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A Systematic Review of Commercial Building Greening with CiteSpace

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Abstract The commercial buildings greening can generate multiple benefits to achieve a sustainable building and business environment. However, a comprehensive systematic review of commercial buildings greening across multiple disciplines has yet to be reported. This study conducted a systematic analysis of 39 literature on commercial building greening from Web of Science over the past 19 years and utilized CiteSpace to visualize the academic evolution and trends in this field. Key findings were: 1) The number of publications in the past five years has increased, indicating that commercial building greening research has received widespread attention. 2) The large number of publications means that the research field of commercial building greening is relatively broad. 3) The study of commercial building greening has become a global participation and cooperation research topic. The top cooperating countries mainly come from the United States and Europe, while the differences in cooperation between institutions in developing countries are less significant. 4) The greening of commercial buildings is more related to research on behavioral activities. 5) The research on commercial building greening has developed from architecture and plants to interdisciplinary fields, including psychology, economics, and management. 6) The cost of commercial buildings greening is generally an obstacle to installation. This study provides specific references for stakeholders and plays a crucial role in determining the evolution of commercial building greening research and predicting future research needs and opportunities.

Keywords Commercial building greening, Systematic review, CiteSpace, Visualization

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1. Introduction

Urban greening greatly improves the urban environment and residents' quality of life (Haaland and van Den Bosch, 2017). However, with the development of urbanization and the increase in population, more buildings are built, resulting in the continuous reduction of green ecological space. The contradiction between the shortage of urban green space and the increasing demand for greening has become progressively prominent, and the cost of green construction is also gradually increasing (Artmann et al, 2019; Russo and Cirella, 2018). Building greening is a new mode that intensively utilizes land (Pérez-Urrestarazuet et al., 2015). Entirely using building planes and facade space resources can effectively increase the greening area and improve the quality of cities (Baranzini and Schaerer, 2011). Relevant studies have also fully proved that building greening has significant value in pollution control (Hachoumi et al., 2021), energy management (Block et al., 2012), mitigation of energy consumption (Hao et al., 2020), and improvement of aesthetics (Veisten et al., 2012).

In addition, there have been reviews on building greening: the impacts on sustainability of building environment (Al-Kayiem et al., 2020), especially energy characteristic (Seyam, 2019;Safikhani et al., 2014; Raji et al., 2015) and environmental education (Pacini et al., 2022), health and well-being benefits(Fonseca et al., 2023), specifically aimed at the elderly (Carver et al., 2020), employees (Colenberg et al., 2021) and residents(Chen et al., 2021), even the association with birth weight (Dzhambov et al., 2014), design (Manso et al., 2014), specifically for indoor soundscapes (Hasegawa et al., 2021), plant species (Pan, 2020; Dahanayake et al., 2017), technologies (Medl et al., 2017), benefits and costs (Manso et al., 2021), carbon emission reduction (Charoenkit and Yiemwattana, 2016), policies (Irga et al., 2017). Moreover, there are also comprehensive systematic reviews of VGS research across multiple disciplines (Besir and Cuce, 2018; Bustami et

al., 2018; Ghazalli et al., 2019). Thus, it can be seen that review research has become one of the best ways to understand this domain's dynamic mechanism and whole theoretical structure and conduct future research more efficiently and effectively.

There are different focuses in commercial building greening. Some scholars have studied commercial buildings greening research from multiple perspectives in the past, as follows: Greening commercial buildings is a positive way to reduce the harmful impact of buildings on the environment and achieve sustainability goals (Rupasinghe and Rupasinghe, 2020; Teotónio et al., 2018). In addition, relevant research shows a sustainable relationship between greening and shoppers' well-being (Amérigo et al., 2013; Herzog et al., 2008), and has been used widely for commercial purposes, indoor and outdoor (Ghazalli et al., 2019). Specifically, installing ecological elements can promote consumers' intention to visit and purchase (Do Paco and Raposo, 2009) and positively affect shopping behavior and emotions (Brengman et al., 2012). These also show that in addition to the benefits of general building greening, the greening of commercial buildings can effectively enhance the attractiveness of places and stimulate potential consumption, thereby increasing the turnover (Yin, 2015), further enhancing the competitiveness of the commercial buildings and promoting the overall development of the region and even the city (Zhang, 2014; Wang, 2008). These show multiple benefits generated by the greening of commercial buildings that help to achieve a sustainable building and business environment, which may explain why greening systems have been retrofitted in many commercial spaces. For building developers and greening operators, the various values and economic competitiveness are more significant than the theoretical and development, while decision-makers mainly focus on policy formulation. Summarizing the research results of commercial building greening would help us understand the research evolutions and hotspots, thereby providing new insights for future research directions. However, a comprehensive systematic review of commercial buildings greening across multiple disciplines has yet to be reported.

The aim of this systematic review on commercial buildings greening is to identify the trends, innovations, and future research directions by constructing the overall theoretical research framework of the domain from a more intact and comprehensive view. Specifically, this review collectively identified commercial building greening-related papers in the Web of Science (WOS) database from 2004 to 2023 as the research object. Using the information visualization software CiteSpace, we analyzed the literature quantitatively and summarized the evolution status and hotspots in commercial building greening research in the past 19 years. By subdividing the research on commercial building greening into different themes, possible future research trends were explored and predicted. This study provides specific references for stakeholders and plays a crucial role in determining the evolution of commercial building greening research and predicting future research needs and opportunities.

