ASEAN Engineering Journal

Full Paper

A BIBLIOMETRIC REVIEW OF THE CRITICAL SUCCESS FACTORS (CSFS) FOR PUBLIC PRIVATE PARTNERSHIP IN DEVELOPING GREEN BUILDING PROJECTS

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Article history
Received
26 February 2025
Received in revised form
06 August 2025
Accepted
02 September 2025
Published online
31 May 2026

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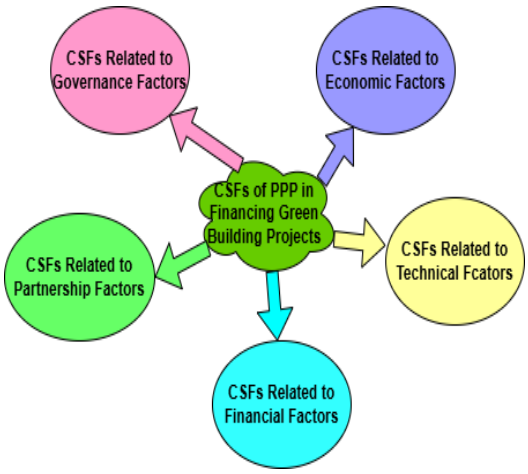
Graphical abstract



Abstract

The development and adoption of green building (GB) projects not only have environmental and social benefits, but also long-term financial benefits. However, one of the major obstacles of GB development is the lack to long-term financial support, and to meet this challenge of GB project development public-private partnerships (PPPs) could be the potential solution. Though, many studies have been published for identifying the success factors or crucial factors of PPP project in various aspects of construction industry, the systematic investigation of Critical success factors (CSFs) of PPP for developing GB projects remains unexplored. Therefore, this study aims to conduct a bibliometric systematic literature review on the CSFs of PPP projects and their significance in the success of GB project development. This study collected 14 articles from 2002 through October 2024, based on keyword search in SCOPUS. The co-occurrence analysis of the keywords of selected articles indicated that the critical success factors of PPP from these articles could be extensively helpful for the development of green building projects. The findings revealed 41 success factors that affect the effectiveness of PPPs in green building development, with the predominant categories being: Governance Factors, Economic Factors, Technical Factors, Financial Factors and Concession (Partnership) Factors. The analysis of CSFs in successful PPP projects can offer practical guidelines for researchers and professionals, helping them to design and implement effective PPP models that could enhance the successful implementation of PPP for green building development. The findings can also inform policymakers in creating supportive regulatory frameworks that encourage green building practices in the construction and real estate sectors.

***Keywords*:** Public-private partnership (PPP), Critical success factors (CSFs), green building (GB), construction industry.

1.0 INTRODUCTION

The detrimental impacts of the building industry have been one of the most widely discussed subjects, both locally, nationally, and globally. According to Davda [1], 50% of landfill waste, 23% of air pollution, and 40% of water pollution are attributed to pollution caused by the construction industry worldwide. Since the life-cycle of a building requires maintenance, operation, production, as well as the transformation of raw materials and demolition, the building industry is inherently environmentally detrimental. [2]. Moreover, the building industry is the largest consumer of energy, consuming 41% of energy, and produces 39% of all energy-related CO2 emissions worldwide [3, 4]. Moreover, the emissions intensity and energy intensity related to conventional buildings were, respectively, 48 $kgCO_2/m^2$ and 606 MJ/m^2 in 2020 [5]. Therefore, there is global pressure to make the building industry environmentally sustainable, and the adoption of green building (GB) is being recommended globally to replace the conventional building [6]. The green buildings are usually characterized by improved water and energy efficiency, higher environmental performance, lower environmental pollution, better waste management, and improved air and indoor quality environment [7]. Other than the ecological

advantages, green buildings are more comfortable and healthier to live and work in. Moreover, recent findings have shown the economic benefits of green buildings, since the lifecycle of green buildings requires lower maintenance and equipment cost, less energy and water consumption, as well as reduced material and natural resource consumption [8, 9, 10].

Green building is deemed a vital method to mitigate the negative impact of construction activities. According to the Evaluation Standard of Green Building, green buildings are buildings that provide environmental benignity, energy savings, pollution reduction, healthy residential environments, and comfortable utilization experiences throughout the entire lifecycle of the asset [11]. The application of green building not only provides ecological benefits, but also economic values, because it can reduce operational and building maintenance costs [2]. Therefore, due to the global environmental concern of the building industry, the promising social, economic and ecological advantages of green building adoption, over the last decade or so, many countries have adopted and implemented various policies such as regulatory frameworks, financial incentives and tax concessions to promote and develop the broad adoption of green building projects [12, 13]. However, the development and completion of green building projects requires new technologies, green materials, extensive computational analysis and simulation, and intricate architectural design. Therefore, delivering the green building projects is more cost-intensive and often requires many hands-on specialists and expertise [2, 13, 14, 15]. Moreover, studies also reported that the productivity, cost, and project delivery time of green buildings are worse than those of traditional building projects [16, 17]. According to Khoza & Rabie [18], Public-private partnership (PPP) frameworks have the potential to facilitate the development and delivery of green building projects. These frameworks can include full participation from the private sector in the design and development of green buildings, as well as a variety of alternative procurement strategies.

Public-private partnerships (PPPs) are financed and managed by government and private companies [19]. This financial instrument is often used to finance large building and housing projects [20]. PPP aims to boost development projects and secure funding through collaborations with the business sector, which can strengthen climate resilience and sustainable economic growth [21]. Governments must use green strategies to support public projects through PPP partnerships, resulting in widespread green building adoption [22]. By encouraging public-private collaboration, the PPP reduces business risks and, therefore, the development of green building projects can be boosted [12]. Effective PPP contract execution internationally, particularly in the United States and the United Kingdom, has set a paradigm for developing nations to secure government projects [23]. However, PPP-associated construction projects face issues like long repayment periods, high loan interest rates, long delivery times, and a lack of transferability and stakeholder confidence [24-26]. PPP initiatives might suffer from inadequate risk allocation if not thoroughly reviewed at the idea and feasibility stages [27, 28]. Therefore, investigating the key factors responsible for PPP implementation in green building project development is a significant research topic. Very few studies have attempted to analyze the success factors of PPP implementation in green building and sustainable building project development [16, 29, 30]. This implicit research gap requires deep attention and empirical investigation to systematically identify the success factors of PPP implementation in green building project development.

According to Rockart [31], Critical success factors (CSFs) are defined as several key areas of activity in which favorable results are essential for a manager to attain his objectives. According to Liu [32], because of the diverse evolution of PPP projects, a significant number of academics have applied the concept of CSFs to improve comprehension and maximize the sustainable implementation of PPP policies. Previous studies have demonstrated that the formation of PPP is dependent on several factors. These factors include political commitment [33], fiscal conditions [34], institutional support, PPP policies, legal and regulatory frameworks [35], and economic investment in conjunction with the governmental backing for PPP initiatives [36]. Recent studies have identified many obstacles that stand in the way of the implementation of Public-Private Partnerships in developing economies. These obstacles include insufficient financial resources from the government, inefficiencies within the public sector, significant uncertainties in the contractual environment, deficiencies in the capacities of both public and private partners, insufficient political will, and administrative obstacles [37-40]. To address potential uncertainties during the development of the project, it is essential to have effective risk management in public-private-partnership-financed green building projects. Additionally, it is necessary to acknowledge the varied risk preferences and priorities of stakeholders [41, 42, 43]. These factors have attracted significant interest from academics over the past few decades and are associated with positive organizational outcomes, which facilitate both the sustainability and effectiveness of institutions. Therefore, there is an emerging need to employ a bibliometric content analysis method to highlight the success factors of public-private partnerships for green building development projects.

