as many keywords as possible, which better fits the needs of future analysis.

The search terms were created using a truncated method in order to identify as much literature as possible that fulfilled the requirements. The search terms were divided into three categories: corporate, green building, and capability. The Boolean AND operator was used to link the three groups of keywords together, while the search terms for each theme were linked using Boolean OR operator to maximize the search results. As a result, the search settings in this study are (contractor OR builder OR corporate OR firm OR company OR enterprise) AND (green construction OR sustainable construction OR environmentally friendly construction OR eco-friendly construction OR low carbon construction) AND (capability OR ability OR capacity OR competence). A total of 976 preliminary works of literature were eventually retrieved.

3.4. Exclusion Criteria

Considering the loose search strategy for the literature in the previous phase and the duplication of data between different databases, this phase also needed to set relevant exclusion criteria for the literature that did not belong to the scope of this study. Firstly, duplicate literature was undoubtedly removed in the first instance. Secondly, studies that did not pass peer review were excluded according to the usual practice of the systematic review of studies in the current state of the literature [16,34,37]. This means that book

chapters, conference papers, book reviews, and editorials will be excluded from the studies reviewed in this study. Finally, given that most of the studies were written in English, fewer studies were published in other languages (e.g., French and Greek), and the threshold for learning other languages was too high, all articles not written in English were excluded. This method also used for studies in Follmer and Jones [41], Hasan, Ghosh [37], and Cillo, Petruzzelli [42].

After applying these exclusion criteria to weed out irrelevant articles, we were left with 757 articles that could be evaluated within the scope of this review.

3.5. Relevant Literature Selection

For the selection of relevant literature, this study used a stepwise progressive four-stage review method. The review criteria were not the same in different stages. The first three stages of the review aimed to retain all potentially relevant literature, so the review criteria were lenient. The fourth stage of the review was the most rigorous because it was directly related to the relevance of the selected literature to the research topic. The methodology of the four-stage review is specified as follows:

First, the study reads through the titles and eliminates literature that is clearly incompatible with the present study. When the relevance to the study could not be directly determined by the title, the abstract of the article was briefly read for the second stage of the review judgment. When the abstract of the article did not give a sufficient basis for judgment, the third stage of review was conducted by reviewing the introduction of the article. The fourth stage of the review was judged mainly by reviewing the full text of the literature, and in this stage only those studies that made significant contributions to or presented important insights into the study of CGCC were retained, and this ensured that the literature was highly relevant to the topic of this study.

Through the four-stage review, a total of 62 literatures were retained and proceeded to the next phase while 695 literatures were excluded.

3.6. Literature Supplementation

Literature supplementation is carried out in two main steps: firstly, literature supplementation based on references of identified literature; and secondly, literature supplementation based on expert opinions.

(1) Literature supplementation based on references

According to Vrontis and Christofi [16], and Pak, Kooij [43], the references of 62 documents retained in the previous phase were similarly reviewed by us using a four-stage review method to supplement the possible literature. With this step of literature supplementation, an additional four works of literature were included in the analysis.

(2) Literature supplementation based on expert opinion

Following the approach of Vrontis and Christofi [16], we presented our research literature to seven experts in the green construction area and asked them if there was any literature that should be included but was not included in our literature list. By asking for expert opinions, we added an additional eight references.

3.7. Literature Search Summary

Through a step-by-step manipulation of the above search process, we included a total of 74 literatures that met the requirements. Figure 1 illustrated the entire process of the literature search and the addition and deletion of literature at each stage.

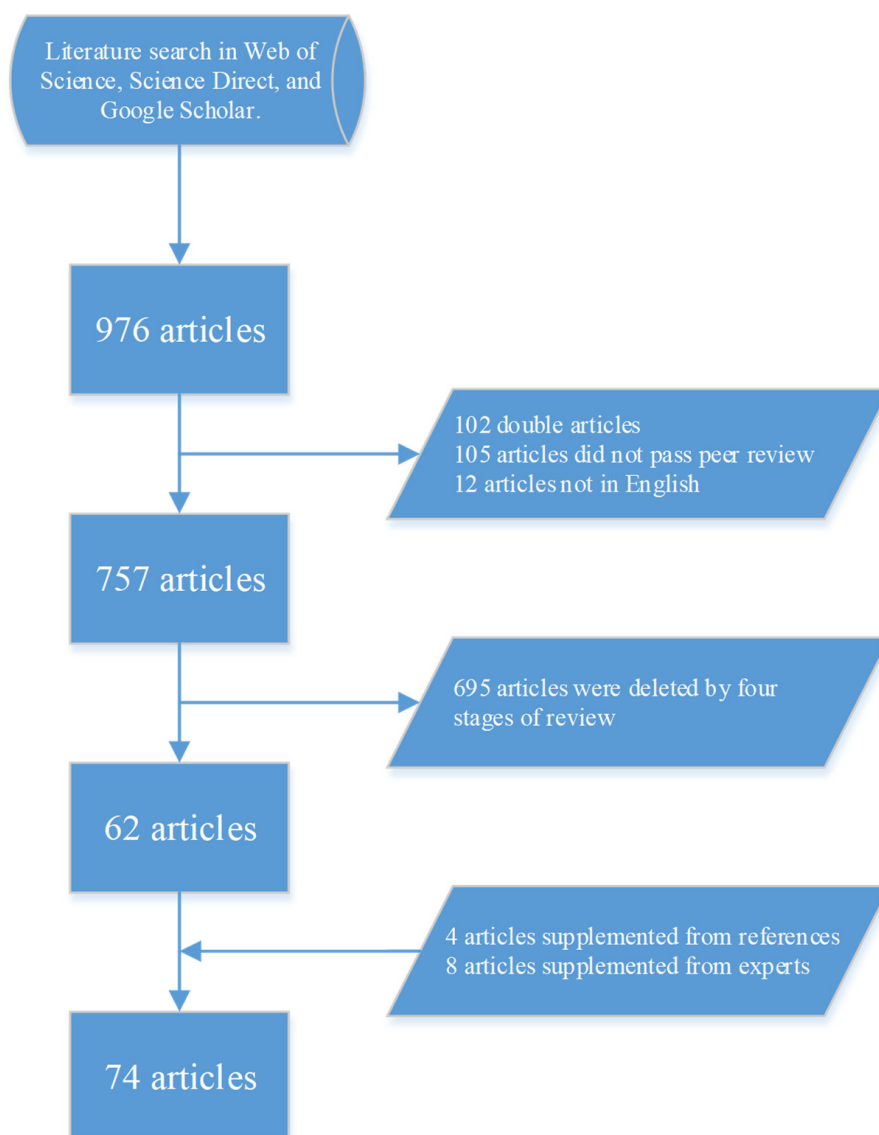


Figure 1. Literature search process.

4. Descriptive Review of the Literature

Descriptive review of the existing literature enables a visual presentation revealing the trends and characteristics in CGCC research. In this part, we report publication growth trends, top research outlets, scientific collaboration networks, and influential research highlights. Benefiting from this, a preliminary map of the existing literature and research gaps were revealed.

4.1. Publication Growth Trends

As shown in Figure 2, since 2005, the number of articles published annually has significantly increased, with a peak in 2019 ($n = 12$). Despite being established nearly 20 years ago, the research of CGCC is still growing rapidly. The results show that the number of academic studies on the CGCC topic has grown exponentially over the past five years (478% compared to the first 5 years): 58.1% of the studies were generated in the past 5 years. It also shows that CGCC research has expanded in scope and branch over time.