2. Methods

2.1. Systematic review

The systematic review is an increasingly popular literature review in various research fields. It is characterized by the fact that it follows a reproducible method by other scholars (Mavrigiannaki and Ampatzi, 2016). This study adopted a strict protocol with a four-phase process (Moher et al., 2009): identification of relevant papers, screening according to established criteria, classification according to themes of papers, and finalizing the number of papers for inclusion in the review.

2.1.1. Identification

The identification phase established reproducible search parameters according to eligibility criteria and specifying the database(s) searched. Following the convention of other systematic review papers, the WOS was chosen as the popular indexed electronic database for the systematic review (Moher et al., 2009). Based on the database, we used keywords that can be classified as greening, like 'building integrated greening', 'greenery/greening system', 'biophilic design', 'biophilic atmosphere', 'natural plant', 'nature', 'eco-natural environment', 'indoor plants', 'vertical greening system/VGS', 'green roof (system)/GRS', 'roof/rooftop garden' and various words which were about commercial building, such as 'shopping center', 'shopping center mall', 'store', 'retail', 'City Centre', 'mixed-use building', 'Commercial complex', 'high rise building', 'hotel', 'airport'. The research was conducted in March 2023 and supplemented in July.

2.1.2. Screening

Studies identified from WOS were screened to exclude papers considered ineligible for the review. Search criteria are as follows: duplicates; non-English; non-peer reviewed papers, like letters, conference papers, short notes, and books, non-relevant to commercial building greening, which was determined by examining the titles and abstracts of each paper.

2.1.3. Classification

Relevant papers and valuable information from the field of commercial building greening research were extracted through the systematic review, and different themes were classified for discussion to reflect the research focus of each paper and predict the research trends. A large amount of research was dedicated to one or more other fields. The papers were divided into 6 themes: remediation potential, consumer psychology, biophilic design, vegetation and crop production, economics, and management and services.

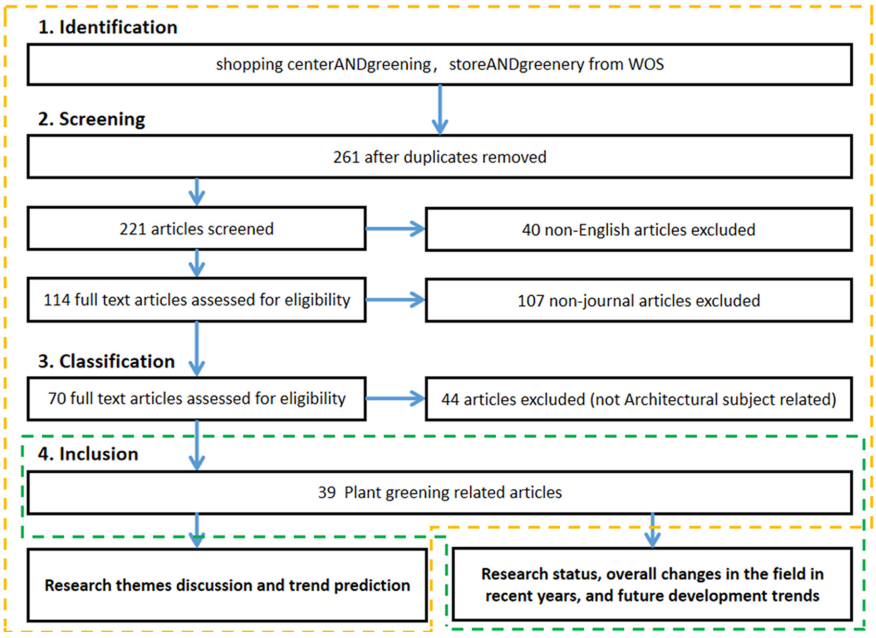


Figure 1. Summary of four-phase flow for inclusion and analysis methods in the review.

2.1.4. Inclusion

The research selected for review at this stage was limited to the greening of commercial buildings, including the greening inside and outside of commercial buildings, such as VGS, green roof, atrium greening, and other green spaces in commercial complexes, such as hotels, airports, and other types. The four-stage process is shown in Figure 1.

2.2. CiteSpace

Based on the above, this study combined the systematic review with visual analysis software to comprehensively analyze commercial building greening literature. Its significant advantage lies in its ability to display a large amount of textual information in the visual language and display research progress and trends in the field as a knowledge graph, facilitating researchers to conduct intuitive analysis of the field and reducing research workload. We used CiteSpace to visualize the collected data to obtain a knowledge network of the research field (Figure 1). Firstly, the papers selected from the systematic review were imported into CiteSpace in text format. The related parameters were set: the time interval was from 2004 to 2023, and the node settings included author, institution, country, cited literature, cited journal, author, and critical words. Through running CiteSpace, we obtained journal and citation, popular keywords and keyword citation bursts, author-affiliated countries, themes and methods. By comparing and analyzing the obtained knowledge network maps, it is possible to quickly understand the current research status, overall evolution in this field in recent years, and future development trends.

3. Results

Originally, a search on the WOS found 261 papers by generic search term set for this study. Firstly, 191 non-English papers, non-journal papers, and unrelated to architectural subjects were excluded. In the screening process of the remaining 70 papers, we found that "greening" means green plants and refers to green products in the commercial field, green energy saving in commercial buildings, green travel methods to reach business centers, and green consumption behavior.