Conducting a bibliometric review to map out existing research on Critical Success Factors (CSFs) in Public-Private Partnership (PPP) for green building project development is crucial for identifying research trends, highlighting research gaps, and understanding the intellectual structure of the field. By systematically analyzing patterns in academic publications, a bibliometric review can reveal the most frequently studied topics, methodologies, and key contributors, thereby providing a comprehensive overview of the field's evolution [44]. This review can also pinpoint under-researched areas and emerging themes, guiding future research to address the gap of CSFs of PPP in green building development [45]. Furthermore, insights from this bibliometric review can inform policymakers and practitioners about the most effective CSFs, aiding in the successful implementation of PPP for green building projects [46]. Therefore, the main objective of the paper is to provide a comprehensive bibliometric analysis of studies published between 2002 and October 2024 to identify the CSFs for PPP projects in green building development. This analysis aims to map out existing research, identify the key success factors, guide future studies, and enhance the successful implementation of green building projects.

2.0 OVERVIEW

2.1 Overview of Green Building

Numerous definitions of green building exist. Kibert [47] defined green building as "healthy facilities designed and constructed in a resource-efficient manner, employing environmentally-friendly principles." The phrase green building is often used interchangeably with sustainable building and high-performance building. Bradley [48] identified four fundamental principles of green buildings: minimizing environmental impacts, improving occupant health, ensuring return on investment for developers and the local community, and considering the life cycle during planning and development. Typical components of these definitions include a life cycle view, environmental sustainability, health concerns, and community impacts [49]. To make green building project development more accessible, a variety of assessment methods have been developed. The most prominent green building assessment tools include the following: Leadership in Energy and Environmental Design (LEED, United States), the Building Research Establishment Environmental Assessment Method (BREEAM, United Kingdom), the Green Building Council of Australia Green Star (GBCA, Australia), the Green Mark Scheme (Singapore), the German Green Building Network (DGNB), the Comprehensive Assessment System for Built Environment Efficiency (CASBEE, Japan), the Pearl Rating System for Estidama (Abu Dhabi Urban Planning Council), the Hong Kong Building Environmental Assessment Method (HK BEAM), and the Green Building Index (Malaysia) [50, 51].

Mostadam was established by the Saudi Ministry of Housing as part of the “Sustainable Building” initiative, serving as a comprehensive sustainability rating and certification system aimed at ensuring the long-term sustainability of residential structures in the Kingdom of Saudi Arabia (KSA) [52]. Mostadam tackles many sustainability challenges pertinent to the Kingdom of Saudi Arabia and aligns with the objectives of Vision 2030. Similar to LEED and other grading systems, Mostadam may certify several building types, including commercial, residential, and existing structures [53]. Mostadam adheres to the Saudi Building Code (SBC), specifically the Saudi Green Building Code (SgBC), and has been designed to exceed the minimal SBC standards to provide a superior level of sustainability for residential structures [54]. The Saudi Building Code (SBC) comprises legal, administrative, and technical laws that delineate the minimum criteria for building design and construction in the Kingdom of Saudi Arabia (KSA) [54].

The benefits of green buildings have demonstrated efficacy in decreasing energy usage and facilitating innovative advancements in renewable energy and resource conservation. The British Columbia Forest Facts (2011) classifies these benefits as "tangible and intangible." Green building efficiency can decrease water and energy use by 20%–40% and 20%–30%, respectively [55]. The productivity of building occupants can be augmented while simultaneously improving their health, safety, and comfort. Comparing green building techniques to traditional building methods, energy savings can result in cost savings of up to 30% to 55% [56]. According to Ifeanyichukwu et al. [17] and Assylbekov et al. [57], it is also possible to minimize operating costs, utility and trash accumulation, and maintenance costs. According to Taherian et al. [58], the typical initial cost needed to design and build a green construction is outweighed by the economic advantages of green building. According to a US study of 99 green buildings, energy use is 30% lower than in non-green buildings [59]. Similarly, Oluwadare (2018) discovered that green buildings can balance higher human expenses.

According to Assylbekov et al. [57], the social benefits of green building design are centered on the enhancement of people's quality of life, health, and overall physical and mental well-being. According to Abdulsalam et al. [61], certain environmentally friendly buildings that operate exceptionally well have a positive impact on society. According to an assessment of some of the current research on the social advantages of green building, building traits that residents prize include high marketability, appealing design, and good environmental features [62]. Benefits to physical well-being, such as improved air quality and natural illumination in general, as well as increased productivity, are examples of social benefits that green buildings offer to a greater degree than conventional building approaches [60, 61].

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Apart from that, the benefits of green building practices are reflected in eco-friendly accommodations that contribute to an increase in the biodiversity of the surrounding environment. According to Ahmed & El-Sayegh [7], green buildings are beneficial to the environment since they reduce carbon emissions and conserve water. As stated by Kwame & Julian [63], the environmental benefits of green architecture include the improvement of the quality of air and water, the reduction of waste, the preservation of natural resources, and the preservation of biodiversity. In a similar attempt, Abdulsalam et

al [61] highlighted that green buildings can minimize pollution, lower utility expenses, and protect natural resources.

2.2 Public-Private Partnership (PPP) in Green Building (GB)

Projects can be executed using a variety of contractual agreements between public and private enterprises to supply services or assets through a PPP, which is a specific procurement method. For example, "public-private partnerships are arrangements whereby private parties participate in, or provide support for, the provision of development, maintenance and management of projects, and a PPP project results in a contract for a private entity to deliver public services," Grimsey & Lewis [64]. To finance large-scale construction projects like highways, bridges, and tunnels—projects that would put a heavy burden on the budgets of most governments, especially those in developing nations—the PPP model is reportedly becoming more popular [65]. The primary goal of public-private partnerships, as stated by Alfen & Barckhahn [66], is to have the private sector assist with the provision of public services. This shifts the traditional role of the public sector from owner and provider of services to buyer and custodian of public interests. They went on to say that this was motivated by the belief that the government should prioritize essential services and let the private sector handle the rest more efficiently and cost-effectively.

Despite the environmental, social, and economic benefits of green building projects, green building construction is one facet of social infrastructure that has received little funding [67]. Private companies are not interested in providing green building development on their own because the revenue from end users is not enough to make the project profitable [68]. As a result, the government must step in to subsidize the industry. According to Ismail [69], PPPs are used more sparingly and depending on the specifics of each case because the housing market is not a monopoly one and does not benefit financially from utilities and construction projects, which are often linked with volume concerns. Since the amount collected from end users is inadequate, green building construction projects necessitate government subsidies to make the project financially viable for investors [68, 70, 71]. On the other hand, private sector partnerships have been on the rise as a means for governments to fund essential sustainable development and green building initiatives. Participatory public-private partnerships have supplied public housing in numerous nations, including Canada, the United States, India, South Africa, and Malaysia [72-74]. Following policy changes in the UK to encourage the formation of a housing association sector and to decrease the role of local authorities in providing public housing, public finance initiatives (PFIs) were effectively used to produce green buildings [73]. The goals of PPPs in green building may differ since they have developed in various nations from diverse circumstances, as pointed out by Aziz & Kassim [75]. In addition, they mentioned that implementing PPPs in public housing aims to transfer risk, boost innovation, enhance the public sector's reputation, decrease regular costs, and improve Value for Money (VFM). However, there are many types of PPP. Since PPP-associated projects are diverse, the functional mechanism of PPP is also diverse. The following Table 1 lists the definition of some popular types of public-private partnerships.

