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Review

How Satisfaction Research Contributes to the Optimization of Urban Green Space Design—A Global Perspective Bibliometric Analysis from 2001 to 2024

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Abstract: With rapid global sustainable growth and urbanization, green spaces—central to urban green infrastructure—provide essential ecosystem services that significantly enhance residents' quality of life and well-being. This importance has grown even more evident during the COVID-19 pandemic. Therefore, the research on satisfaction with urban green spaces has become an essential topic for scholars in recent years. A systematic review could be helpful as research trends and effective optimization strategies are still unclear. To fill this gap, this study conducted a bibliometric analysis of 313 high-quality papers published on the Web of Science since 2001. The findings revealed: (1) Key journals and significant developments associated with this field of research, especially from China and the United States, emerging as the major contributors. (2) Keyword clustering analysis identified key themes, including public engagement, historic preservation, environmental justice, walkability, green space accessibility, and restorative environments. These findings emphasize the importance of data-driven and innovative planning strategies for enhancing residents' well-being, tourism, and urban sustainability. (3) Research on satisfaction with urban green spaces has shifted from a singular to a more diversified focus, contributing to the optimization of urban green spaces through four main aspects: residents' needs, ecological functions, management strategies, and research approaches. The conclusions offer strategies for researching the optimization of urban green spaces and provide valuable insights for residents, scholars, urban planners, and designers.

Keywords: urban green space (UGS); satisfaction; bibliometric; CiteSpace; visualization

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1. Introduction

The rapid development of global urbanization has brought increased attention to the quality of life for urban residents and environmental issues [1,2]. Urban green space (UGS), as vital green infrastructure, offers numerous ecosystem services that enhance the quality of life and environmental health of urban dwellers [3]. The United Nations Sustainable Development Goal (SDG) 11—Sustainable Cities and Communities—emphasizes the essential function of UGS in improving urban livability, fostering citizens' health, and ensuring universal access to green public areas. During the 2016 United Nations Conference on Housing and Sustainable Urban Development in Quito, Ecuador, the New Urban Agenda was ratified, highlighting the essential importance of green space development for attaining inclusive, safe, resilient, and sustainable urban development. These efforts offer support and direction for strengthening residential environmental quality, improving inhabitants' well-being, and fostering green and sustainable development. All of these highlight the global importance of UGS development and the pursuit of fulfilling residents' aspirations for a better life.

Against this backdrop, research on UGS spans multiple disciplines and has achieved significant outcomes [2–7]. The accessibility of UGS is a crucial research area. Studies show that factors such as the number, area, and spatial distribution of UGS significantly

impact the function of green spaces, user comfort, and urban environmental quality [8]. Additionally, research has explored the management of UGS, providing theoretical and practical guidance for sustainable urban development [3]. Other studies have examined the effects of UGS on health behaviors, physical activity, mental health, and subjective well-being [9]. UGS also offer environmental benefits, such as reducing air pollution and relieving stress [10]. Therefore, UGS **is** recognized for providing ecosystem services, improving public health, promoting social equity, and mitigating climate change [11]. However, existing green space designs still fall short of meeting various resident needs [12,13], raising the issue of environmental equity. Therefore, satisfaction research with UGS can better optimize their future and enhance residents' well-being.

With the rise in public environmental awareness, residents' expectations for UGS extend beyond infrastructure improvements, seeking diverse functions and services [14,15]. However, the current state of comprehensive research on existing findings and the development trends of research hotspots remains unclear. The direction and methods of current UGS construction and optimization are unclear. Therefore, a comprehensive quantitative analysis of research trends, thematic evolution, and research hotspots, based on existing studies, will help further optimize UGS, enhance residents' quality of life, and work toward achieving sustainable development goals while providing guidance for optimizing existing UGS. Based on this, this study employs bibliometric methods to systematically analyze and compare the research on UGS satisfaction by quantitatively assessing the number of publications, key journals, and leading institutions in this field domestically and internationally. This aims to provide a comprehensive overview of the current state, evolution trends, and critical issues in the field, summarize major problems in existing research, highlight studies with significant contributions, and identify potential future research directions. This paper aims to promote the practical application of existing research findings, contributing to the optimization and sustainable development of UGS. Thus, this study seeks to address the following three questions:

- RQ1: What is the global productivity distribution in the field of satisfaction research applied to UGS design across publication time trends, countries/regions, institutions, and journals?
- RQ2: What are the key research themes in satisfaction studies that promote the application of UGS design?
- RQ3: What are the thematic evolution and emerging research trends in satisfaction studies that drive UGS design? How can we promote the optimization of urban green spaces?