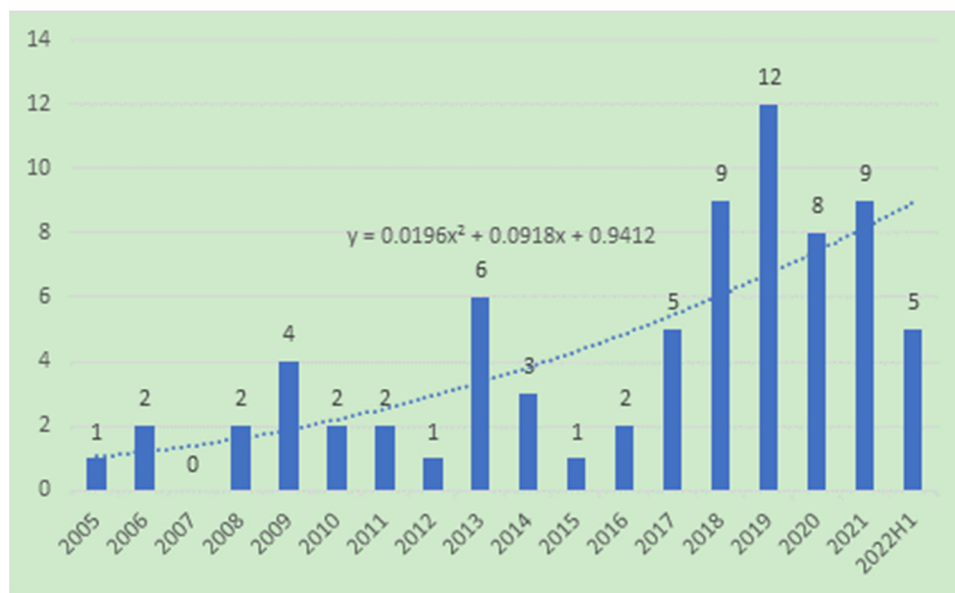


Figure 2. Year profile of publication. Note: The X-axis represents the different years and the Y-axis represents the number of publications published in each year.

4.2. Top Research Outlets

42 journals published 74 articles. As shown in Figure 3, the top 15 journals (those with more than two articles) contributed 47 papers, or 63.5% of the total. The Journal of Cleaner Production and Sustainability are tied in first place (8, 10.8%), followed by International Journal of Construction Management (4, 5.4%), Journal of Construction Engineering and Management (3, 4.1%), Sustainable Cities and Society (3, 4.1%), and Environmental Science and Pollution Research (3, 4.1%). Seven of the top 15 journals are from the UK, four are from the US, two are from the Netherlands, one is from Germany, and one is from Sweden. Table 1 shows that most of the papers are in the fields of environment and sustainability management and construction management. This fits with the connotation of CGCC. Environment and sustainability management journals that appear in the review ($n = 17, 40.5\%$) mainly include the Journal of Cleaner Production, Sustainability, Sustainable Cities, and Society. Construction management journals that appear in the review ($n = 16, 38.1\%$) mainly include the International Journal of Construction Management, Journal of Construction Engineering and Management, and Journal of Management in Engineering.



Figure 3. TOP 15 journals in CGCC by publication number. Note: The Y-axis represents the different journals and the X-axis represents the number of publications published in each journal.

Table 1. Field of research based on journals and papers.

Field	Numbers of Papers	Numbers of Journals
Environment & sustainability	38	17
Construction management	26	16
Engineering management	3	3
Financial management	1	1
Technology management	1	1
Law and political	2	1
General management	1	1
Energy management	1	1
Corporate social responsibility	1	1

We examine the number of citations in our existing literature to reveal more about the impact of publication outlets on the research domain. The 10 most cited articles are Gupta and Barua [44] (citations: 248); Qi, Shen [45] (citations: 245); Hoffman and Henn [46] (citations: 212); Salem, Solomon [47] (citations: 155); Tan, Shen [48] (citations: 145); Varnäs, Balfors [49] (citations: 121); Lam, Chan [50] (citations: 115); Salem, Solomon [51] (citations: 111); Li, Chen [52] (citations: 92); and Berardi [53] (citations: 81). The results also show that the authors of the 10 most cited articles in our existing literatures are mainly from the United States (4 articles) and China (3 articles), with one each from Singapore, India, and Sweden. The most cited articles were published in the Journal of Cleaner Production, Organization & Environment, Journal of Management in Engineering, Habitat International, Journal of Environmental Management, Lean Construction Journal, Journal of Construction Engineering and Management, and Energy Policy. Hence, the articles were not strictly confined to environment and sustainability management or construction management. The cross-disciplinary focus character of the CGCC research topic is a good sign that it is important and has a lot of potential.

4.3. Scientific Collaboration Networks

Increased communication and output in the realm of academic research is possible when researchers work together in well-connected teams, which in turn increases their access to resources such as funds, expertise, and specialties [37]. The leading researchers, universities, and countries/regions working on CGCC were identified through systematic analysis. Collaboration increases the possibility that a paper will be published in a high-impact journal and increases the number of times that paper will be cited [54]. Co-authorship analysis allows for the study of the scientific co-operation network. For this purpose, we used VOSviewer for co-authorship analysis, with authors as our unit of analysis, and full counting as our counting method to identify the list of leading researchers. Only 22 of the 218 authors counted had at least two publications and five citations each. The network of 22 authors is depicted in Figure 4. They are divided into 10 clusters and represented by different colors, and interconnected by 17 links. The size of the node reflects the number of publications by that author.

Figure 4 shows a collaboration network led by three eminent authors: Shen Liyin, Hong Kong Polytechnic University (HK); A. Genaidy, University of Cincinnati (USA); and J. Solomon, University of Cincinnati (USA). It is important to note that Figure 4 also shows scattered scholarly contributions by many authors who do not belong to any of the pre-existing clusters in the network. It is important to stress, however, that researchers can collaborate more closely in the future to make contributions to CGCC research.

Table 2 displays the countries/regions that are actively researching CGCC, along with seven metrics, including number of documents (ND), total citations (TC), total link strength (TLS), average citation per country/region (AC), average published year (AY), normalized citation (NC), and average normalized citation (ANC). The NC was calculated by dividing the TC by the total number of citations published per year. The ANC was calculated by dividing the TC by the average number of citations published per year [55]. In order to avoid excessive fluctuations when analysing AC and ANC from a single document

for a country, the table specifies a minimum of two documents per country/region. The collaboration network between countries and regions is depicted in Figure 5. To ensure that the relationship between each country/region can be displayed in the figure, both the minimum number of documents and citations for a country were set at 1. Finally, a 33-item map was generated.