Table 1 Different Types of PPP

Types of PPP	Description
Build, Operate and Transfer (BOT)	This type of public-private partnership involves the private sector financing, operating facilities, and transferring ownership to the public entity upon completion or contract termination, such as road construction.. [76]
Design, Finance, Build, Operate and Transfer (DFBOT)	In this type of public-private partnership, the private party designs, constructs, and operates the construction projects, with financing coming from markets or other financial sources. Ownership is usually transferred after the contract period, typically ten to thirty years. Gautrain Rapid Rail Link worked on a DFBOT-style project [21].
Build, Own and Operate (BOO)	Private parties construct, own, and operate facilities used by public entities, such as commercial offices and industrial and warehouse space. The public partner rents the facility on a long-term lease, with the option to purchase the property at the end of the lease [77].
Design, Finance, and Operate (DFO)	In this type of public-private partnership, the public institution that requires automobiles for its operations is an example of a public-private partnership in which the private party will furnish, finance, and manage the vehicles rather than making an outright purchase of them. The private partner is responsible for the design, funding, and management of the project. The private party is responsible for returning the automobiles after the contract period has come to an end [18]
Build, Transfer, and Operate (BTO)	This sort of public-private partnership does not involve the funding, construction, or maintenance of the asset; instead, it is characterized by the fact that the asset is passed to the public sector once the construction work has been completed. Another illustration of this would be the construction of a school on behalf of the public sector, which would then be transferred to the public sector upon completion [78].
Design, Build, Finance, and Operate (DBFO)	Project planning, funding, construction, and operation are all responsibilities that fall under the purview of the private partner. In accordance with the terms of the contract, the asset will be handed to the public sector after the specified period. Hospitals and public tourism buildings are two examples of structures (Rogerson 2016).

2.3 Critical Success Factors (CSFs)

Since the 1950s, success in project implementation and management has been studied from various perspectives to improve project delivery, efficiency, and management [91]. Several studies reported that there are many project and geographic demographic factors that can lead to the success or failure of the projects, and many of these factors are often beyond management control [92, 93, 94]. The concept of CSFs in project management was first introduced by Rockart [95] from the Sloan School of Management at the Massachusetts Institute of Technology. Since then, various definitions of CSFs have been proposed by many scholars. According to Rockart [95], Critical success factors (CSFs) are those activities and features whose

positive scores are responsible for the project manager to achieve project and organizational success. In general, CSFs are considered the crucial element of a project that are identified as the key factors for project success. Therefore, to ensure efficient project management and project implementation success, it is necessary to identify and implement the CSFs of a project for successful project delivery, outcomes, and execution [96]. Even though the earliest studies on the identification of critical success factors were published in the last decade of the 20th century [91], the investigation into the CSFs of PPP in the construction industry and sustainable building development started in the early 21st century.

Hsueh & Chang [97], Osei-Kyei & Chan [98], and Wang et al. [99] demonstrated that due to the wide variations and diverse nature of PPP projects, the CSFs associated with PPP-financed projects are highly contextual and dependent on project types and septicity, which contain various degrees of importance during project management and execution. CSF for the green construction program within the PPP framework, tailored explicitly for sustainable development and environmental accountability [100]. Shah et al. [101] indicate that the interrelationships in PPP projects imply the significance of collaboration between the public and private sectors in fostering conducive conditions and adhering to sustainability regulations among critical success factors. Research indicates that governmental variables and policies significantly influence private sector decision-making to ensure the incorporation of sustainability aspects in project planning and implementation [101]. Finally, the subsequent three case studies demonstrate key success factors (CSFs) that have been effectively implemented to enhance sustainability in green construction projects. The examples indicate that effective risk management and stakeholder engagement are critical success elements for improving sustainability in green construction projects.

a) Wen and Qiang [51] employed a Bayesian-Network Model to refine stakeholder concerns and improve decision-making efficiencies. The model identified significant stakeholder interests—green design and construction, consistent project finance, and accessibility to service facilities—that had a substantial impact on social sustainability. The problems were resolved, enabling the project to achieve improved sustainability outcomes.
b) Mok et al. [102] conducted a comprehensive stakeholder analysis framework that was utilized to identify the permeability and inconsistencies that influence stakeholder interactions. The framework was founded on empirical methodologies (e.g., interviews/surveys) and rationalistic approaches [102]. Through this comprehensive process, we effectively engaged stakeholders, established explicit sustainability objectives and adequate design flexibility, and accomplished successful projects.
c) Herath et al. [15] strategies for risk mitigation in green construction projects. Avoidance, transference, mitigation, escalation, and acceptance are core techniques in risk treatment, and the grounded theory case studies [15] provided a foundational analysis of the intrinsic characteristics of green construction projects. The findings demonstrated the significance of risk management in achieving sustainable objectives and enhancing project success.

Despite extensive literature addressing various worldwide sectors concerning public-private partnerships, there exists a significant study gap in the detailed examination of the viability and success of PPPs, particularly in relation to green building projects [103,104]. A study deficit is apparent in this domain, necessitating further in-depth studies specifically focused on the socio-economic regulatory framework impacts within the structure of PPP-related project development.

Public-private partnerships (PPPs) amalgamate public funding with private capital, facilitating the execution of substantial projects that would otherwise be unfeasible due to constrained financial resources. Moreover, it is crucial to recognize that public-private partnerships in green building project development face unique problems arising from specific demographic trends, swift urbanization, and the volatile dynamics of the economy [103]. The substantial expansion of population and growing demand for housing intensifies the urgency for green building projects' adaptation and development. Thus, identifying and comprehending the CSFs within the realm of PPPs for green building project development becomes an imperative endeavor [103, 105]. However, identifying CSF of PPP for green building project development by bibliometric analysis can significantly contribute to understanding research trends in the field of PPP for green building development. By systematically analyzing patterns in academic publications, such as citation networks, keyword co-occurrence, and co-authorship patterns, the analysis can provide insights into the evolution of research in PPP for green building development [106, 107]. For instance, bibliometric analysis can reveal which CSFs are most significant, which are least important, and their relevance to the specific geographic, social, and economic factors. Additionally, bibliometric analysis can uncover emerging themes by detecting new keywords and topics that are increasingly appearing in recent publications [107].

3.0 METHODOLOGY

3.1 Study Design

This study typically commences with the identification and quantification of particular words or content within a text to comprehend its contextual application. The study is divided into three stages. Stage 1 deals with the data collection and Scopus search, Stage 2 incorporates the data selection and extraction, and Stage 3 conducts the content analysis and comprehensive review. These stages are elaborately discussed in the following sections. The following Figure 1 illustrates the research framework of this study.

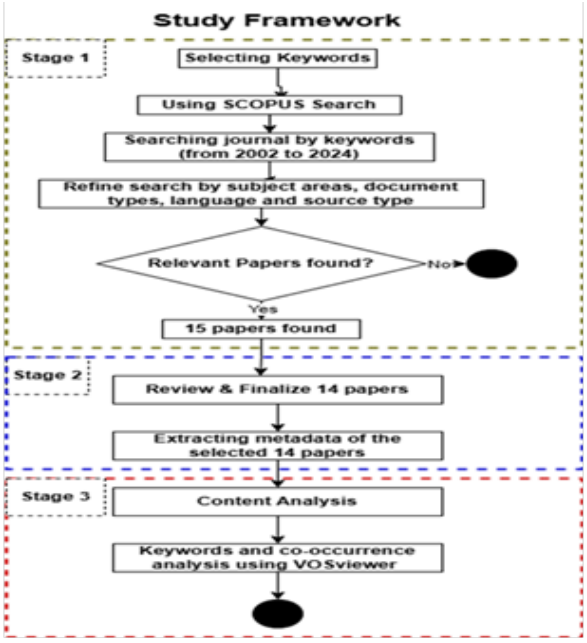

Figure 1 Study framework.