After screening, 39 papers are related to green plants in commercial buildings. The most studied topic was related to the restorative potential of green plants, with 19 papers. Secondly, the research involves consumer behavior, biophilic design, economic benefits, etc. This part would detail the research status and future trends of commercial building greening research from publication trends and commercial building greening research trends.

3.1. Publication trends

3.1.1. Publication year

Researches on commercial building greening have been published since the first study on the effects of indoor greenery on people's behavior was published in 2004. The number of papers published has fluctuated each year (Figure 2). In 2019, the number of papers increased to 8, which may be related to the relevant report issued by the Intergovernmental Panel on Climate Change (IPCC) in 2018, which triggered scholars' thinking about building greening. There was a decrease after 2020, but according to the publication trend, the number of papers will continue to increase steadily in 2023 and beyond.

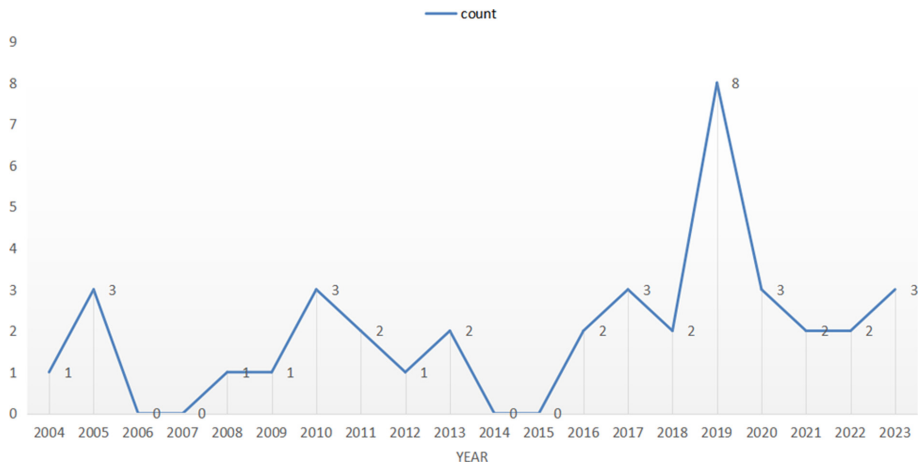


Figure 2. Number of commercial building greening papers published by year.

3.1.2. Journal and citation

Research on commercial building greening has been published in various fields, including economics, environmental science, psychology, management, and urban studies. The most popular journal was the Journal of Services Marketing, with 4 papers published (10.3%) and 3 papers (7.7%) in the Journal of Retailing and Consumer Services. Other popular journals of commercial building greening publications are shown in Figure 3. As can be seen from the figure, although the number of papers published by each journal is small, the number of publications is extensive. That shows that the research field of commercial building greening is broad and spans many disciplines.

According to the citation records of the WOS database, as of July 2023, the 39 papers included in this study had been cited 2292 times. Although the number of papers published between 2006 and 2014 was small, the number of citations increased from 61 in 2013 to 102 in 2014 and showed a steady upward trend in the following years (Figure 4). The study of greening commercial buildings is expected to increase in the next few years gradually.

According to the WOS database, papers in the field that have been cited more than 100 times (as of July 2023) are shown in Table 1. The most cited paper is the study that greening landscapes contribute to resilience and attention (Berto, 2005). Another study focuses on the influence of green elements on people's behavioral intention in hotels (Lee et al., 2010). These two papers are cited far more frequently than other papers, and the other three are also related to the effect of greening on people's behavior. The first four papers are from the Journal of Services Marketing. In general, papers related to recovery potential and environmental behavior were among the top cited.

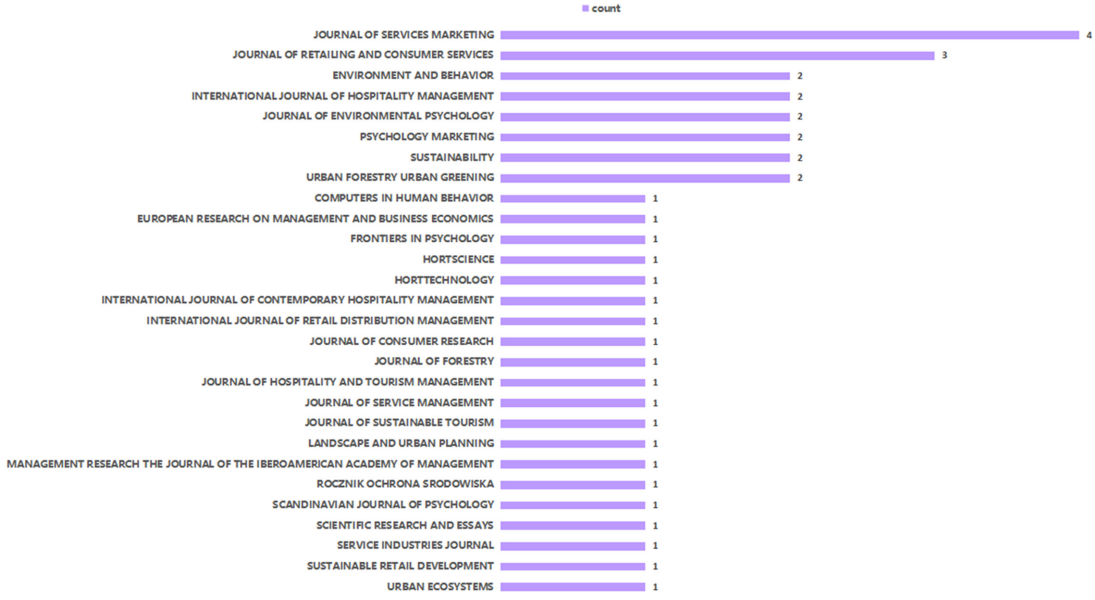


Figure 3. Top journals for commercial building greening publications.