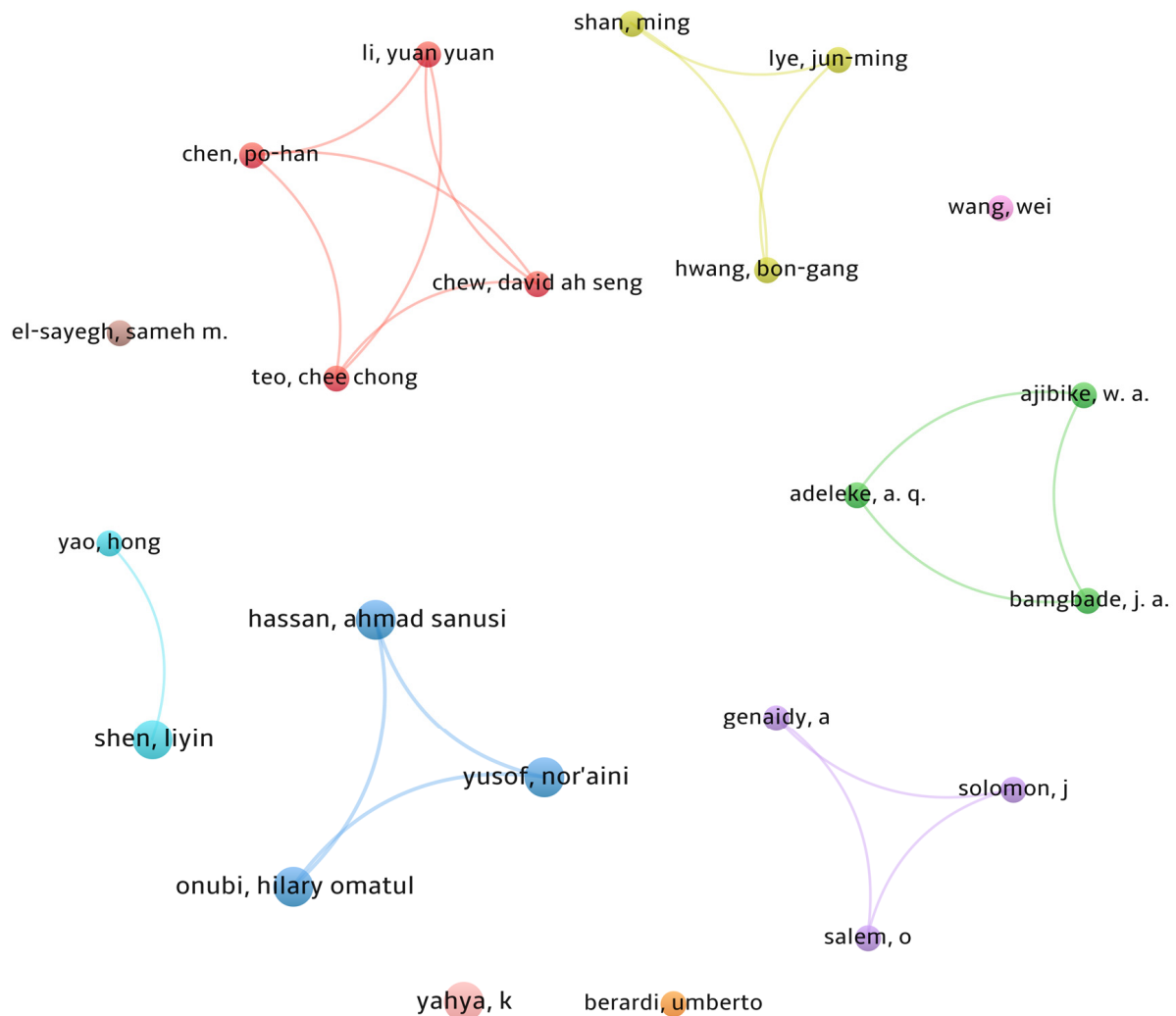


Figure 4. Researcher collaboration network map.

Table 2. Summaries of main countries/regions engaged in CGCC research.

Country/Region	ND	TC	TLS	AC	AY	NC	ANC
Mainland China	24	554	2327	23.08	2018	22.8206	0.9509
Malaysia	10	47	460	4.70	2019	6.3429	0.6343
United States	10	609	391	60.90	2012	9.4574	0.9457
Australia	8	87	1217	10.88	2019	7.8069	0.9759
Hong Kong, China	7	597	1310	85.29	2013	7.6888	1.0984
Singapore	5	167	887	33.40	2015	5.4857	1.0971
England	3	65	498	21.67	2015	2.4945	0.8315
The Netherlands	3	85	243	28.33	2015	2.9893	0.9964
Taiwan, China	3	147	479	49.00	2013	2.9318	0.9773
Italy	2	81	121	40.50	2015	1.4301	0.7151
Scotland	2	31	110	15.50	2018	2.2143	1.1071
Sweden	2	194	127	97.00	2009	3.0794	1.5397
UAE	2	19	61	9.50	2021	1.2632	0.6316

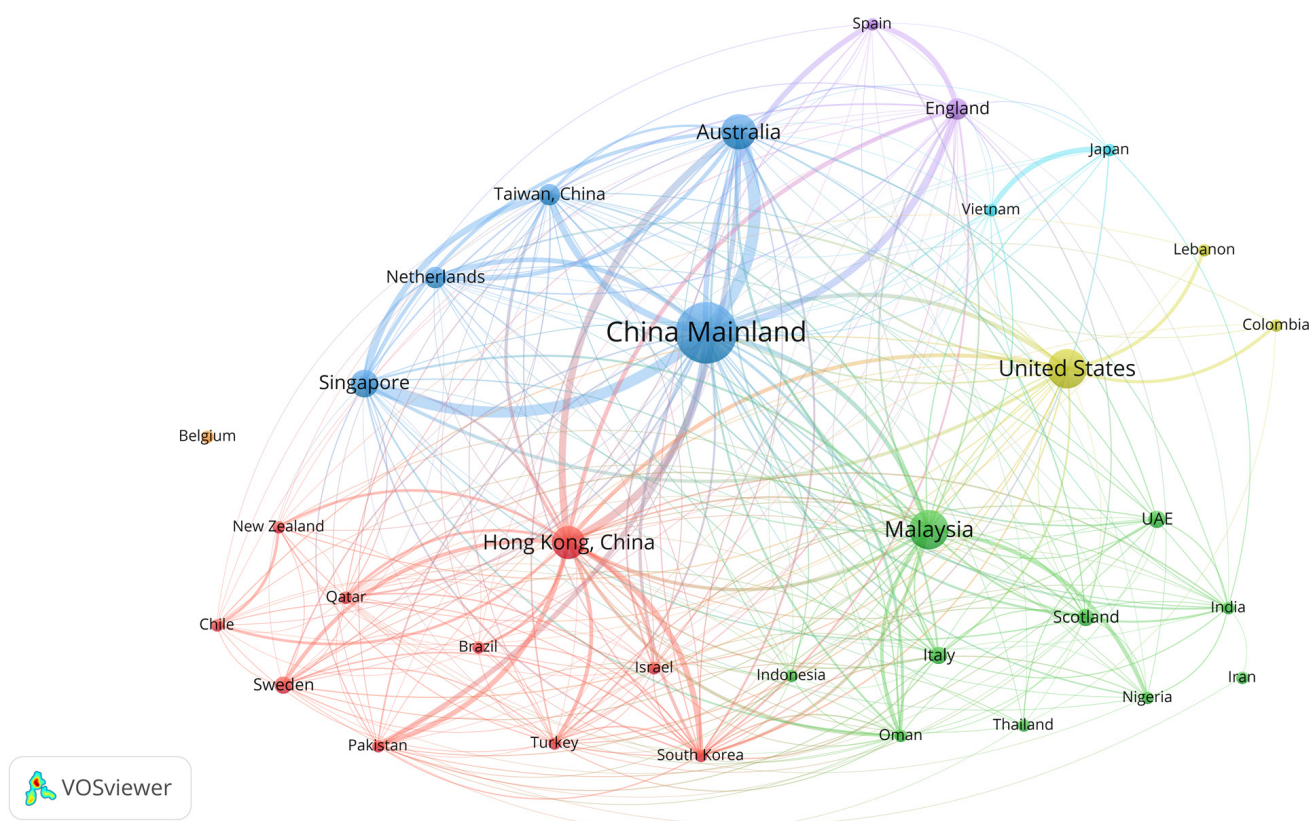


Figure 5. Map of countries/regions engaged in CGCC research.

According to Table 2, CGCC research is a worldwide concern field, especially in Asia, Europe, and North America. The United States has the highest TC, but Mainland China has the most publications. Hong Kong, Singapore, Scotland, and Sweden have fewer publications, but they maintain a high ANC value ($ANC > 1$) which demonstrate their significant influence. In addition, the AY of Mainland China ($AVY = 2018$, $ND = 24$), Malaysia ($AVY = 2019$, $ND = 10$), Australia ($AVY = 2019$, $ND = 8$), Scotland ($AVY = 2018$, $ND = 2$), and UAE ($AVY = 2021$, $ND = 2$) are all within 5, which indicates that their role in promoting CGCC is becoming increasingly active.

Figure 5 shows two evidences. First, the global CGCC research is divided into five main communities based on a partnership, using different colors to differentiate between them. They are dominated by Mainland China, Hong Kong, United States, Malaysia, and England, respectively.

Second, the degree of international co-operation in the field of CGCC varies widely from different countries/regions, as shown by the size of nodes and the thickness of connection lines. Among them, Mainland China, Hong Kong, and Australia have a greater degree of international co-operation, with 15 (62.5%), seven (87.5%), and five (71.4%) publications produced by cross-country/region co-operation, respectively. However, Malaysia and the United States have a lower degree of international collaboration, with eight (80%) and seven (70%) publications produced entirely by domestic institutions. This may be due to the large differences in CGCC development models across different countries [56]. In addition, while CGCC has a broad scope and decentralized knowledge structure, the attention of current researchers was mostly focused on their specific areas of interest, such as implementation [57], performance [58], and profound impact [59]. Consequently, academic institutions with different backgrounds are not co-operating extensively at this time.

As shown in Figure 6, among the 114 institutions that contributed to CGCC research, those with more than two publications and over 10 citations were built into a 16-item, 95-link network. The five different colors mean that the 16 institutions were divided into

five clusters, the size of the nodes reflects the number of publications published by each institution, and the thickness of the connection lines reflects the strength of the connections between them.