3.2 Data Collection

In Stage 1, academic journals that published papers from 2002 to October 2024 about the critical success factors for public-private partnerships in the building and construction sector were searched and identified. The Scopus search engine served as the principal research tool because to its extensive coverage of numerous articles across several fields, including business, engineering, management, and construction. Review studies generally employ keyword searches to locate journal articles pertinent to their research aims. Keywords are typically generated from the researchers' interests and objectives, as well as a literature review, and are established both before and during data analysis. The present study employed a comparable search methodology, using keywords to identify publications pertinent to PPPs in the housing sector. The search was initially performed in the Scopus database, focusing on the title, abstract, and keyword columns. The whole search script is followed:

TITLE-ABS-KEY (“critical success factors” OR “critical factors” OR “success factors”) AND TITLE-ABS-KEY (“public private partnership” OR “private finance initiative” OR “ppp” OR “pfi”) AND TITLE-ABS-KEY (“green building” OR “green housing” OR “sustainable building” OR “construction industry” OR “building industry”) AND DOCTYPE (ar OR re) AND SUBJAREA (engi OR deci OR manag OR econ OR soci) AND PUBYEAR < 2025 AND LANGUAGE (“english”) AND SRCTYPE (j).

The research focused exclusively on the critical success factors of partnerships in green building development, encompassing all relevant studies while excluding those unrelated to partnerships in this domain. The Scopus search generated a small number of papers for critical success factors of PPP in green building project development. This number is relatively small compared to the other bibliometric review studies, such as PPP or the critical success factors of the construction industry.

3.3 Data Selection

After collecting the articles by the initial search in Stage 1, the collected articles were reviewed with further caution in Stage 2 to ensure that the selected articles’ contents are relevant to the scope of this study. The Scopus search generated only 15 papers, one of which was within the scope of public health and was thereby excluded from consideration. The search results revealed the following journals: International Journal of Construction Management, Civil Engineering and Architecture, Advances in Civil Engineering, Engineering, Construction and Architectural Management, Jordan Journal of Civil Engineering, Journal of Construction in Developing Countries, Construction Management and Economics, Built and Environment, IOP Conf. Series: Materials Science and Engineering and Journal of Construction Engineering and Management. The following Table 2 shows the list of Journals and the number of articles selected for the study. The final table of selected publications is presented in Appendix A.

Table 2 List of Journals and the number of articles selected for the study.

Selected Journal	No. of Relevant Studies
Journal of Construction Engineering and Management	3
Construction Management and Economics	2
Journal of Construction in Developing Countries	1
International Journal of Construction Management	2
Jordan Journal of Civil Engineering	1
Engineering Construction and Architectural Management	1
Proceedings of Institution of Civil Engineers Management Procurement and Law	1
Advances in Civil Engineering	1
Journal of Healthcare Engineering	1
Jurnal Kejuruteraan	1

3.4 Analysis and Tools

In the final phase, Stage 3, the selected articles from Stage 2 underwent content analysis and a comprehensive review to extract various information from each article. These extracted data include number of publications (annually) on the CSFs of PPP associated projects, the study region or country of each article, study findings and the respective contributions. The subsequent sections of this article offer insights into the progress of developing CSFs for PPPs in green buildings across several nations, drawing on contributions from researchers and pertinent government entities in those regions. The analyzed 14 studies employed various research approaches to identify and prioritize the critical success factors for public-private partnerships in green building projects. The essential aspects of the success of any program or initiative can be examined numerically, qualitatively, or through a mixed-method approach combining both analyses. For the bibliometric analysis of the selected 14 studies, VOSviewer (Version 1.6.20) was used. For the analysis, the bibliometric .csv files were downloaded from

Scopus Search. This file includes data on the authors' names, authors' keywords, keywords, title, references, and other bibliographic data. This study used only keywords to conduct the bibliometric analysis. The co-occurrence of the keywords from each article were mapped in VOSviewer.

4.0 RESULTS

4.1 Annual Publications on CSFs for PPP Projects

The preliminary study findings found 14 papers on the critical success factors for public-private partnerships in green building among 14 periodicals and academic resources. The most significant focus from scholars and researchers in this field has occurred over the previous decade. This is unsurprising considering the challenge presented by the global scarcity of green buildings, prompting governments to develop strategies to deliver housing at accessible prices and in sufficient quantities to meet increasing demand.

Figure 3 illustrates the quantity of published papers that have examined the critical success factors for public-private partnerships in green building from 2002, the earliest identified publication, until the conclusion of October 2024. Over the past decade, ten papers have been published, reflecting an increasing interest in examining the critical success factors for public-private partnerships in green building. Research papers are a crucial mechanism by which academic studies enhance industrial practices and inform policy development. Several studies on critical success factors were linked to extensive research initiatives aimed at developing collaboration models for sustainable construction. This highlights the necessity of identifying and quantifying Critical Success Factors prior to initiating the design of a partnership model in a specific domain. The acquired research papers were meticulously examined to ascertain the countries of origin of the studies. Figure 4 illustrates the quantity of articles published on this topic by country. Figure 3 demonstrates that China has been the predominant subject of publications about critical success factors for public-private partnerships in green building within the selected journals and academic resources, with a total of three publications, followed by the UAE with two articles. The remaining countries (Australia, Kenya, Uganda, the United Kingdom, Malaysia, India, Ghana, Syria, and Vietnam) have only one publication each.

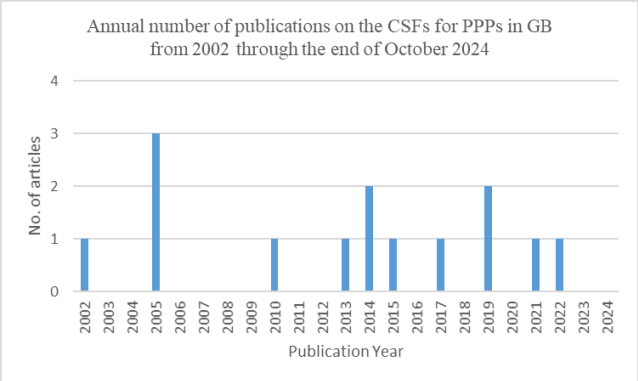

Figure 3 Annual number of publications on the CSFs for PPPs in GB from 2002 through the end of October 2024.