The structure of this article will be divided into six sections: Section 1 introduces the status and issues of the research topic and identifies the research gaps. Section 2 illustrates details of the research methodology and strategies. Performance analysis in Section 3 describes the global research trends, including the publications' time trend, citation frequency, journal impact, country/institution contribution and collaborations, and core publications. Through temporal keyword analysis, Section 4 explores the major themes of the UGS satisfaction research. Section 5 traces the temporal evolution of satisfaction research themes, identifies hot keywords and emerging trends, and discusses their implications for UGS optimization. The research conclusions, limitations, and prospects are summarized in Section 6.

2. Materials and Methods

2.1. Research Method

This study employs bibliometric analysis. Bibliometric analysis uses quantitative methods to study and analyze literature, describing a discipline or field's development dynamics and potential connections [16]. The term "bibliometrics" was first introduced by Alan Pritchard in 1969 to describe the application of mathematical and statistical methods to the study of books and other communication media. However, its practices date back even further [17]. Since then, many scholars have refined the methods and objectives of

bibliometrics, allowing for statistical analysis of literature based on authors, institutions, countries, journals, collaboration networks, and development trends [18,19]. Knowledge mapping can explore the framework and development trends within a research field, with computer software helping to visualize the relationships between various elements [16,20]. Therefore, development trends, journal impacts, and citation patterns in a specific subject area can be observed using bibliometrics. Bibliometrics is widely applied in various fields such as humanities, social sciences, and medicine [21–23].

CiteSpace (version: 6.4.R1) and the R-package Bibliometrix (2024.04.2) are the core tools used in this study. CiteSpace is one of the most frequently used bibliometric analysis software, capable of constructing relationships between literature and displaying the evolution of hotspots and critical trends over time [24,25]. Bibliometrix, developed within the RStudio project, processes large bibliometric datasets and provides comprehensive tools for systematic analysis [26]. The R-package allows direct data import from core databases like the Web of Science and converts it into formats suitable for quantitative analysis [27]. Descriptive analysis, co-citation, keyword analysis, author collaboration networks, and long-term trend analysis are all supported by CiteSpace and the R-package toolkit, which can both calculate fundamental bibliometric indicators, including total publications, citations, authors, and journals. These tools provide scholars with reliable quantitative support in their research fields [26,27]. Some metrics are involved in CiteSpace: Q-value is used to assess the structure of the network, which ranges from 0 to 1; S-value measures the credibility of the network, which ranges from −1 to 1; *p*-value evaluates the significance, which ranges from 0 to 1 [24,28,29]. In recent years, the rapid development and progress of research in different disciplines have led to increasing recognition and acceptance of bibliometric analysis among scholars. Therefore, bibliometrics has become a powerful analytical method.

This study will analyze the research topic of how satisfaction reviews can contribute to the optimization of UGS design based on the methodology of Systematic Literature Review (SLR) [25,30,31]. Figure 1 will show the research framework of this article, which consists of four steps: data collection, data processing, data analysis and visualization, and conclusions.