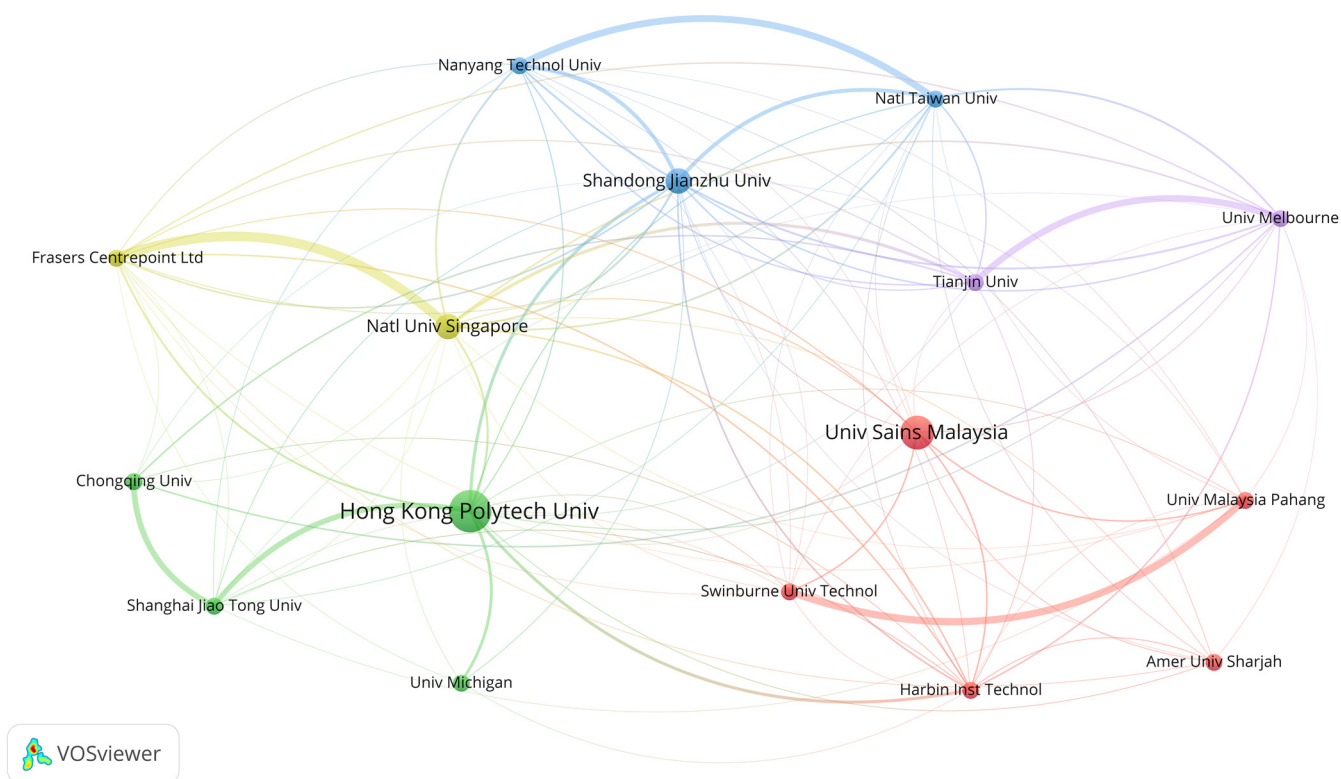


Figure 6. Map of global collaboration network among institutions.

No institution published more than seven publications (10% of 74). Only two institutions (Hong Kong Polytech University and University Sains Malaysia, respectively) published four or more papers (5% of 74) and the studies were relatively independent. Therefore, it can be argued that no institution has led CGCC research to date. However, some of the institutions located in Asia and North America have a higher reputation in CGCC due to higher citations, including the Hong Kong Polytechnic University (Hong Kong, China, 548 citations), Shanghai Jiao Tong University (Shanghai, China, 260 citations), University Michigan (Michigan, USA, 225 citations), Nanyang Technological University (Singapore, 133 citations), and National Taiwan University (Taipei, China, 133 citations). In addition, Figure 6 illustrates the lack of inter-organizational collaboration in research.

4.4. Influential Research Highlight

We perform the publications co-citation analysis to identify the most influential publications and build the co-citation network. As shown in Figures 7 and 8, this study built a co-citation visual network graph containing 22 items, for which the minimum number of citations was set to 20 (one item was not connected to other items, so it was deleted). The nodes in the map represent documents identified by the first author and publication year. The publishing and co-citation dates are shown by the node and link colors, respectively. The literature in Figure 7 uses different colors to indicate the difference in its clustering, and the literature co-occurrence demonstrates “local concentration and overall dispersion”, indicating that a number of CGCC researchers were well-recognized and produced common ideas and results. The year 2010 was a watershed year for CGCC research, with many highly cited papers published around 2010. Co-citation data over time demonstrates the rapid growth in CGCC expertise.

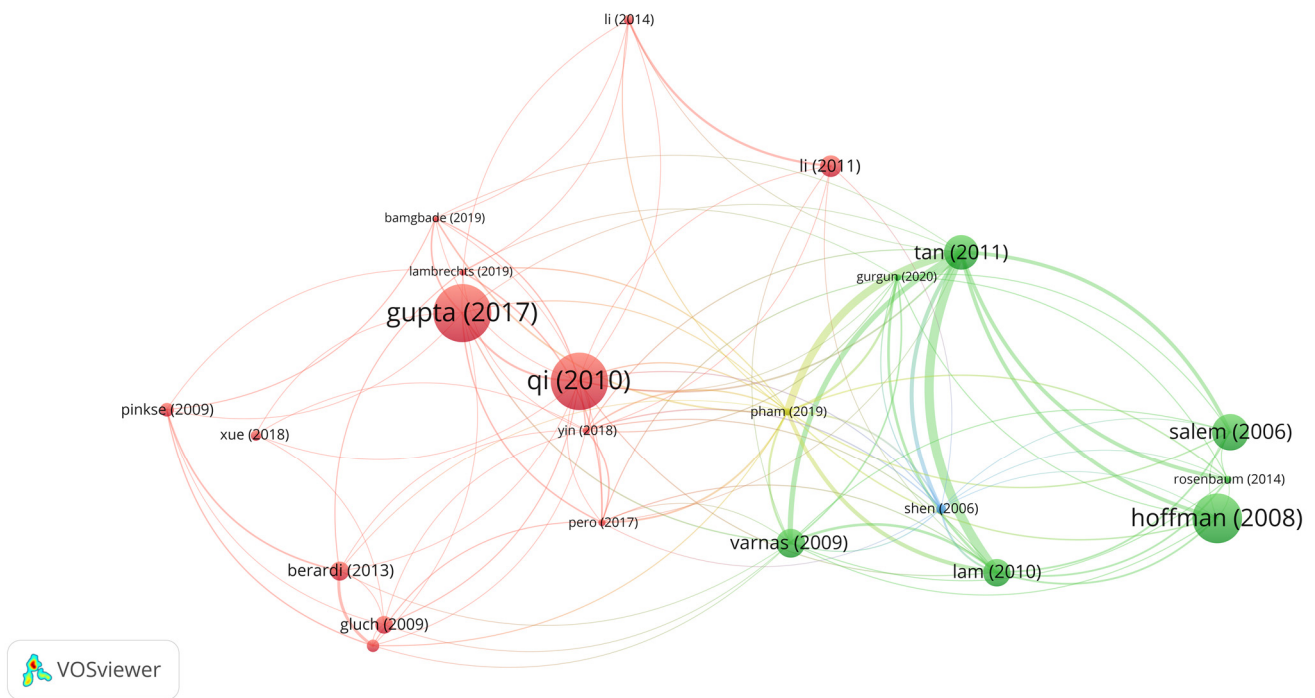


Figure 7. Map of the influential publications and co-citation by cluster.