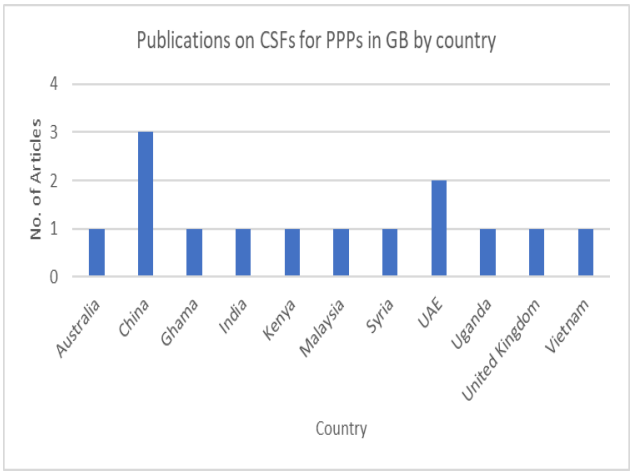

Figure 4: Publications on CSFs of PPP projects in GB by country

4.2 Keyword Co-Occurrence Analysis

Figure 2 illustrates the co-occurrence of the keywords of 14 articles. Four major clusters thematically distinguish the keywords. It was observed that Cluster 1 is composed of 7 keywords and "public-private partnership" occurs most in the Cluster 1. Cluster 2 is composed of 6 keywords: "critical success factors" is the highest occurring keyword while "green building" is the second highest occurring keyword, and this cluster also contains "public private partnership" and each keyword occurs single time in the Cluster 2. Cluster 3 is composed of 6 keywords, and "public private partnership" is the highest occurring keyword, while "success factors" is the second highest occurring keyword, occurring a single time in Cluster 3. Finally, Cluster 4 is composed of 3 keywords and "public private partnership" is the highest occurring keyword while "success factors" is the second highest occurring keyword, occurring single time in the Cluster 4. According to co-occurrence of the keywords, green building is strongly revealed through extensive connections to the keywords of this context. A practical overview of Cluster 2 also indicates that green building is a prominent construction project sector that could extensively be benefited from successful PPP projects. Therefore, identifying the critical success factors of PPP from these articles could be extensively helpful for the development of green building projects.

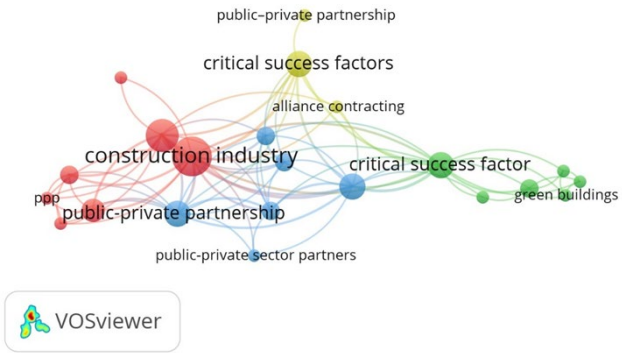

Figure 2 Network map of keyword co-occurrence analysis

4.3 Bibliographic Coupling

Bibliographic coupling serves as another quantitative examination that investigates the relationship between items—an item refers to a journal in this study—through the identification of a document that has been cited by two distinct documents from two distinct sources. In other words, any pair of documents associated with two different sources is linked to one another provided that they have both cited the same reference, and this correlation generates a link between the sources about that pair of documents. In this context, the strength of a link between two sources is determined by the frequency of pairs of documents that satisfy the explained condition. Thus, the TLS in this case is calculated by aggregating the strength values of the links associated with each source. The results are illustrated in Figure 4, encompassing three clusters. In this visualized network, the size of nodes represents the magnitude of citations received by individual sources, and the strength of the link between each pair of sources determines the thickness of lines. Taking the number of citations received by a journal into account, the most cited sources that are involved in the sample have played a significant role in the bibliographic network of Cluster 1.

Cluster 1 successfully forms the underlying conceptual groundwork for green public-private partnership (PPP) scholarship through the Journal of Construction Engineering and Management, which generated three seminal studies that together garnered 767 citations with a total link strength (TLS) of 133. These pieces work together to develop key managerial structures that focus on stakeholder alignment, risk distribution, and metric-based performance, and thereby create a high level of cross-referencing amongst researchers. Cluster 4 deepens this managerial literature by focusing additionally on economic feasibility: two articles in Construction Management and Economics (which together have garnered 709 citations and a TLS of 43) explore financing arrangements and cost benefit assessment, and the Journal of Construction in Developing Countries (with 36 citations and a TLS of 29) places these economic appraisals in the context of growing marketplaces. Bibliographic coupling between Clusters 1 and 4 indicates a win-win scenario: practical managerial guidelines are complemented with added effectiveness through strong economic rationale, and therefore reanimate the field's most highly cited contributions.

Together with the main themes, Clusters 2, 5, and 3 mark out focused and emergent areas of study. Cluster 2, centered on the International Journal of Construction Management (150 citations, TLS 53), examines procurement strategies and contract delivery systems; further, a paper in the Jordan Journal of Civil Engineering (13 citations, TLS 2) reviews the enablers of local regulatory systems. The aggregate considered in Cluster 5—spanning from Engineering Construction and Architectural Management (65 citations, TLS 18) to the Proceedings of the Institution of Civil Engineers Management Procurement and Law (2 citations, TLS 17)—analyzes architectural integration and legal design, with a focus on procedural detail too often neglected in wider assessments. Finally, the interdisciplinary research in Cluster 3—spanning Advances in Civil Engineering (11 citations, TLS 21), Journal of Healthcare Engineering (17 citations, TLS 4), and Jurnal Kejuruteraan (2 citations, TLS 10)—spotlights emerging integration of green construction activity with performance metrics applicable to a range of technologies or sectors. Together, the clusters not only define core dimensions of the field but also its widening borders, thus outlining potential inquiry that weaves together managerial precision and economic assessment, procurement finesse, and advanced interdisciplinary scholarship. Table 3 summarizes the impactful sources in each cluster, which are sorted according to their respective citation values.

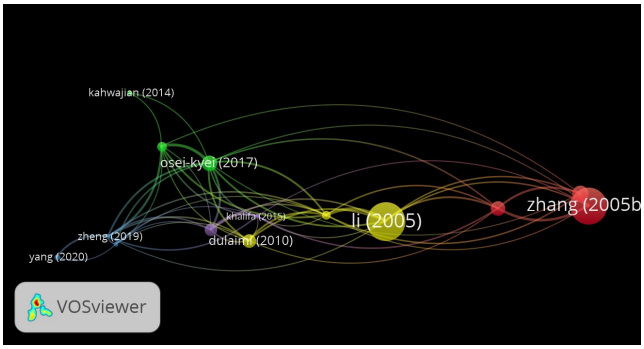

Figure 3 Network map of bibliographic coupling based on the sources (journals).

Table 3 Sources with the highest impact on each cluster, sorted by citation value.

Cluster	Selected Journal	No. Studies	Citations	TLS
Cluster 1	Journal of Construction Engineering and Management	3	767	133
Cluster 4	Construction Management and Economics	2	709	43
	Journal of Construction in Developing Countries	1	36	29
Cluster 2	International Journal of Construction Management	2	150	53
	Jordan Journal of Civil Engineering	1	13	2
Cluster 5	Engineering Construction and Architectural Management	1	65	18
	Proceedings of Institution of Civil Engineers Management Procurement and Law	1	2	17
Cluster 3	Advances in Civil Engineering	1	11	21
	Journal of Healthcare Engineering	1	17	4
	Jurnal Kejuruteraan	1	2	10

4.4 Co-citation Analysis

Co-citation analysis is a methodological strategy used to measure the frequency at which two scholarly articles are cited together, and hence reveal the implied networks that emerge within a specific research sector. By building a co-citation frequency matrix and computing total link strength (TLS) for all discovered clusters, it becomes possible to trace thematic centers and intellectual streams. In bibliometric analysis regarding the critical

success factors (CSFs) of public–private partnerships (PPPs) in green buildings, co-citation analysis not only isolates studies that act as building blocks but also explains the degree of interaction between subfields or their level of interdependence. The TLS values—26 for Cluster 1, 19 for Cluster 2, and 12 for Cluster 3—are used as indicators of academic connectivity, hence channeling attention into spheres of agreement and those in need of added synthesis.