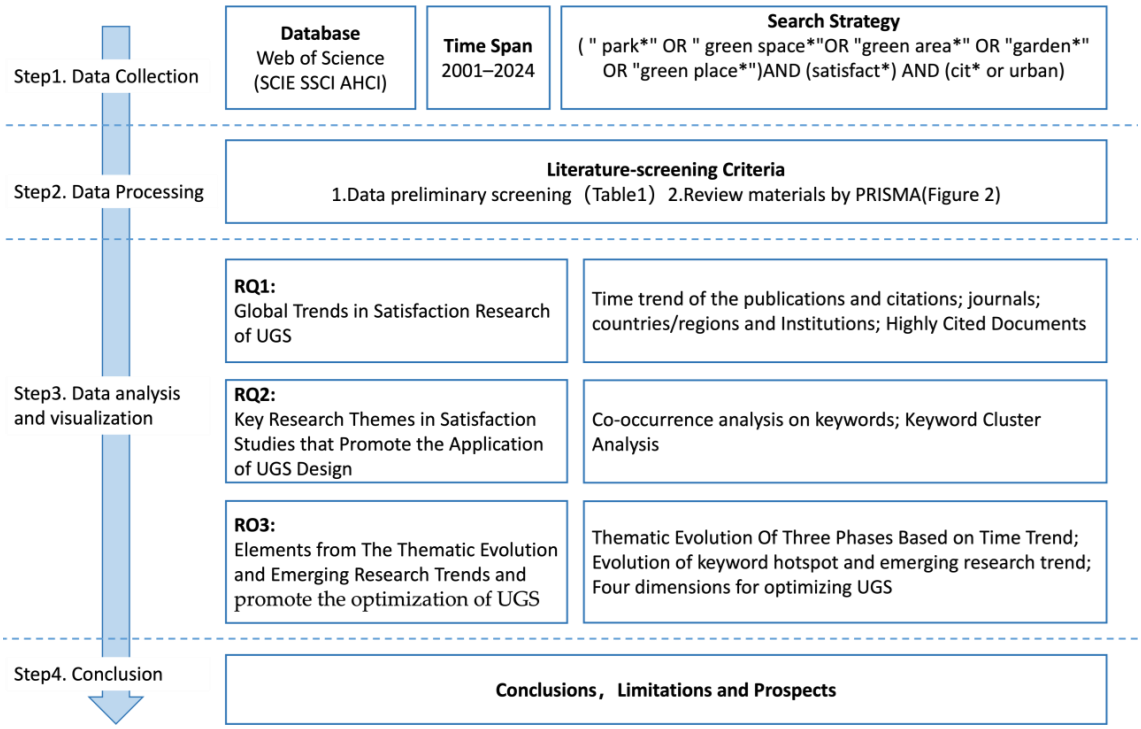


Figure 1. Research framework of the topic.

2.2. Research Strategies and Data

The data search strategy for this paper was to determine the database first. After that, a preliminary selection of exclusion and inclusion criteria was applied in the database, and the keywords for the search strategy were determined based on the research topic. To ensure the comprehensiveness and accuracy of the data, this study selected three indexes from the Web of Science (Core Collection): Science Citation Index Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts and Humanities Citation Index (AHCI). Web of Science is a comprehensive and widely recognized high-quality digital literature database [16,20,23,26]. Some scholars also regard it as the most suitable database for bibliometric analysis [23,26,29], as it provides information such as titles, authors, institutions, countries, abstracts, keywords, references, and citation counts, making it ideal for data analysis. After selecting the database, a search strategy that aligns with the research topic must be established. The strategy should cover all relevant literature on the topic while excluding irrelevant studies. Based on the research topic of "how satisfaction research contributes to the optimization of urban green space", two core elements, "satisfaction" and "urban green space", were identified. The term "urban green space" is then expanded into related terms like "park", "green space", "green area", "garden", "green place", "city", and "urban" through associated concepts and professional terminology. Work with the Boolean logic operators (AND, OR, NOT) to join the terms in a search algorithm. The wildcard "*" can be used to broaden the search term's reach and capture several derivatives and variations of related roots. This can increase accuracy and cover as much pertinent literature as possible [30]. After multiple discussions and attempts, the final search strategy was determined as TS = (("park*" or "green space*" or "green area*" or "garden*" or "green place*") and (satisfact*) and (cit* or urban)). The period was set from 1 January 2001 to 27 July 2024, with the language restricted to English and the document type limited to articles or review articles. A total of 944 valid articles were retrieved (Table 1).

Table 1. Summary of data source and selection.

Category	Specific Standard Requirements
Research database	Web of Science Core Collection
Citation indexes	SSCI, SCIE, AHCI
Searching period	January 2001 to July 2024
Language	English
Searching keywords	("park*" or "green space*" or "green area*" or "garden*" or "green place*") and (satisfact*) and (cit* or urban)
Document types	Articles or Review Article
Data extraction	Export with full records and cited references in plain text format
Sample size	944 (before manual screening)