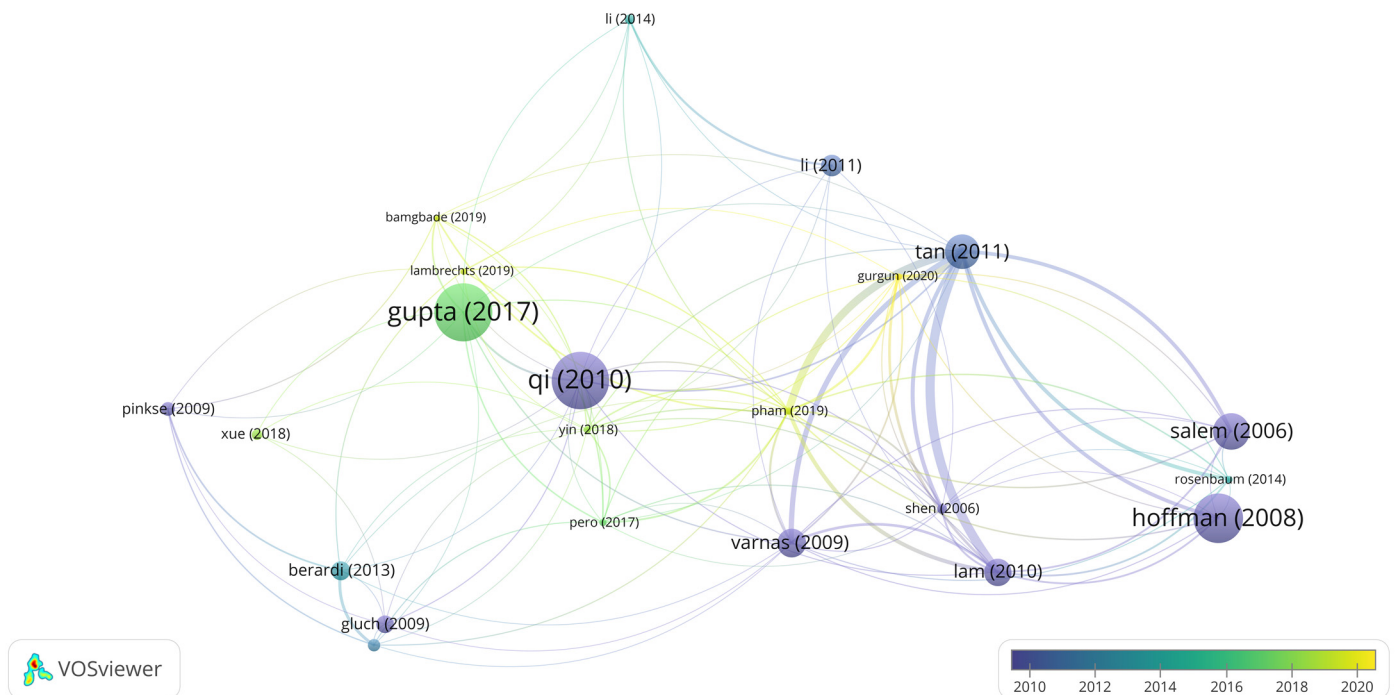


Figure 8. Map of the influential publications and co-citation by year.

Table 3 lists the top 15 most cited papers by year, TC, TLS, and topics. Gupta and Barua [44] received the most attention; the short publication time and high citations indicate their high impact in CGCC. The second is Qi, Shen [45], one of the first empirical studies to examine the shaping factors and impact factors of CGCC. The third is Hoffman and Henn [46], whose main contribution is to introduce social psychology into the research of CGCC which has enhanced the explanation of the barrier factors in the application of CGCC and enriched the theory of CGCC. These were followed by papers by Salem, Solomon [47] and Tan, Shen [48], which focused on the contractor's lean construction capabilities and

sustainable construction capabilities, two concepts highly similar to CGCC. Other highlighted documents involve: (1) approximate concepts of CGCC, such as the contractor's lean construction capability [51], green purchase capability [49], green specification [50], and green innovation capability [60]; (2) influence factors of CGCC, e.g., critical impact factors of CGCC [52] and barriers of CGCC [61]; (3) stakeholder's impact on CGCC, such as stakeholder's impact CGCC [53,62] and the firm relationship's impact on CGCC; and (4) performance of CGCC, such as environmental performance of CGCC [63].

Table 3. List of publications with the highest impact in CGCC.

Document	Year	TC	TLS	Topic Relate to CGCC
Gupta and Barua [44]	2017	248	26	Contractor's green innovation capability
Qi, Shen [45]	2010	245	31	Contractor's green innovation capability
Hoffman and Henn [46]	2008	212	40	Barriers of CGCC
Salem, Solomon [47]	2006	155	41	Contractor's lean construction capability
Tan, Shen [48]	2011	145	437	Contractor's sustainable construction capability
Varnäs, Balfors [49]	2009	121	87	Contractor's green purchase capability
Lam, Chan [50]	2010	115	222	Contractor's green specifications
Salem, Solomon [51]	2005	111	0	Contractor's lean construction capability
Li, Chen [52]	2011	92	14	Critical factors of CGCC
Berardi [53]	2013	81	27	Stakeholder's impact on CGCC
Gluch, Gustafsson [60]	2009	73	8	Contractor's green innovation capability
Pinkse and Dommisse [61]	2009	58	13	Barriers of CGCC's adoption
Albino and Berardi [64]	2012	51	26	Firm relationship's impact on CGCC
Xue, Zhang [62]	2018	43	4	Stakeholder's impact on CGCC
Shen, Yao [63]	2006	42	54	Environmental performance of CGCC

5. Thematic Analysis of the Literature

The study analysed the TOP 10 keywords by performing keyword analysis on the existing literature. The keyword clustering map drawn based on the keyword analysis provides the basis for the study to carry out thematic analysis.

Table 4 lists the top ten keywords with TLS more than 30 and occurrences more than 5, which indicate their higher degree of influence. The keyword with higher TLS was considered to be more influential when two or more research areas were compared together.

Table 4. Main topics of research focus.

TLS Rank	Keyword	Occurrences	TLS
1	sustainability	15	70
2	management	14	66
3	performance	17	60
4	barriers	10	54
5	sustainable construction	11	50
6	impact	10	42
7	construction	10	39
8	innovation	8	37
9	construction industry	10	34
10	critical success factors	5	31

As can be seen from Table 4, the existing body of knowledge on CGCC focus on sustainability, management, performance, barriers, impact, innovation, and critical success factors. In contrast, research on CGCC evaluation, CGCC enhancement, and CGCC building have received less attention.

Furthermore, we can clearly see that current research was divided into five major research clusters in Figure 9, which are research cluster 1 "What affects the application of CGCC?"; research cluster 2 "What is the performance of CGCC?"; research cluster 3 "What is the further impact of CGCC?"; research cluster 4 "How does CGCC promote

green building?"; and research cluster 5 "What is the relationship between CGCC and sustainability?". The five major research clusters were subsequently discussed below.