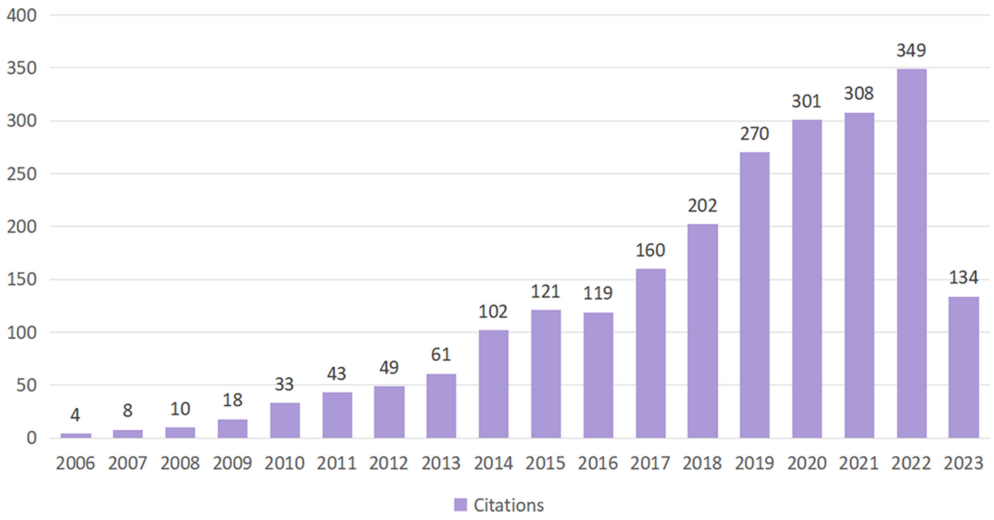


Figure 4. Top journals for commercial building greening publications.

Table 1. Top-cited papers in Commercial Building Greening up to July 2023

No.	Times cited	Paper title	Authors	Journal	Year Published
1	558	Exposure to restorative environments helps restore attentional capacity	Berto, R	JOURNAL OF ENVIRONMENTAL PSYCHOLOGY	2005
2	491	Understanding how consumers view green hotels: how a hotel's green image can influence behavioural intentions	Lee, Jin-Soo; Hsu, Li-Tzang (Jane); Han, Heesup; Kim, Yunhi	JOURNAL OF ENVIRONMENTAL PSYCHOLOGY	2010
3	290	An expanded servicescape perspective	Rosenbaum, Mark S.; Massiah, Carolyn	JOURNAL OF ENVIRONMENTAL PSYCHOLOGY	2011
4	117	The center cannot hold: Consuming the utopian marketplace	Maclaran, P; Brown, S	JOURNAL OF ENVIRONMENTAL PSYCHOLOGY	2005
5	116	Effects of an indoor plant on creative task performance and mood	Shibata, S; Suzuki, N	SCANDINAVIAN JOURNAL OF PSYCHOLOGY	2004

3.1.3. Popular keywords and keyword citation bursts

We have analyzed the popular keywords used in the paper, and the Table 2 lists the top 10 keywords used most. The most popular keywords are impact, behavior, benefits, environment, and biophilic design. Although the use of impact is the most frequent, the central is not strong, and the reason may be that the scope of the keyword is too large. The centrality of behavior is the highest and has a high persuasive effect. It can be seen that the study of commercial building greening is more related to the research of behavioral activities.

Keyword citation bursts are also analyzed, reflecting changes in hot spots in specific research fields and emerging trends in themes. The first ten keyword citation bursts are extracted, as shown in Figure 5. From 2004 to 2023, the research frontier changes over time, and it can be seen that recovery is the keyword with the most prominent and most extended duration of early impact (2004-2012). Later, it gradually transitions to transformative service research, social interaction, and experience and focuses on studying shopping malls. The most powerful keywords cited this year are "image" and "biophilic design," which reveals the study trend of building greening and will receive continuous attention in the future.

Table 2. Popular keywords from Commercial Building Greening papers

No.	Keywords	No. of times used	Centrality
1	Impact	10	0.02
2	Behavior	8	0.54
3	Benefits	6	0.19
4	Environment	6	0.12
5	Biophilic Design	6	0.17
6	Experience	5	0.05
7	Health	5	0.03
8	Atmospherics	5	0.12
9	Attention Restoration Theory	4	0.17
10	Stress	4	0.17