2.3. Review Materials

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol is primarily used to guide researchers in systematically collecting, analyzing, and reporting on existing literature related to a specific research topic [30,32,33]. Therefore, this research followed the PRISMA guidelines to further screen the retrieved articles according to the four steps of "Search–Initial Screening–Inclusion–Synthesis" [20,26,34,35]. First, three duplicate articles were removed, leaving 941 papers. Next, each article was reviewed, and those unrelated to the study's theme were excluded, ensuring that all remaining articles focused on satisfaction studies and UGS. Team members independently conducted the screening to minimize subjectivity during the screening process. In case of disagreement, discussions were held to determine whether to include the article. After the screening, 628 articles unrelated to the theme were removed, leaving 313 articles. Second, the data's author (AU) and source (SO) fields were corrected and standardized. Identifiers were added to distinguish authors with the same name, preventing the impact of name changes on the analysis results. Third, keywords were standardized. Variations in word forms,

such as tense or singular/plural, caused duplications in the keyword co-occurrence map. Fourth, country names were standardized. For instance, the People's Republic of China was unified as China, and America was unified as USA. After manual screening, 313 papers were finalized as the research sample. The PRISMA flowchart is shown in Figure 2.

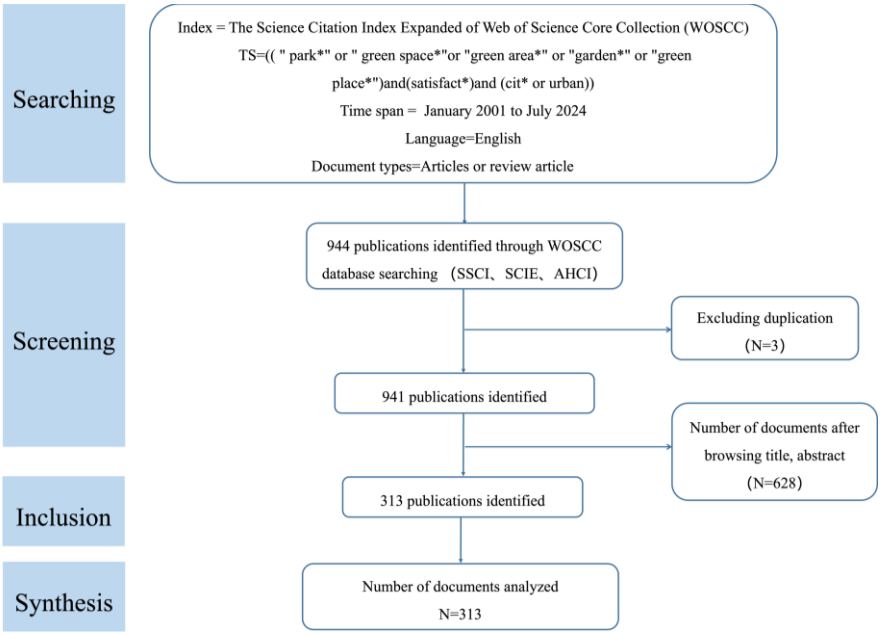


Figure 2. The PRISMA flowchart.

3. Performance Analysis (RQ1)

The analysis of Figure 3 shows that between 1 January 2001 and 27 July 2024, 313 theme-related articles were published globally, sourced from 88 different publications, with an average annual growth rate of 17.4% and involving 1059 authors. The articles contained 1085 keywords, with an average citation count of 24.44 per paper. This section will analyze the overall development trends, countries/institutions, journals, and highly cited papers in this research field to address RQ1.



Figure 3. Overall statistics about the topic from R-Bibliometrix.

3.1. Time Trend of the Publications and Citations

The number of publications reflects the development trend of a topic. Figure 4 illustrates the publication trend of UGS satisfaction. Overall, the number of papers on this topic increased rapidly over time: less than four papers per year from 2001 to 2012 and less than eight per year from 2013 to 2016. From 2017 to 2020, the publication rate tripled, stabilizing at around 20 papers per year. Another surge occurred in 2021 (44 articles), peaking in 2022 (56 articles), before a slight decline. However, as of August 2024, data on publications have not been fully collected; therefore, the current trend appears to be declining. The

COVID-19 pandemic in 2020 seems to have accelerated the output in this field due to increased demand for UGS for physical activity, stress relief, and mental well-being [36–38]. The trend line's R^2 value is 0.992, close to 1, indicating that the prediction fits the real development trend in the field.