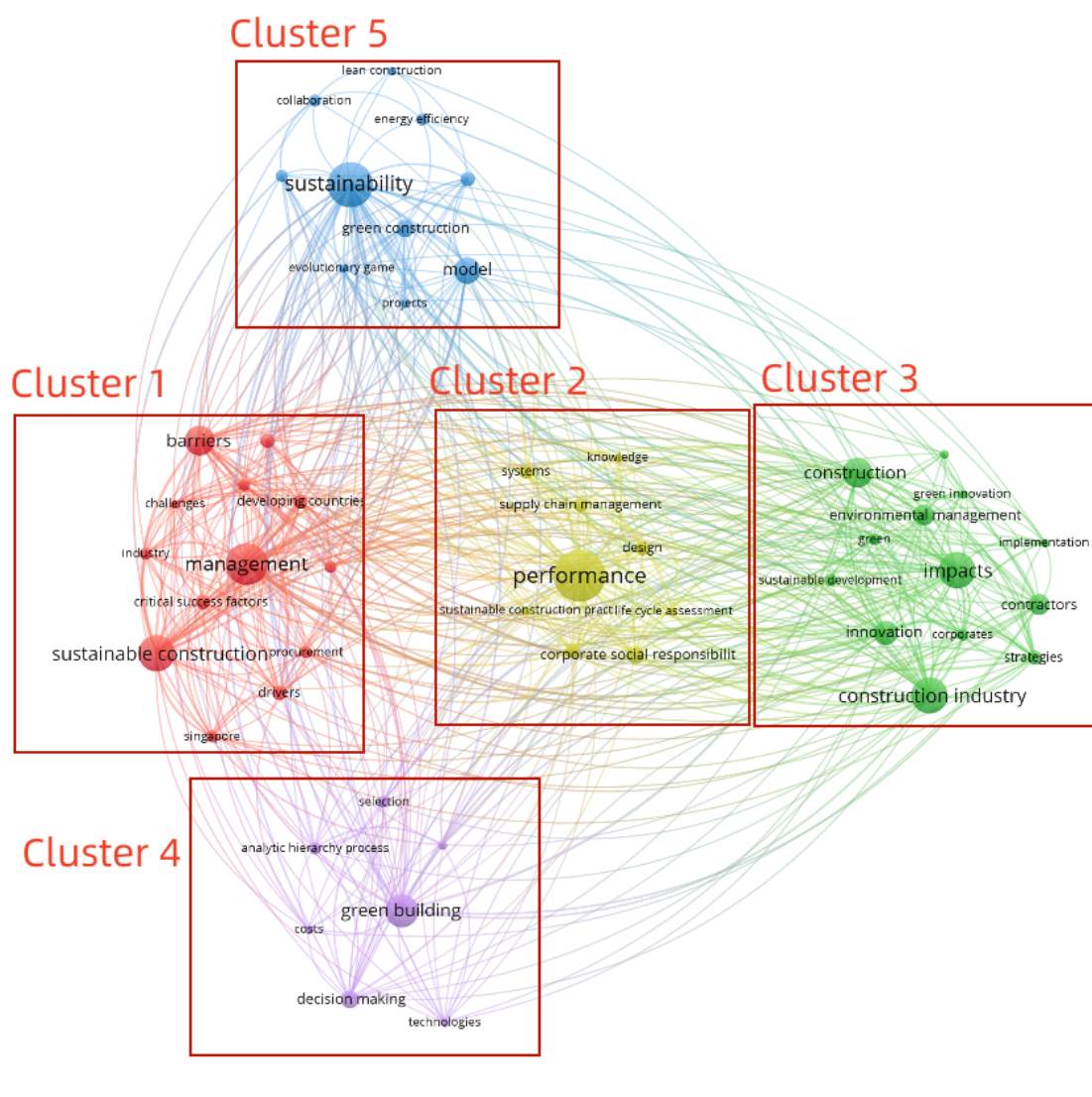


Figure 9. Map of main research topics.

5.1. Research Cluster 1: What Affects the Implementation of CGCC?

5.1.1. Barriers of CGCC Implementation

The concept of green construction has been discussed for a very long time, but the concept of CGCC has not been generally taken seriously by construction companies, one of the reasons being that it is hindered by many aspects.

From the owner side, most of owners are primarily driven by financial interests, and the initial green construction process triggers additional cost investments; therefore, financial pressure is currently one of the biggest impediments to the implementation of CGCC [61]. At the same time, the lack of effective publicity, guidance, and incentives, as well as the organizational inertia (accustomed to the implementation of traditional construction processes) of the owner, are all hindering the application and implementation of green construction to varying degrees [53,57,61,65].

From the contractor side, green construction capabilities require more in management and technology than traditional construction capabilities [66], and contractors' access to green construction management and green construction technology is still relatively lacking [61]. This has a substantial effect on the implementation of CGCC, which is even

more pronounced among small- and medium-sized contractors [57,61]. At the same time, the additional work generated during the implementation of CGCC leads to lower productivity and additional risks that hinder the implementation of CGCC [52,67]. Furthermore, these reasons lead to the fact that the current implementation of CGCC will trigger more construction costs, which affects the profit and return of contractors. Thus, the financial pressure becomes an important obstacle to the implementation of CGCC [57,61,65,67,68].

5.1.2. Challenges of CGCC Implementation

The implementation of CGCC is challenging because they are not generally valued by owners.

One major challenge is how to promote their green construction capabilities to owners and create demand for CGCC among owners [61].

Furthermore, while there have been many successful green construction implementation cases, there have been few successful green construction contracting cases, and how to clearly identify the boundaries of green construction contracts' responsibilities is also a challenge for the implementation of CGCC [69].

Finally, the implementation of CGCC requires changes to the organizational structure and stakeholder relationships in the construction process [57]. For example, in the traditional project construction process, contractors are only involved in the project after the bidding process is completed, but the implementation of green construction requires contractors to be involved in the design phase of the project as early as possible, which is also a challenge for CGCC.

5.1.3. Drivers of CGCC Implementation

The current research on critical success factors of CGCC implementation is extensive and varied, with the major five dimensions being government, stakeholder, company leadership, company staff, and construction team. The role of critical success factors for CGCC implementation in each dimension is shown in Figure 10.

(1) Government dimension

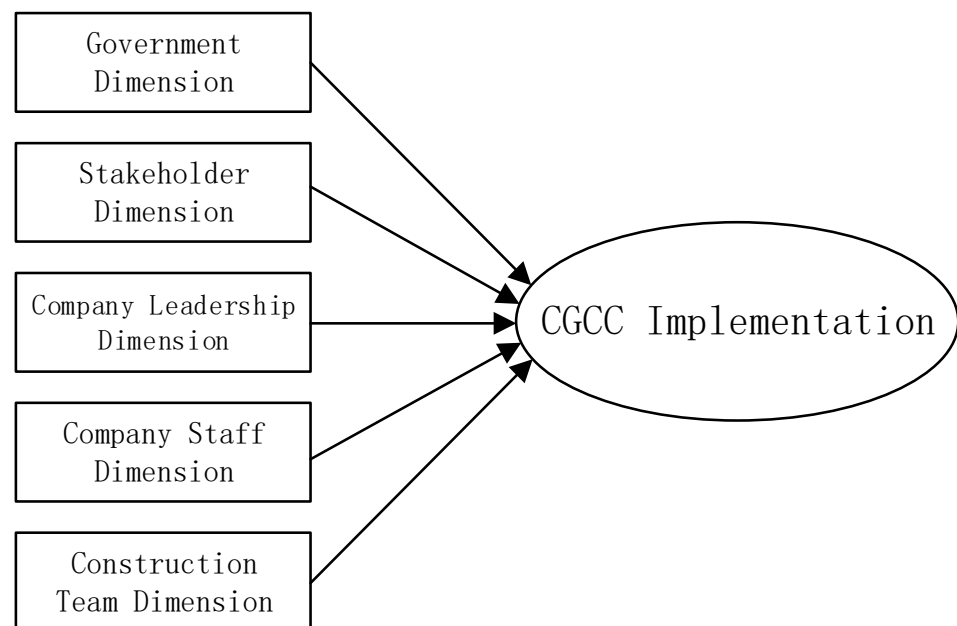


Figure 10. Drivers of CGCC implementation.

The government is the primary advocate for green construction [70], and it also plays an essential role in promoting CGCC. The more thorough the government's guarantee structure in green construction, the more obvious the positive incentive effect of CGCC [71]. The government's effect on the CGCC may be seen in three ways: regulation, subsidies, and positive publicity [72].

Government regulation is a powerful tool to promote CGCC implementation. Current government regulations for CGCC implementation lack consideration of social and economic aspects, and some key policies and regulations are not fully implemented [72]. The reason for this dilemma may be that the current guidelines for green construction are not particularly clear and there is a lack of regulatory guidance for green construction [50].

Government subsidy is an effective tool to promote the implementation of CGCC [73]. At the moment, common types of subsidies include lump-sum government subsidies (LGS), and unit government subsidies (UGS). UGS not only reduce the investment of green buildings but also provide a better incentive for contractors to implement CGCC, whereas LGS allows developers to increase their cost affordability from contractors [74]. Different types of government subsidies have different stimulating effects, with direct subsidies being more effective than tax breaks, combination types of subsidies being more effective than a single-type subsidy [75], and dynamic subsidies being more effective than static subsidies [76]. In addition to positive government subsidies, penalties as a negative incentive also have a stimulating effect on CGCC implementation [76].

Although in the mature stage of green construction, the use of CGCC by contractors is motivated by a variety of benefits and does not necessitate extensive government publicity. However, it should be noted that a significant portion of contractors are still unaware of the benefits of green construction [77] and that more government efforts are needed to promote green construction and CGCC implementation [78]. Government positive publicity for green construction can be beneficial in promoting the implementation of CGCC [79].

(2) Stakeholder dimension

The implementation of CGCC is accompanied by the green construction implementation process. Due to the extensive number of stakeholders involved in green construction, it is not viable to achieve green construction just by relying on contractors alone. Furthermore, considering green construction is more technically demanding than traditional construction [80], the green construction process necessitates greater collaboration among partners [81]. As a result, the interconnection of stakeholders influences CGCC implementation [50]. The more closely and deeply involved the stakeholders are with each other [80], the easier it is to implement CGCC.

The general public is the ultimate demander of green construction. The greater general public awareness of green construction, the higher their recognition of green construction, which results in the general public's willingness to pay a higher premium for green construction, and the easier the implementation of CGCC [67].

The same holds true for developers, who are another type of demander. The greater the developers' awareness of green construction, the greater their acceptance of it [67,82]. In addition, the more detailed the developer's green construction project requirements are in the bidding phase, the more incentive the contractor has to implement CGCC [50,83].