From Figure 4, it is evident that Cluster 1, with 13 basic items and a maximum TLS of 26, marks the conceptual boundary of fundamental knowledge. Studies with high interconnectivity continually highlight the importance of governance models, stakeholder integration approaches, and systems integration for performance measurement. To illustrate, the high citation rates of shared-value contracting and risk allocation matrices indicate the combined scholarly efforts toward optimizing best practices in the field of project management. The implications of the findings imply a revolutionary paradigm shift in the research field, where discourses of research results have consolidated into recognized models—like balanced scorecards designed explicitly for environmentally sustainable public-private partnerships—and where continuous innovations continuously improve such elements as social impact assessments and environmental risk premiums. Clusters 2 and 3 represent complementary but less cohesively connected pathways. Cluster 2 includes 11 articles and exhibits a Total Link Strength (TLS) of 19, analyzing financial engineering with a range of contractual modalities including pay-for-performance agreements, blended financing approaches, and adaptive procurement practices. The moderate TLS suggests an enduring discussion; despite the formulation of core strategies, there remains enduring contention in calibrating the incentive mechanisms that balance public interests with private benefits. Cluster 3 is made up of 5 articles with a TLS of 12, representing interdisciplinary convergence by focusing on lifecycle carbon accounting, the choice of advanced semiconducting and optoelectronic materials, and in situ monitoring systems for sustaining infrastructure. The decreasing link strength suggests innovation in these strategies, as well as potential synergies with governance and financial structures. Overall, the co-citation profile marks a firm core of governance policies, an emerging financial-contractual framework, and an elaborating technical-analytical dimension, thereby guiding researchers toward integrative questions that permeate all three clusters.

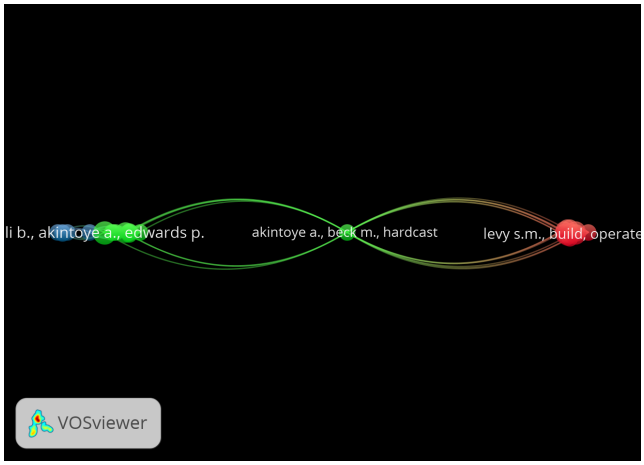

Figure 4 Network map of co-citation analysis.

4.5 Analysis of Contents

After an exhaustive analysis of the 14 papers included in this study, a thorough list of critical success factors was identified and presented (refer to Table 4). The prioritization and ordering of criteria were determined based on the frequency of occurrence of each component as outlined by various writers. The primary factor was the most prevalent in the analyzed studies, followed by the second most prevalent, and so on. Forty-one critical success variables were discovered from the fourteen publications; however, the results shown in Table 4 to Table 8, are restricted to factors recognized in a minimum of two publications. The various names or descriptions of the detected CSFs were combined to enhance classification. Tables 3 to 7 illustrate numerous elements that affect the effectiveness of Public-Private Partnerships in green development, with the predominant categories being:

- Governance Factors
- Economic Factors
- Technical Factors
- Financial Factors
- Concession (Partnership) Factors.

4.5.1 Governance Factors

There are significant factors that impact the governance of Public-Private Partnership (PPP) financed green building projects to ensure their effectiveness and sustainability. Political stability is a vital governance factor, because it paves the way for a stable, long-term environment that attracts investment that has faith in the stability and reliability of the Private sector investors [108]. A stable economic system allows for private investment, reliable income streams, and a favorable business environment [2]. Moreover, the local market needs must also be met to ensure a steady revenue stream from services and infrastructure supporting PPP projects, thereby sustaining the viability of the projects [2]. The successful governance of PPP requires an operative legal framework that clearly defines the rights and responsibilities as well as the interests of all stakeholders to ensure transparent and just transactions [109]. PPP projects face significant challenges to success as well, and it would be almost impossible without government support. Governments can impose policies, offering or providing incentives and resources that can be instrumental for significantly increasing the project's viability and execution [110]. This support reduces financial risks, includes tax incentives, and reorganizes regulation such that private investors can thoroughly benefit by participating in these arrangements [108]. Public interest and awareness are also important factors, which ensure the participation of the community [111]. Additionally, PPP involves partnership with the private sector, which enables the projects to access technologies, best practices, and innovative solutions that will ensure quicker gains in productivity as well as increase the quality of the projects [112]. The following Table 3 illustrates the CSFs of PPP related to Governance Factors for financing green building projects.

Table 4 CSFs of PPP related to Governance Factors for financing green building projects.

No		Success Factors	Sources
Governance Factor			
CSF1	GF1	Political Stability	[108, 113-119]
CSF2	GF2	Stable and promising economic system	[114, 115, [120-123]
CSF3	GF3	Adequate local market	[114, 115, 116]
CSF4	GF4	Viable legal framework	[108, 113, 117, 119, 120, 123, 124]
CSF5	GF5	Adequate government support	[108, 111, 120], 122, 124]
CSF6	GF6	Public interest and awareness	[111, 113, 118, 122, 124]
CSF7	GF7	Privatization	[111, 116, 117, 123, 124]

4.5.2 Economic Factors

Public-private partnership (PPP) plays an essential role in the viability and execution of green building initiatives. Due to the rapid growth of urbanization and the demand for sustainability in the building industry, there is a national demand for developing green building initiatives [114, 117]. This demand guarantees the proper operation of green building projects for an extended period, providing a consistent stream of income and justifying the initial investment [114, 117]. For the success of PPP projects, the competitive advantages between stakeholders such as private investors, government agencies, and local communities significantly impact the success of PPP-financed green buildings [117, 118, 120]. To enable the rapid development and success of green building projects with stability and predictability, it is essential to have the long-term financial incentives of loans, funds, and insurance [117, 120]. Another economic prerequisite for the success of PPP green building projects is access to suppliers [123, 124]. Robust and streamlined supply chains ensure the availability of materials, technologies, and services, hence postponing or eliminating observing delays, cutting costs, and guaranteeing the quality of materials in the project [121, 124]. A strong supplier network enhances local economies by increasing employment and promoting economic development [123]. The following Table 4 illustrates the CSFs of PPP related to Economic Factors for financing green building projects.

Table 5 CSFs of PPP related to Economic Factors for financing green building projects.