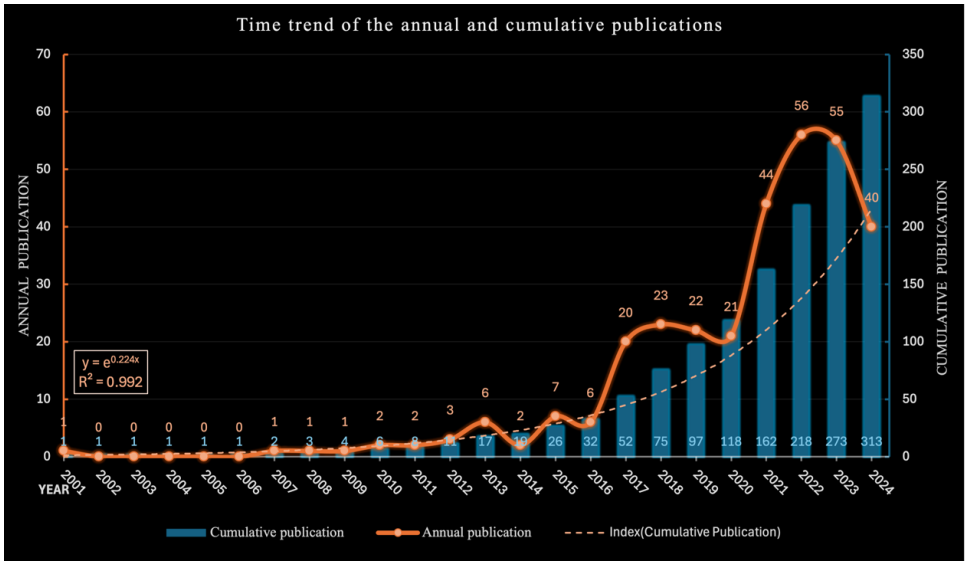


Figure 4. Time trend of the annual and cumulative publications.

Figure 5 shows the annual average citations per publication from 2001 to 2024. The highest average citations occurred in 2013, reaching 15.4. This peak may be due to the sixty-sixth World Health Assembly in May 2013, where the Ministers of Health from 194 Member States adopted WHO's Comprehensive Mental Health Action Plan 2013–2020. Since then, research on the health benefits of UGS has increasingly focused on their impact on mental health and well-being, resulting in significant progress [39,40]. Over the past decade, from 2015 onward, the annual average number of citations has fluctuated downward, possibly due to the citation half-life. Since this study collected data in August 2024, the citation accumulation for more recent publications may be insufficient, resulting in the lowest value in 2024.

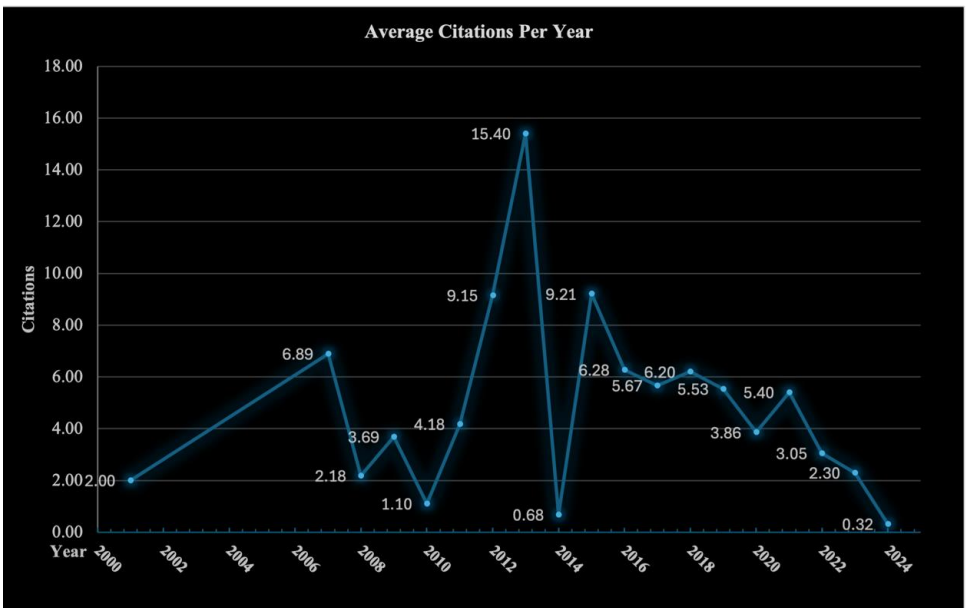


Figure 5. Average citation per year.

3.2. Analysis of Journals

Journals are the primary carriers of academic research, and analyzing journal publications can reflect academic trends in the field [41]. Some scholars point out that critical factors in measuring a journal's influence are the number of articles published and the number of citations within the field [41–43]. Therefore, this study analyzed the top 20 journals by publication volume in this field and calculated the average citations per article.