Co-operation between contractors, suppliers, and designers in the green construction process can benefit CGCC implementation [64]. The more effective the contractor's contact with other participants [80], the more fully the collaborative innovation of the green construction process may be released [62], and the smoother the CGCC implementation.

The social context also influences the implementation of CGCC. Corporate social responsibility (CSR) and coercive pressure can both facilitate contractors implementing CGCC, while coercive pressure is also a positive mediator and a facilitator between CSR and CGCC [84].

(3) Company leadership dimension

The attitude of the company leadership plays a key role in the implementation of CGCC, and the firm's implementation of green construction by the company leadership can significantly contribute to the enhancement of CGCC [73,85]. The more specific the company leadership's green construction goals, the more obvious the role of the company leadership's attitude [85]. In addition to the positive contribution of company leadership attitudes to the implementation of CGCC, there is an equally positive effect of the company leadership's capabilities [86].

Since green construction requires more communication with other stakeholders, the emotional intelligence and communication skills of the company leadership can contribute to the implementation of CGCC [85]. Furthermore, the green construction process requires more comprehensive consideration than traditional construction process; thus, the organizational and management skills of company leadership can also contribute to the CGCC implement [81].

The company leadership's perceived usefulness and perceived ease of use for green construction promotes the CGCC implement [71]. Transformational company leadership is more receptive to green construction and promotes the CGCC [87].

(4) Company staff dimension

In addition to the company leadership, the company staff have an equally significant impact on the implementation of CGCC [88].

Green construction capabilities can be achieved and enhanced through the combined efforts of the staff within a company [81]. Technical experts and experienced workers in green construction will undoubtedly give a strong technical support and have a positive contribution to the CGCC implementation [73]. It should be highlighted, however, that there is a dearth of green construction experts and staff, and there is an urgent need to train appropriate experts and staff to enhance CGCC [89].

In addition, green construction capabilities can also be promoted and enhanced by creating a corporate culture of green construction [52], developing organizational rules and regulations related to green construction [90], increasing research and development investment in green construction technologies [91], and improving the overall innovation capability of the company staff [71].

(5) Construction team dimension

The project practice has the most direct impact on the implementation of CGCC because it directly affects green construction projects' cost control, return on investment (ROI), and other aspects [73]. The influence of the construction team is undoubtedly the most decisive during the project practice process [92], especially the role played by the project management office in it [93].

Through explicit target management [94], strengthened construction team partnerships [94], and continual green construction skill training [95], construction teams can strengthen the complete release of CGCC.

Furthermore, the construction team's awareness on green construction [92], social perception [71], and green construction technology mastery level [50] also have positive contribution to CGCC.

5.2. Research Cluster 2: What Is the Performance of CGCC?

CGCC not only reduces construction material and energy consumption, waste generation during construction [96], environmental pollution, and environmental load, but it also improves construction efficiency, employee and customer satisfaction [97], health and safety performance during construction, and project and corporate social image and competitiveness [15]. Furthermore, CGCC can lower construction costs [98], increase project and supply chain profitability, and benefit from economic incentives such as government subsidies [99]. As a result, CGCC can realize environmental, social, and economic benefits.

5.2.1. Environmental Benefits

Environmental benefits are the most significant benefits enhanced by CGCC implementation compared to social benefits and economic benefits [63], which may be related to the longer duration of application of environmental management systems in green construction [70]. The two most obvious aspects of the environmental benefits of CGCC are energy management and waste management [100].

CGCC optimizes the occupancy of materials, equipment, and labour to varied degrees, reducing unnecessary energy waste and achieving environmental savings, and is environmentally friendly [101]. Furthermore, due to green construction necessitating a higher level of supplier integration on the part of the contractor, it can also improve energy management performance [102]. The preceding two points also lead to a direct favourable relationship between CGCC and energy management [103]. It is also worth noting that energy management is the most influential aspect in the CGCC economic benefits improvement [104].

CGCC can improve project waste management performance by reducing burdens in areas such as energy and construction materials [100]. Although the leadership of the project manager has no significant impact on economic benefits and social benefits, it has a significant impact on waste management benefits [86]. However, it is important to be alert that contractors often bring a negative impact on waste management benefits when considering the supply chain balance of green suppliers and traditional suppliers [58].

5.2.2. Social Benefits

CGCC can enhance construction workers' safety and health benefits since the working environment in traditional construction is harsher and is much better in green construction. In addition, CGCC is consistent with societal values for low carbon and the environmental friendliness; therefore, it can improve the brand reputation and social influence of the company and the project. Thus, the key social benefits components for CGCC are employee safety and health performance and brand image.

According to Onubi, Yusof [100], CGCC has a positive influence on the safety and health benefits of project, which in turn improve customer satisfaction. Hence, safety and health benefits act as a mediator and moderator between the CGCC and customer satisfaction [105]. Different client types also have an impact on the improvement of safety and health benefits due to CGCC, in project with weak CGCC, public clients perform better in terms of safety and health benefits than private clients, but private clients have a stronger impact on improving safety and health benefits than public clients [106]. However, it should be emphasized that contractors often disregard the attainment of safety and health benefits in pursuit of desired profits; therefore, the government needs to ensure the sufficient economic returns of contractors in order to guarantee the safety and health benefits at a high level [107].

The CGCC can also improve contractors' market competitiveness and brand image [93,108], with the larger contractor benefiting from the increased market competitiveness [70].

5.2.3. Economic Benefits

CGCC can undoubtedly bring economic benefits to projects and contractors [109], but the mechanism by which CGCC works is currently unclear [110]. There is a consensus that such economic benefits are mainly brought about by economic incentives such as government subsidies and tax breaks in the early stages of CGCC, and by advancing green construction techniques, lowering construction materials, and conserving energy during the mature stages of CGCC [107]. In order to better release the economic benefits by CGCC during the green construction process, contractors need to have adequate and effective communication with other suppliers [102]. It is important to note that there is a potential motivation for contractors to sacrifice overall supply chain profits in order to balance the profits of different suppliers (traditional and green suppliers) [58].

5.3. Research Cluster 3: What Is the Profound Impact of CGCC?

The profound impact of CGCC is mainly manifested in three levels: optimization of the construction industry chain, green development of society, and national economic development.

CGCC enhances the communication and management capabilities between contractors and the supply chain's upstream and downstream, reshaping the role and position of contractors played in the construction industry chain [59], while also promoting the overall tightness of the construction industry chain [111,112]. Therefore, CGCC can optimize the construction industry chain.

Many sectors are involved in the construction industry's upstream and downstream industry chains [113]. As a result, the CGCC can effectively promote not only the green and sustainable process of the construction industry [63,114], but also the green transformation of the upstream and downstream industrial chains, thereby encouraging the entire green and sustainable transformation of society [113].

The growth of national GDP and the construction of green infrastructure had a strong positive link (correlation coefficient of 0.9987) [115], and the construction of green infrastructure is also largely dependent on CGCC. Therefore, it is reasonable to infer that CGCC not only promotes the competitiveness of the entire construction industry, but also contributes to the growth of the national GDP.

5.4. Research Cluster 4: How Does CGCC Promote Green Building?

Green buildings differ from traditional buildings in design, materials, and construction, and there are more barriers to the green building construction process [116], which need to be guaranteed by CGCC. The stronger the CGCC, the less impact these barriers will have [117]. As a result, CGCC is a necessary prerequisite for achieving green buildings [118] and also a way of realizing them [119].

CGCC organically integrates green construction materials and green construction techniques [120], and ultimately forms green buildings through the material conversion process [121]. Therefore, as the final physical result of the green construction process, the green building is the final material embodiment of CGCC [116]. In addition, CGCC is also the beginning of the whole life cycle of the green building and the guarantee of its good operation [118].

5.5. Research Cluster 5: What Is the Relationship between CGCC and Sustainability?

There is widespread awareness of the need to adequately address the harmful effects of the construction process on construction workers, resources, environment, and society; the implementation of CGCC can help mitigate such harmful effects to achieve social sustainability [122]. In addition, CGCC implementation is more than just the use of green technologies and materials; it is more like a fundamental sustainability change in the culture, society, and organization of the construction industry [123], as it provides significant sustainability improvements in cost savings, waste minimization, environmental friendliness, safety and health performance improvements, and customer satisfaction [124,125].