No		Success Factors	Sources
Economic Factor			
CSF8	EF1	Long-term demand for GB projects/services	[111, 114, 117]
CSF9	EF2	Competitive advantages among the stakeholders	[113, 115-118, 120]
CSF10	EF3	Adequate economic returns/profitability	[108, 113, 115, 120, 122]
CSF11	EF4	Long-term financial incentives (i.e., loans, funds, insurance, etc.)	[114, 116, 117, 120, 122, 123, 124]
CSF12	EF5	Suppliers availability	[111, 118, 121, 123, 124]

4.5.3 Technical Factors

Public-Private Partnership (PPP) projects are crucial for developing green building initiatives. Numerous technical conditions are essential for the success of these projects [111, 118, 122]; their absence may hinder implementation. These include robust leadership, efficient organisation and structure, and the project team's capacity to execute and deliver [117]. The entrepreneurial perspective of innovators can advance projects within firms to apply innovative ideas and effective institutional practices to achieve both environmental and economic objectives [118, 120]. An effective project structure must be clearly defined, encompassing distinct roles and duties alongside resource allocation and coordination. To advance through technical challenges and achieve project milestones, the project team must collaborate cohesively, adapt to changes, and implement effective solutions [108, 113]. Transparency, trust, and cooperation in the implementation of Public-Private Partnership (PPP) projects, as perceived by government and EAL private authorities, facilitate improved partnerships through institutional reforms that necessitate skills in partnership, negotiation, conflict resolution, and collaboration between public and private entities [119, 121, 123]. In addition to experience in managing a PPP project, which is essential for performance and return on investment, seasoned project managers possess insights from prior projects regarding operational dynamics. Diverse participants contribute varied viewpoints from specialists on networks, facilitating a more comprehensive project management approach that leads to more inventive and effective solutions [120]. The implementation of sophisticated technology and environmental practices will occasionally dissociate PPP projects from hearings [121,124]. A fundamental objective of sustainability within the environmental dimension necessitates a method to mitigate detrimental effects and enhance resource efficiency over the long term, as noted in references [116-119]. Public health and safety are also critical considerations, ensuring safe, healthy, and comfortable environments for occupants [118, 119]. The following Table 5 illustrates the CSFs of PPP related to Technical Factors for financing green building projects.

Table 6 CSFs of PPP related to Technical Factors for financing green building projects.

No		Success Factors	Sources
Technical Factor			
CSF13	TF1	Role of the enterprise and entrepreneurs	[111, 118, 119, 121, 122]
CSF14	TF2	Efficiency in project organization and structure	[108, 111, 114, 117, 118, 120]
CSF15	TF3	Capability and efficiency of the project team	[108, 113, 115, 118, 119, 121]
CSF16	TF4	Better communication between the government and private authorities	[108, 111, 119, 121, 123, 124]
CSF17	TF5	Partnership skills	[114, 118, 121, 122]
CSF18	TF6	Experience in PPP project management	[113, 114, 117, 122]
CSF19	TF7	Diverse Participants	[114, 116, 120]
CSF20	TF8	Innovative technical solutions	[108, 118, 121, 124]
CSF21	TF9	Environmental Sustainability	[108, 111, 113, 114, 115, 116, 118, 119, 122, 124]
CSF22	TF10	Public health and safety	[113, 115, 118, 119, 122, 123]

4.5.4 Financial Factors

The financial success of public-private partnership (PPP) in developing green building projects depends on several critical factors and is driven by assessment efficiency. Efficient financial analysis is crucial for identifying potential risks and opportunities associated with the building type, hence guiding stakeholder decisions [123, 124]. A meticulously designed framework for investment, insurance, and lending schedules is employed to maintain a stable cash flow and mitigate the risk of inefficiency or budget overruns [121, 122]. Affordable loans, minimal interest rates, and extended payback terms may effectively alleviate the financial constraints of a project and enhance its economic viability [123, 124]. Equity finance, as an independent and essential element in the financial framework of PPP projects, together with the appropriate level of currency debt, is the critical factor in achieving an optimal capital structure. Long-term financial planning requires stable fixed and low-interest rates to establish clear objectives for minimizing borrowing expenses [114, 115]. PPP projects, especially those with extended lifecycles, necessitate long-term loan or debt financing mechanisms to ensure financial stability and sustained access to capital over the project's duration [117]. Effective management of financial variations is essential for the project's financial stability, including techniques to mitigate market volatility, currency variances, and interest rate swings. Financial Stability: Proficient management of financial fluctuations helps ensure the long-term viability of a project [121, 122, 123]. The following Table 6 illustrates the CSFs of PPP related to Financial Factors for financing green building projects.

Table 7 CSFs of PPP related to Financial Factors for financing green building projects.

No		Success Factors	Sources
Financial Factor			
CSF23	FF1	Efficient financial analysis	[117, 121, 123, 124]
CSF24	FF2	Investment, insurance and loan schedule	[111, 113, 117, 121, 122]
CSF25	FF3	Structure and sources of the loans	[108, 113, 119-124]
CSF26	FF4	Equity finance and currency debt	[115, 117, 118]
CSF27	FF5	Higher equity/debt ratio.	[108, 113, 114, 118, 121, 122]
CSF28	FF6	Fixed and low interest rate	[108, 113, 114, 115, 117, 118, 121]
CSF29	FF7	Long-term loan or debt financing system	[114, 117, 119]
CSF30	FF8	Adequate financial fluctuation	[114, 115, 118]
CSF31	FF9	Long-term financial incentives (i.e., loans, funds, insurance, etc.)	[108, 115, 119-124]

4.5.5 Concession (Partnership) Factors

Public-Private Partnership (PPP) projects associated with the development of green building initiatives are often influenced by partnership or concession-related factors. The partnership factors are crucial in a PPP-associated project, since these factors are the key drivers that govern the relationships and agreements between the involved parties. Therefore, the nature and type of the concession agreement are crucial to the project's success, as it outlines the terms and conditions under which the private sector is granted the right to build and operate the project [108, 113, 119, 120]. Besides the nature and type of concession agreement, another crucial factor is the trust and openness among the partners and stakeholders associated with the project development and delivery. Trust and openness among the project stakeholders are essential since the key considerations of green building projects are long-term sustainability and environmental benefits. Moreover, in PPP-associated projects, another crucial concession factor is the insurance agreements that cover various aspects of the project, including construction, operation, and environmental liabilities, and hence mitigate the potential and unexpected financial risks [119, 121-124]. Several studies also reported that agreements among the stakeholders related to project operation and supply significantly influence the smooth execution and long-term success of PPP projects [111, 115, 117]. A well-structured supply agreement allows the project stakeholders to engage in the definitive terms for the procurement of materials, equipment, and services required for the project's construction and operation, ensuring a reliable supply chain and necessary resources. On the other hand, agreements associated with the project operation outline the terms for the management and maintenance of the project once it is operational, ensuring efficient and sustainable operation [113, 114-119]. Lastly, a well-structured risk-sharing agreement is crucial for enhancing the financial and operational stability of PPP-financed green building projects [108, 113, 121]. The following Table 7 illustrates the CSFs of PPP related to Concession Factors for financing green building.

Table 8 CSFs of PPP related to Concession Factors for financing green building projects.

No		Success Factors	Sources
Concession Factor			
CSF32	CF1	Nature and Type of Concession Agreement	[108, 113, 119-124]
CSF33	CF2	Trust and Openness	[108, 113, 115, 117, 119, 121, 123, 124]
CSF34	CF3	Agreement between stakeholders	[108, 116, 119, 123, 124]
CSF35	CF4	Loan agreement	[111, 113, 114, 116, 117, 122]
CSF36	CF5	Insurance agreement	[114, 116, 118, 121]
CSF37	CF6	Design and construct contract	[114, 119, 124]
CSF38	CF7	Supply agreement	[111, 115, 117, 118, 120]
CSF39	CF8	Operation agreement	[113, 114, 115, 119]
CSF40	CF9	Transparency and accountability	[108, 113, 117, 119, 120, 121, 123, 124]
CSF41	CF10	Risk-sharing agreement	[108, 113, 121-124]