Samuel Bradford proposed Bradford's Law in 1934, which describes the distribution pattern of academic journals and is used to study the distribution of literature across journals [44]. As shown in Table 2, according to Bradford's Law, journals are divided into three zones. Urban Forestry and Urban Greening (45 articles, 113 citations), Sustainability (38 articles, 355 citations), and International Journal of Environmental Research and Public Health (25 articles, 439 citations) are the top three journals in Zone 1. This indicates that these three journals receive significant attention in research on UGS satisfaction. Additionally, other journals with more than 10 publications include Landscape and Urban Planning (21 articles, 1546 citations), Land (16 articles, 77 citations), and Forests (14 articles, 73 citations), with Landscape and Urban Planning having the highest number of citations (Table 2).

Table 2. Information on the top 20 journals about the topic.

Zone	Rank	Journal	Documents	Citations	Average Cation Per Paper	IF
Zone1	1	Urban Forestry and Urban Greening	45	113	2.51	6
	2	Sustainability	38	355	9.34	3.3
	3	International Journal of Environmental Research and Public Health	25	439	17.56	4.614
Zone2	4	Landscape and Urban Planning	21	1546	73.62	7.9
	5	Land	16	77	4.81	3.2
	6	Forests	14	73	5.21	2.4
	7	Journal of Outdoor Recreation and Tourism-Research Planning and Management	9	49	5.44	3.6
	8	Buildings	6	9	1.50	3.1
	9	Cities	6	214	35.67	6
	10	Ecological Indicators	5	141	28.20	7
	11	Environment Development and Sustainability	5	4	0.80	4.7
	12	Frontiers in Public Health	5	23	4.60	5.2
	13	Building and Environment	4	1	0.25	7.1
	14	Fresenius Environmental Bulletin	4	1	0.25	0.489
	15	Heliyon	4	8	2.00	3.4
	16	International Journal of Sustainable Development and World Ecology	4	4	1.00	3.716
Zone3	17	Land Use Policy	4	134	33.50	6
	18	Applied Research in Quality of Life	3	18	6.00	2.8
	19	Ecological Economics	3	1	0.33	6.6
	20	Frontiers in Psychology	3	1	0.33	2.6

In summary, the journals' research domains include urban forestry, urban development, environmental science, landscape architecture, land use and planning, and public

health. Research in the journal Urban Forestry and Urban Greening often focuses on the relationship between UGS, human well-being, the environment, and plants [45], particularly during the COVID-19 pandemic, when the demand for green spaces and mental health issues increased [46–50]. The most-cited journal, Landscape and Urban Planning, includes articles that focus on green spaces, sustainable development, ecosystems, and green infrastructure. The most-cited articles address the impact of green spaces on residents' well-being during the COVID-19 pandemic [51,52]. It can be concluded that the rapid growth in attention and demand for UGS due to the pandemic has driven scholarly interest and development in this field.

3.3. Analysis of Countries/Regions and Institutions

This study examined 313 publications related to 56 countries to determine whether nations have significantly advanced the UGS satisfaction field in influencing urban design improvements. Figure 6 shows the interconnections between countries, institutions, and authors.