3.1.4. Author affiliated countries

The country of origin was analyzed based on author

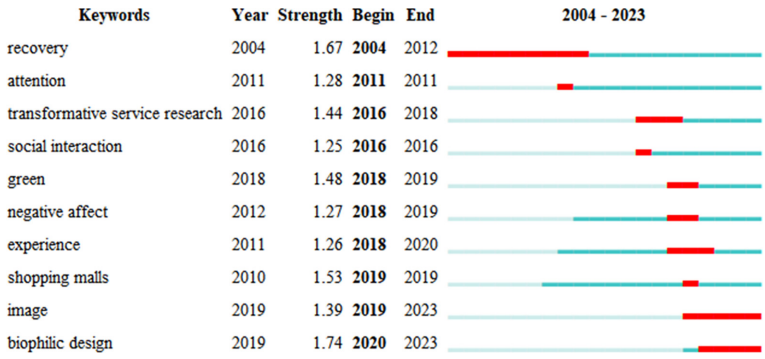


Figure 5. Top 10 Keywords with the Strongest Citation Bursts.

affiliations and the top 10 are shown as Table 3. All countries are accounted for in events of multiple authors from different countries. The top countries are shown in Figure 6, with the highest number of papers from the USA (30%), taking the lead in the field of research. Colombia is next with 13%. Research on commercial building greening is the most popular in North America, followed by Europe (28%), Asia (21%), South America (19%), and Africa (2%). More prominent are studies in Northern Europe (England, Belgium) and South Asia (India). Rosenbaum, Mark S. and Contreras Ramirez, German, ranked the top in the number of published authors, and 4 were jointly published. The ranking of the country where the author belongs is the same as that of the country in the research field.

3.1.5. Themes of commercial building greening papers

Theme related to restoration potential was the most common, including restoration of health, restoration of urban problems, and restoration of business places, with 19 papers (30%). Other themes are Consumer psychology, with 15 papers (24%), Biophilic design, 8 papers (13%), Economic benefits, 11 papers (17%), Vegetation and crop production and management and services, with 6 and 4 papers, respectively (10% and 6%).

Table 3. Top 7 most collaborative authors of Commercial Building Greening research

No.	Authors	Counts	Year	From country
1	Rosenbaum, Mark S	4	2011	USA
2	Contreras ramirez, German	4	2016	USA
3	Willems, Kim	3	2010	BELGIUM
4	Brengman, Malaika	3	2010	BELGIUM
5	Kumar, Deepak S	3	2017	INDIA
6	Purani, Keyoor	3	2017	INDIA
7	Ortegon-cortazar, Leonardo	3	2019	COLOMBIA
8	Rosenbaum, Mark S	4	2011	USA
9	Contreras ramirez, German	4	2016	USA
10	Willems, Kim	3	2010	BELGIUM

We evaluated the papers and divided them into related sub-themes. Of these papers, 22 (56.4%) contained 2 or more sub-theme. Three strong multi-theme papers were identified, one covering 5 sub-themes and the other two covering 4 sub-themes. Drawing on the theory of attention

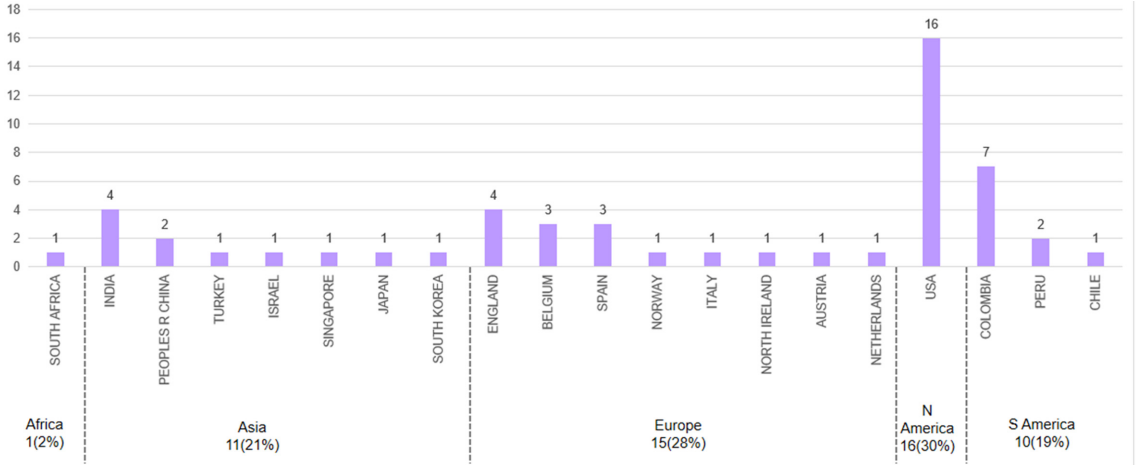


Figure 6. Top 10 Keywords with the Strongest Citation Bursts.

recovery, they link biophilic design with human health by assessing consumers' reactions to biophilic store design in the commercial retail environment, empirically demonstrate the recovery potential of commercial buildings, and lead to the ecological natural environment becoming a recent theme of concern in shopping mall management (Rosenbaum et al.,2018; Rosenbaum et al., 2016; Joye et al., 2010).

3.1.6. Research methods

Of the 39 selected papers, 70% used two or more research methods. Among them, the survey method was used most, with 31 (79.5%), followed by 23 literature research methods (59%), 10 experimental methods (25.6%), 4 case study methods (10.3%), and 3 observation methods (7.7%).

In the survey method, the most used research method is the Stated Preference Survey (SP) (14 papers), followed by the willingness to Pay (WTP) survey method (5 papers). That is mainly because most of the papers are about the influence of people's behavior, which is more in line with the research needs. Among them, 23 papers adopted the "literature research + survey method" or "literature research + experimental method." Designing experiments by summarizing literature is popular for commercial building greening-related researches.