5.0 DISCUSSION

The governance environment shapes both the feasibility and performance of PPPs in green building by providing structural stability and clarity. Political stability (GF1) reduces sovereign risk and bolsters investor confidence in long-term green PPP commitments. At the same time, a stable and promising economic system (GF2) ensures the financial predictability needed to absorb the higher upfront costs of sustainable technologies and align private returns with environmental outcomes [114-117, 122, 124]. An adequate local market (GF3) guarantees sufficient demand for green-certified buildings [116-119], incentivizing developers to integrate energy-efficient systems and advanced materials from project inception, and a viable legal framework (GF4) codifies environmental standards [114, 120], enforces contracts, and clarifies dispute-resolution procedures, thereby defining risk allocation and performance benchmarks critical to PPP agreements [115, 116]. Adequate government support (GF5)—through subsidies, guarantees, or tax incentives—bridges the cost gap between conventional and green construction by internalizing externalities within the project's financial model [119-122], and strong public interest and awareness (GF6) create demand-side legitimacy that reinforces political mandates for robust green criteria and secures the social license to operate [113, 118, 122, 124]. Finally, privatization (GF7) introduces market discipline and innovation incentives, compelling private partners to optimize lifecycle performance and embed cutting-edge sustainability technologies to differentiate their bids and secure long-term revenue streams [111, 116, 123]. Together, these governance factors form a theoretical framework in which institutional stability, economic predictability, legal rigor, fiscal support, societal engagement, and market mechanisms converge to enable effective, sustainable PPP delivery in green building projects.

Long-term demand for green building projects and services (EF1) provides foundational revenue certainty that reduces demand risk and enables lifecycle cost–benefit analyses favoring sustainable investments [114, 117], while competitive advantages among stakeholders (EF2) allow firms to leverage proprietary technologies, specialized expertise, or green certifications to differentiate PPP bids and capture higher margins [116-118]. Adequate economic returns and profitability (EF3) serve as the theoretical linchpin by ensuring private entities internalize externalities through premium pricing or shared-savings models and public partners secure value-for-money via performance-based payment mechanisms [113, 115, 120]. Long-term financial incentives (EF4)—such as concessionary loans, dedicated green funds, and insurance schemes—decrease the weighted average cost of capital for green PPPs and align cash flows with extended environmental performance metrics [122, 124], and supplier availability (EF5) underpins project feasibility by ensuring a reliable, cost-efficient supply of green materials and technologies [111, 118, 121], lowering procurement risk and fostering industry clustering around PPP opportunities.

Technical factors serve as the operational engine of PPPs in green building by marrying entrepreneurial leadership with disciplined project execution and innovation. The role of enterprises and entrepreneurs (TF1) injects vision and risk-taking capacity that spur green initiatives [119, 121], while efficiency in project organization and structure (TF2) and the capability and efficiency of the project team (TF3) establish streamlined workflows and high-performance delivery systems [117-121]. Better communication between government and private authorities (TF4) and strong partnership skills (TF5) build the trust and alignment essential for multi-stakeholder collaboration [108, 118, 121, 124]. Experience in PPP project management (TF6) and the inclusion of diverse participants (TF7) bring accumulated know-how and broadened perspectives that enhance adaptive capacity and risk mitigation [114, 120]. These capabilities are amplified by innovative technical solutions (TF8) that optimize resource use and embed digital monitoring tools, all underpinned by a steadfast commitment to environmental sustainability (TF9) and public health and safety (TF10), which ensure green building projects achieve ecological benchmarks and safeguard community well-being [114-122].

In green buildings supported by PPP, viability, meticulous financial analysis underpins project lifecycle costing, risk-adjusted returns, and sustainability targets. Synchronized investment, insurance, and loan scheduling ensure cash inflows align with debt service and operating expenditures to mitigate liquidity mismatches [121, 123, 124]. Loan structure—from concessional public debt and green bonds to commercial financing—shapes the weighted average cost of capital and risk-sharing between public and private partners, directly influencing affordability and market confidence [113, 120-123]. Calibration of equity finance and currency-denominated debt alongside an optimal equity-to-debt ratio balances sponsor returns with credit risk, making upfront investments in advanced green technologies more attainable [114-118]. Fixed, low-interest rates and long-term financing systems with staggered maturities and refinancing buffers improve cost certainty and resilience against macroeconomic volatility in PPP-financed green building projects. The implementation of adequate financial fluctuation mechanisms, such as reserve accounts and covenant flexibility, balances unexpected cost overruns or revenue shortfalls [120-123] during the project development and maintenance phase. Moreover, long-term financial incentives—including tax credits, viability gap funding, concessional loans, and insurance schemes—correct market failures, bridge the green investment gap, and tie public policy objectives to private sector returns.

Finally, the concession factors critically shape green PPP outcomes by defining the nature and type of the concession—whether build-operate-transfer, design-build-operate, or lease arrangements—while fostering trust and openness among partners and securing clear agreements between stakeholders that align objectives and responsibilities [111-116]. The viability of robust loan and insurance agreements underpin financial stability by delineating repayment terms and risk coverage [114, 117, 122]; Strategically negotiated supply and operation agreements guarantee resource availability and service continuity [117-120], while transparency and accountability provisions, such as performance monitoring and reporting clauses, reinforce stakeholder confidence and governance [120-124] improves the investors' trust towards the adaption of PPP financed green buildings. Moreover, well-structured risk-sharing agreements allocate technical, financial, and operational risks optimally between public and private entities, collectively de-risking projects and enhancing lifecycle performance of green buildings [121-124].

6.0 FUTURE PERSPECTIVE

The comprehensive framework of governance, economic, technical, financial, and concession factors suggests that future research should prioritize the development of multidimensional measurement tools and context-sensitive models to unpack how these types of factors interact over the life cycle of PPP-financed green buildings. For example, implementing empirical studies on political stability, economic predictability, and legal robustness could quantify the related indices that can be tracked alongside sustainability performance metrics. Moreover, comparative analyses between the established and emerging markets of PPP-financed green building development would illuminate how variations in government support, public awareness, and privatization strategies shape project outcomes. Additionally, future work can develop predictive models to guide policymakers in designing governance environments optimized for green building projects by integrating the standardized indicators for trust, transparency, and stakeholder alignment.

Regarding the contractual and financial aspects of PPP-financed green building projects, the findings highlight the need for in-depth investigations into how specific concession terms (such as risk-sharing mechanisms and financing structures) reduce the financial risks of green building projects and align public and private incentives. Therefore, future research should employ specific financial modelling to evaluate the sensitivity of weighted average cost of capital and refinancing triggers under varying macroeconomic conditions. Future works based on field experiments could also test the efficacy of performance-based contracts and supply agreements, assessing their capacity to maintain feasibility and potential of PPP in developing green building projects.

7.0 CONCLUSION

A literature review of published articles was performed employing a bibliometric content analysis method to encapsulate the pertinent aspects of public-private partnership for green building development projects. The highlighted studies were journal publications and some reviews, including some that examined critical success factors within the context of developing a public-private partnership paradigm for green building initiatives. The analysis revealed that the majority of published articles were predominantly centered in developing nations in Africa and Asia, where private sector involvement in green building is essential to address increasing demand. The four most often stated categories of critical success factors throughout the research period were Governance Factors, Economic Factors, Technical Factors, and Financial Factors, along with Concession (Partnership) Factors. Each category of the Critical Success Factors encompasses multiple elements that may significantly influence the success of Public-Private Partnership projects in green building construction. This study offers governments, foreign developers, financial institutions, and researchers a compilation of the critical CSFs required for establishing partnerships in green building development projects. Future expansion of the current findings may concentrate on creating a framework that outlines the techniques for the optimal exploration of these critical success factors, aiming to enable the effective implementation of public-private partnerships in green building project development.

Acknowledgement

The authors extend their appreciation to the Deanship of Research and Graduate Studies at Universiti Teknologi Malaysia for support and inspiration.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

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