The stronger the CGCC, the more competitive the contractor will be in the market. Therefore, CGCC also brings sustainability to the contractor's operations [48].

6. Summary of Review Findings

CGCC is the capability of the contractor to successfully carry out green construction activities. It is the key to ensuring that green construction activities are carried out smoothly, maximizing resource conservation and minimizing environmental burden. The systematic analysis performed in CGCC was essential in creating a holistic view of the previous studies. Despite over two decades of policy incentives and industry-wide guidelines designed for enhancing CGCC and promoting green construction, CGCC still faces the problems such as low overall level, hindered implementation, unclear composition factors, and lack of evaluation system. Therefore, seeking answers to the questions related to CGCC application

promotion, overall level improvement, competency dimension composition, and evaluation system construction remains relevant to present and future researchers.

Table 5 presents a summary of the findings. More than 20% of the articles on CGCC collected by this study appeared in the Journal of Cleaner Production and Sustainability, which each contributed eight articles. This was followed by the International Journal of Construction Management (four articles), Journal of Construction Engineering and Management (three articles), Sustainable Cities and Society (three articles), and Environmental Science and Pollution Research (three articles). No other journals contributed more than two articles. Despite the fact that CGCC is a complex issue involving multiple actors operating at different levels, the research on this topic lacks a multi-disciplinary approach. More collaborative policy, sociology, management, and economic research is needed to improve CGCC sustainably. More special issues in journals in relevant domains are expected to attract more research to improve CGCC and promote green construction.

Table 5. Summary of key findings.

Prominent Journal Outlets	Co-occurrence of Keywords Analysis
Journal of Cleaner Production	sustainability
Sustainability	management
International Journal of Construction Management	performance
Journal of Construction Engineering and Management	barriers
Sustainable Cities and Society	sustainable construction
Environmental Science and Pollution Research	impact
Co-authorship analysis	construction
Shen Liyin	innovation
A. Genaidy	construction industry
J. Solomon	critical success factors
Prominent organizations	Research clusters
Hong Kong Polytech University	implementation of CGCC
University Sains Malaysia	performance of CGCC
Top countries/regions	profound impact of CGCC
Mainland China	CGCC and green building
Malaysia	CGCC and sustainability
United States	

The co-authorship analysis revealed that researchers, institutions, and countries working in the CGCC domain rarely collaborate. Existing research on CGCC is primarily from China, the United States, Malaysia, and Australia. Although the research literature on CGCC is widely distributed in other countries around the world, there is less research on CGCC in African developing countries. More government and corporate financing, as well as international research collaborations, are needed to address the worryingly low levels of research conducted in most African developing countries.

The keywords “research clusters” (Table 5) revealed more emphasis on research on the implementation, performance, profound impact, and the relationship to green building and sustainability. However, compared with research on CGCC implementation, studies of the structure of CGCC are scarce. Moreover, a scientifically sound evaluation system of CGCC is still to be established. Similarly, the enhancement mechanism of CGCC is still unclear. Future research could provide useful insights in these areas.

7. Theoretical and Practical Contributions

Based on this comprehensive multi-dimensional framework, we critically analysed the CGCC. The six contributions are as follow:

First, this is the first systematic review of the CGCC that we know. We mapped the various research subfields in CGCC research and sorted and highlighted their main research content, focus, and findings.

Second, our theoretical framework encompasses the implementation, performance, profound impact, and the relationship to green building and sustainability. These compo-

nents will help future scholars understand CGCC's underlying mechanisms and conditions, as well as help clarify its impact and function (e.g., enhance the understanding of CGCC formation).

Third, our research indicates that CGCC is a burgeoning area of construction research. Henceforth, this systematic literature review helps us learn more about the different opportunities in which theories about CGCC can be developed. In addition, the application of the systematic literature review method steers the direction of future scholars towards solid evidence bases [126]. Thus, by expanding the scope of our literature review search beyond the green construction literature, we hope that this research will be beneficial to research in the future.

Fourthly, the findings of this review shed light on new research areas that have been understudied to date, as well as on existing gaps and flaws in the existing body of literature. On the basis of the gaps and inconsistencies between theory and practice, future research can significantly contribute to the development of CGCC research. Such a critical analysis of the findings provides, at the very least, a more holistic understanding of the CGCC and further theoretical and practical development.

Fifth, by synthesising and mapping the CGCC literature, our review offers invaluable insights and guidance to practitioners. In particular, our review sheds light on the many positive and negative moderators, conditional, and contextual variables that support and affect CGCC, as well as the many direct and indirect relationships between CGCC and its causes and consequences. Our analysis also helps top-level managers recognise the factors that contribute to or spur the expansion of CGCC.

Sixth, our study offers a comprehensive framework for construction corporations to capture and improve the benefits of green construction capabilities.

8. Limitations and Further Research Directions

8.1. Limitations

Just like any other systematic review, some limitations should be noted in this research. First, due to the diversity of the literature and the multi-disciplinary nature of CGCC, this research also needs to stay at a more general level, thus favouring breadth over depth in the analysis of the results. Second, in order to focus more on the analysis and integration of related studies, we do not provide research propositions that link these elements. Third, while we strongly believe that the publications identified in this research represent the currently available literature on the subject and that it may be unnecessary and impractical to include every published work at the same time, it should be noted that the keyword formula and the specific databases we used in this research may have led to the omission of potentially relevant literature.

8.2. Further Research Directions

When we analysed the existing literature, we found that the research so far has focused more on the influencing factors and influenced factors of CGCC rather than on the enhancement of CGCC. Therefore, we suggest that future researchers should not only focus on the influencing factors of CGCC, but also on the enhancement mechanism and evaluation of CGCC in order to provide more and more useful suggestions for contractors to enhance their own green construction capabilities and popularize green construction.

First, the structure of CGCC has not been mentioned much in the existing studies. Future scholars can conduct an in-depth study on the structure of CGCC, and explore and focus on the interconnection between different elements that constitute CGCC, in order to help academia and industry understand CGCC more comprehensively and enrich the conceptual content of CGCC. At the same time, it is also beneficial to further research the formation and enhancement mechanism of CGCC, which are also quite scarce at present. It is worthwhile for other scholars to conduct further research on the formation and enhancement mechanism of CGCC and what effective measures companies can take to enhance CGCC. Clarifying the internal enhancement path of CGCC can provide fundamental solu-

tions and a theoretical basis for the enhancement of CGCC, improve the overall level of CGCC, and promote the better realization of green construction.

Second, the review found that research on CGCC evaluation is limited. Therefore, we urge researchers to study how to quantify and measure CGCC. A comprehensive evaluation of CGCC is beneficial for developers and owners in selecting suitable contractors for green construction, and also provides guidance for contractors in improving their own green construction capabilities. The enrichment of CGCC evaluation is also beneficial for contractors to better transform CGCC into market competitiveness.

Lastly, despite the fact that a variety of studies have focused on CGCC implementation, the findings should go beyond general prescriptions such as improved resource support, improved human resource strategies, and enhanced professional training to focus on more segment-specific CGCC challenges. Future research efforts should also be directed toward the implementation of CGCC in different segments of the construction industry, which can better address the implementation of CGCC and promote the use of CGCC. Future research on the successful implementation of CGCC in different segments can also provide insights into the critical success factors of CGCC implementation. Research based on key stakeholder perspectives can provide a more comprehensive view of the research to overcome barriers related to CGCC implementation. Future research on CGCC applications must also provide a detailed analysis of CGCC implementation from the developer and owner perspectives to determine the root causes of CGCC implementation blockages and to design practical solutions at the project and organizational levels.

9. Conclusions

In recent decades, CGCC has been the subject of extensive research, which has enriched our understanding of the factors that influence and were influenced by CGCC.

Yet, several gaps still exist in the CGCC field. In this research, a classification of CGCC literature was performed by a systematic overview, highlighting the body of knowledge showing extant research findings. The resulting themes that reflect the up-to-date CGCC practices and trend are: (1) the implementation of CGCC; (2) the performance of CGCC; (3) the profound impact of CGCC; (4) the relationship between CGCC and green construction; and (5) the relationship between CGCC and sustainability.

Several avenues for future study have been suggested, all of which will serve to develop and broaden the field of CGCC as a whole. Finally, we trust that this study will inspire other academics to conduct research that will further advance our understanding in CGCC. We do hope that more people will be encouraged to appreciate the additional information that lies in the dusty volumes of existing CGCC research.

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