3.2. Commercial buildings greening research trends

Although restoration potential was the most covered theme in the study of commercial building greening, findings on other themes were equally important. Studies on other themes have shown the importance of how to view commercial building greening as a complex system. This section provides a detailed account of research progress in the field by theme classification, including restoration potential, consumer psychology, biophilic design, vegetation and crop production, economics, management, and services.

3.2.1. Remediation potential

Remediation potential is the most popular theme in the study of commercial building greening. The restoration potential provided by greening in commercial buildings is usually discussed through its restoration of human health (Berto, 2005; Joye, 2010; Rosenbaum, et al., 2018; Brengman, et al., 2012; Maclaran et al., 2005; Rosenbaum et al., 2016), which helps to overcome the impacts of urban climate change, such as carbon emissions and warming (Bak and Krolikowska, 2019), and at the same time increasing the biodiversity of the city (O'Donoghue and Shackleton, 2013) and working on the restoration of commercial sites (Rosenbaum et al., 2016; Wu et al., 2023; Rosenbaum et al., 2018).

Most studies on the restoration of human health draw on the theory of attention recovery, linking the green design in commercial space with human health, such as linking the green design with the recovery of mental fatigue. Studies have shown that consumers who enter stores in negative emotional states account for no less than 10% of the total shopping population (Maxwell and Kover, 2003). Green elements can stimulate consumers' neural activities related to excitement, interest, reduction of stress, participation, attention, and relaxation, thus confirming the demand for retail green (Rosenbaum et al., 2018) and increasing consumers' happiness (Rosenbaum et al., 2016), promoting the relationship between business environment and shopper happiness. Taking greening as a starting point, relevant studies have mapped that, similar to natural elements, the application of biophilic design in commercial environments positively impacts consumers' attention recovery, perception of place identity, and preference for service scenes (Kumar et al., 2020). Other studies have discussed commercial buildings such as biophilic design hotels and discussed that customers have a higher evaluation of biophilic design hotels regarding health, relaxation, and sleep quality (Ortegón-Cortázar and Royo-Vela, 2019). However, there is no significant difference between biophilic design elements in the hotel environment and customers' psychological responses and subjective well-being (Song et al., 2022).

It's research on the restoration of urban problems aims to implement commercial building greening to help overcome the impact of urban climate change (Bak and Krolikowska, 2019). Another study focused on the parking lot of shopping centers, indicating that greening contributes to urban carbon emission reduction and brings urban cooling benefits (O'Donoghue and Shackleton, 2013). In addition, building greening improves biodiversity by creating an environment for microbes and small animals (bees, birds, etc.) similar to protected or restored habitats in urban environments. A joint study showed that roof gardens that attract the most wildlife are located at lower heights of buildings, particularly below 50 m (Wendy Wong Channel News Asia, 2017). It can be seen that vertical greening and roof greening on the podium of commercial buildings are also close to the original natural ecology (Ai et al., 2013). Studies have been conducted on the species of sparrows, indicating that if there is sufficient green coverage in the commercial area, the possibility of sparrows living in a community will also be increased, which in turn will attract other organisms to improve biodiversity (Nath et al., 2019).

Studies on the restoration of commercial places mainly start from the reality of mall closures and the gradual demise of shopping centers and retail organizations caused by the growth of e-commerce retail, indicating that integrating natural elements into the shopping environment will enable commercial buildings to survive and even flourish (Rosenbaum et al., 2016). It is demonstrated by comparing with consumers in commercial buildings without natural elements (Rosenbaum et al., 2018). In particular, as a place for providing innovative services, commercial building greening can enhance the com-

petitiveness of the place and the overall development of the region and even the city (Wu et al., 2023).

3.2.2. Consumer psychology

From the psychological perspective, this study demonstrates the positive impact of natural elements in commercial building environments or service scenes on consumer behavior by exploring how green elements can strengthen consumer behavior intentions (Rosenbaum and Massiah, 2011), thus improving the cognitive image of shopping malls (Ortegón-Cortázar and Royo-Vela, 2019). For example, consumers may be naturally inclined to patronize consumption environments that feature natural elements, such as aquariums in shopping malls (Windhager et al., 2011), meadows (Rosenbaum et al., 2016), and so on. Middle-class citizens prefer the combination of shopping centers and green spaces to host their leisure and entertainment (Oğuz and Çakci, 2010).

The study also explores the different types of commercial building greening. For terminals, research shows that greenery in terminal design will positively affect consumers' shopping behavior (Oel and Berkhof, 2013). For hotels, this paper studies and discusses that the presence of indoor natural plants as decorative elements will increase the perceived aesthetic value and thus improve consumers' satisfaction (Apaolaza et al., 2020). It can also positively affect consumers' behavioral intention (i.e., the intention to visit again and provide positive recommendations to others) (Lee et al., 2010). In addition, from the perspective of greening around commercial buildings, such as the greening of parking lots in shopping centers (O'Donoghue and Shackleton, 2013) and street view trees (Wolf, 2005), the research also discusses that peripheral greening can help improve consumers' aesthetics and shopping experience.

3.2.3. Biophilic design

Biophilic design refers to integrating natural elements into the design of the built environment (Rosenbaum et al., 2018). Integrating biophilic design (natural elements such as green plants, fountains, and wildlife (such as birds and butterflies) into commercial buildings can effectively encourage specific consumer responses (Rosenbaum et al., 2018) and further explore the beneficial effect of vegetation commercial building design strategy (Joye et al., 2010). Previous studies have confirmed the inverse "U" -shaped relationship between biophilic design attributes and positive consumer responses in business environments (Shin et al., 2023). It is also verified by comparison that implementing biophilic design in the business environment can enhance the positive emotional response of guests more than the standard design. In contrast, the cognitive image and emotional response, in turn, have a positive impact on behavioral intention (Ortegón-Cortázar and Royo-Vela,2019; Lee, 2019). Other scholars focused on the lobby space of commercial buildings, demonstrating that biophilic design in such spaces can significantly affect customer sentiment, satisfaction, and booking intention (Nanu et al., 2020).

3.2.4. Vegetation and crop production

In the development of sustainable commercial buildings, the combination of different vegetation types and the diversity of their manifestations are critical to whether they will inspire consumer pleasure, improve the perceived quality of services (Tifferet and Vilnai-Yavetz, 2017), and cater to the various short - and long-term objectives of business operations (Wei et al., 2020), which are attributed to the natural vegetation tendency (Tifferet and Vilnai-Yavetz, 2017). Regarding vegetation type, it has been suggested that non-water-consuming native or adaptive vegetation species should be used in commercial building greening to mitigate potential market risks from the products provided (Yudelson, 2009). As far as expressing the situation is concerned, vegetation can be integrated into the hotel as indoor potted plants. However, new types of vegetation-based interior design, such as indoor garden sections, plant walls, or hanging plants, are also becoming more popular (Apaolaza et al., 2020). In-store and off-store greening can provide strategic commercial advantages for commercial buildings (Joye et al., 2010). Other studies have explored the introduction of crops for consumption and comfort in commercial environments, such as hydroponics in shopping mall environments (Cooke et al., 2021), for sustainable and innovative adaptive reuse.

3.2.5. Economics

Compared with non-green design, green design of commercial space can improve the aesthetic value and sense of luxury by increasing WTPP (willingness to pay a price premium) (Shin et al., 2023; Lee, 2019); that is, the introduction of greening in the business service environment will enhance consumer perception and advance marketing objectives (Tifferet and Vilnai-Yavetz, 2017).

The research takes airports, hotels, and commercial complexes as examples and validation. Taking airport space as an example, and it is demonstrated that placing greenery in commercial space can increase consumer comfort and is a way to increase income from commercial activities (Oel and Berkhof, 2013). Taking hotels as an example, using indoor natural plants as environmental elements in their restaurants and lobbies can significantly improve customers' booking intentions (Lee, 2019) and increase their willingness to return to generate marketing benefits (Apaolaza et al., 2020; Song et al.,2020). Taking the commercial complex with economic agglomeration and resource integration as an example, the studies discussed that it is the most suitable building for carrying greening because its combination with greening can stimulate potential consumption to increase turnover and further generate direct economic benefits through productive landscape and green themed activities to balance operating costs (Wu et al., 2023). The significance of evaluating the

cost and benefit of commercial complex greening from the whole life cycle perspective was explained, and a refined system construction guideline was proposed (Ortegón-Cortázar and Royo-Vela, 2019).

3.2.6. Management and service

The ecological and natural environment has recently become a topic of concern in the management of shopping malls (Rosenbaum et al., 2018). Some studies have proposed the concept of ecological nature marketing as an innovative way to attract tourists, indicating that an ecological natural environment can improve commercial attractiveness and provide strategic information for the industry, which in turn constitutes an innovative resource to attract and motivate tourists (Ortegón-Cortázar and Royo-Vela, 2019), breaking the new situation of the paradigm of transformative service research.

3.3. Barriers to commercial buildings greening

Over the past decade, the number of commercial buildings with greenery has increased, but their quality still needs to improve. First, commercial building greening costs are high, especially the later maintenance cost. Some studies say that maintenance is one of the essential standards and parameters in the design stage, and the risk and cost should be minimized in its entire life cycle (Chew and Conejos, 2016). Secondly, the indirect benefits generated, such as aesthetic and social benefits, are still being determined (Yin, 2015; Ortegón-Cortázar and Royo-Vela, 2017). Third, there needs to be more sustainability. Due to the relatively short life cycle of plants, inadequate or untimely management, lack of preferential policies, and other factors lead to the unsustainability of greening (Kirkpatrick, 2015; Hami et al., 2018). Finally, the lack of consensus among project stakeholders leads to the lack of coordination of green design, construction, and management of commercial buildings, resulting in the failure to achieve optimal configuration and performance (Wang et al., 2020).

4. Discussion And Conclusions

In this study, we conducted a systematic analysis of 39 literature on commercial building greening from WOS over the past 19 years and utilized CiteSpace to visualize the academic evolution and trends in this field. We have accurately understood the evolution of this field and predicted the trends in research by reviewing publication years, journals, keywords, references, authors, countries, institutions, themes, and methods.

Although the number of papers is limited, we have drawn the following critical conclusions through CiteSpace's graph analysis: (1) The number of publications in the past five years has increased, indicating that commercial building greening research has received widespread attention and more researchers are involved. (2) The large number of publications means that the research field of commercial building greening is relatively broad. (3) The study of commercial building greening has become a global participation and cooperation research topic. The top cooperating countries mainly come from the United States and Europe, while the differences in cooperation between institutions in developing countries are less significant. (4) Co-occurrence analysis helps us understand the current research hotspots, including behavior, benefits, environment, and biological design. The greening of commercial buildings is more related to research on behavioral activities.

More importantly, we have found that research on commercial building greening is no longer just discussing its remediation potential but is increasingly entering multidisciplinary fields. The research on commercial building greening has developed from architecture and plants to interdisciplinary fields, including psychology, economics, and management. The following will specifically elaborate on the research hotspots and trend analysis in each field.

Previous studies have analyzed the impact of green elements in industrial buildings on consumer behavioral intentions from a psychological perspective, and become more mature. The remediation potential of greening in commercial buildings has gradually transitioned from being the most widely linked to human health to studying different access motivations (Ortegón-Cortázar and Royo-Vela, 2019) and genders (Shibata and Suzuki, 2004). In the future, more attention will be paid to the different preferences of other character characteristics for commercial building greening and their consumption emotions in other different building types. Besides, the research on its role in addressing urban issues has gradually transitioned from a simple discussion of how it helps overcome the impact of climate change (Bak and Krolikowska, 2019) to other urban issues such as biodiversity (O'Donoghue and Shackleton, 2013). Research on the remediation of commercial buildings has also focused on the impact of greening on the emerging building type of commercial complexes (Wu et al., 2023).

The success of commercial building greening depends to a certain extent on consumers' instinctive positive emotional response to biological design (Rosenbaum et al., 2018). In addition, selecting appropriate plant species, effectively combining them, and utilizing different forms of plant expression reasonably (Tifferet and Vilnai-Yavetz, 2017) can maximize the capacity, performance, and positive impact of commercial building greening. The impact of greening in different spaces in commercial buildings is different, so it is necessary to explore further the types, combinations, and manifestations of greening required for different spaces.

Research has shown that business practices, greater profits, and green plants are "complementary practices" (Joye et al., 2010). Comprehensive economic analysis should be updated, various economic indicators should be

reasonably quantified and integrated, and economic sustainability should be applied to evaluate different cases. For example, the creative method of introducing crops into the commercial environment maximizes the potential of commercial building greening and benefits from products (Cooke, 2021), which can be considered in future economic analysis. Besides, external economic indicators, such as government efforts, subsidies, and policy formulation, should also be encouraged and included in the evaluation of economic sustainability. For example, Singapore government agencies incentivize building owners to adopt high-rise greenery through subsidies for green installation costs and discounts on total building area (National parks board, 2017; Urban Redevelopment Authority, 2017). Developing an economic sustainability assessment framework for commercial building greening can provide a platform to narrow the gap with other research directions in the field and effectively guide the government in formulating relevant incentive measures and subsidy policies, reducing the cost of building vertical greening for building owners, increasing construction enthusiasm, and promoting com-mercial building greening construction. Studies predict that the complete guidelines for VGS will take five years (Riley, 2017), and the evaluation guidelines for com-mercial building greening will have a shorter time.

Research has shown that managers can invest in designing service landscapes in biological forms to achieve expected results and improve investment returns. Further exploration should be made from managers' perspectives on what kind of green design can create a sense of naturalness among consumers so managers can create more attractive service scenarios with more rational design elements (Kumar et al., 2020).

The cost of commercial buildings greening is generally an obstacle to installation. The combination of widespread implementation and tax policies can reduce various costs, such as installation and initial costs, to significantly improve economic sustainability. In addition, the positive psychological and health effects of commercial building greening are still in the qualitative description stage and have not yet been quantified. The social benefits generated should be clearly and reasonably quantified. Besides, in response to the issue of insufficient sustainability, practical and feasible management policies should be formulated to extend the life cycle of commercial building greening. Finally, based on the theory of value sharing, it is necessary to obtain the interests and demands of operators, consumers, experts and scholars, social organizations, and media in the government series, including national and local governments, relevant management offices, and non-governmental series, in the ecological, social, and economic dimensions through interviews and question-naires, and establish a multi-agent collaborative participation model.

This study has some novelty. Firstly, we described the evolution and trends of research on commercial building greening, provided dynamic mechanisms in this field, helped researchers identify research interests, conducted in-depth research on emerging topics, and provided a reference for more effective progress in future commercial building greening research. Secondly, we clustered the themes of commercial building greening research, providing a novel and comprehensive perspective to help stakeholders, such as users, government, and society, quickly understand the primary information in this field. For example, it can help the government provide a theoretical basis for revising existing or developing new monetary incentives to encourage the greening develop-ment of commercial buildings.

Although this study provides valuable information on the current research status and future development direction of commercial building greening through data mining and classification analysis, there are still certain limitations. The information visualization software Cite-Space used in this study has certain limitations, and there will be better bibliometric software in the future. In addition, the collected files were only sourced from WOS and are all in English, which means that the data could only partially represent the overall situation in the field. Therefore, future research on commercial building greening will further explore this field by comparing papers in different languages and databases and continue to explore more reasonable types, combinations, and manifestations of greening in commercial building spaces from a multidisciplinary perspective. Various economic indicators will be determined, quantified, and integrated to guide the implementation of greening design in commercial buildings in a more scientific manner to bring sustainable ecological, social, and economic benefits continuously.

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