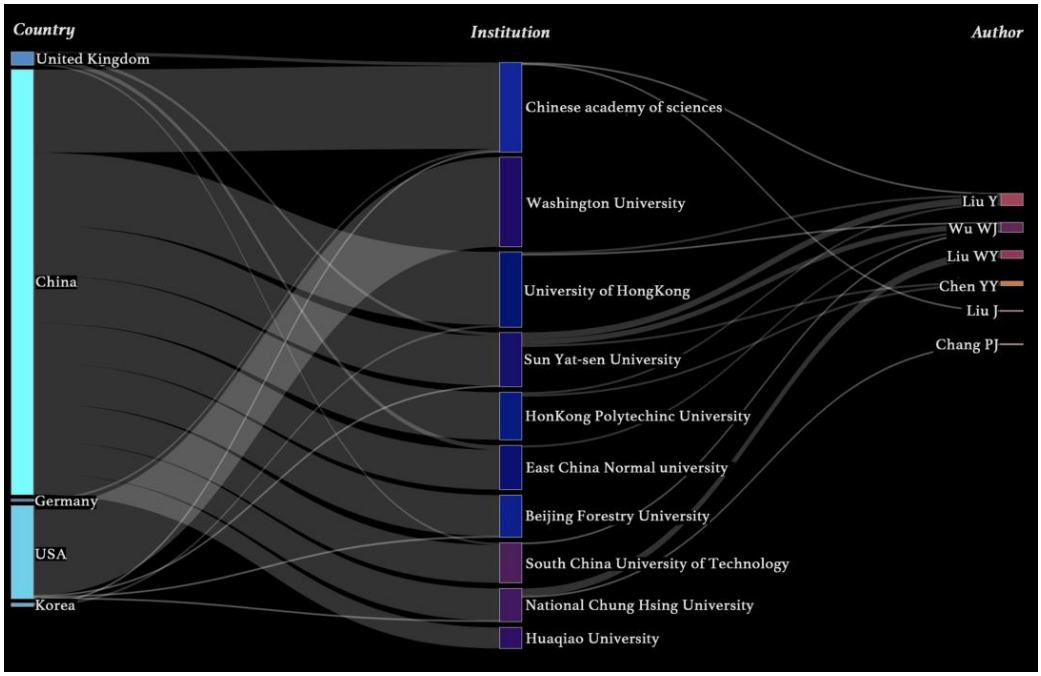


Figure 6. Three-field map about countries, institutions, and authors from R-Bibliometrix.

Table 3 lists the top 10 countries/regions by the number of publications, with China (n = 159) being the most influential, receiving 2251 citations. This suggests that as China urbanized, with increasing education and living standards, individuals began to focus more on the quality of their living environments [2,8,53]. Particularly after the onset of COVID-19, multiple lockdowns heightened the need for green spaces to relieve mental stress, driving park construction and the growth of related economies such as the camping economy [36,54]. These developments have increased the demand for better UGS design, renewal, and transformation to meet individuals' needs. Table 3 shows that the USA (n = 34) and South Korea (n = 23) ranked second and third, with 939 and 298 citations, respectively. Although the United Kingdom (n = 21) ranked fourth in scientific contributions, it garnered 1473 citations, second only to China.

Further analysis of publishing institutions using CiteSpace identified 226 institutions that contributed to research on this topic. Table 4 lists the top 10 institutions by the number of publications, with Beijing Forestry University in China ranking first with 14 publications and 276 citations. The Chinese Academy of Sciences follows with 10 publications, and Hong Kong Polytechnic University ranks third with 8 publications. Upon review, among the top 10 institutions, Karadeniz Technical University (ranked eighth) is in Turkey, Eindhoven

University of Technology (ranked ninth) is in the Netherlands, and the others are based in China. This reflects the fact that Chinese research institutions have a stronger focus on the topic of UGS satisfaction and urban design. Reports such as the Opinions on Comprehensively Promoting the Construction of a Beautiful China and the Opinions on Strengthening the Control of Ecological Zones have also guided Chinese scholars to emphasize and continue to deepen their research in this field.

Table 3. Top 10 productive countries/regions about the topic, ranked by the number of documents.

No.	Country/Region	Document	Percentage (%)	Citations	Average Citation Per Paper
1	China	159	53.9	2215	13.93
2	USA	34	11.5	939	27.62
3	South Korea	23	7.8	298	12.96
4	United Kingdom	21	7.1	1473	70.14
5	Germany	12	4.1	887	73.92
6	Turkey	11	3.7	75	6.82
7	Spain	10	3.4	358	35.80
8	Japan	9	3.1	212	23.56
9	Australia	8	2.7	268	33.50
10	The Netherlands	8	2.7	327	40.88

Table 4. Top 10 productive institutions about topic (ranked by the number of documents).

No.	Institutions	Document	Citations	Average Citation Per Paper
1	Beijing Forestry University	14	276	19.7
2	Chinese Academy of Sciences	10	133	13.3
3	Hong Kong Polytechnic University	8	258	32.3
4	Huaqiao University	6	31	5.2
5	Wuhan University	6	41	6.8
6	Fujian Agriculture and Forestry University	6	7	1.2
7	Zhejiang University	5	103	20.6
8	Karadeniz Technical University	5	45	9
9	Eindhoven University of Technology	5	76	15.2
10	Jinan University	5	86	17.2

3.4. Analysis of Highly Cited Documents

The primary purpose of a highly cited literature analysis is to identify key discoveries, perspectives, and development trends related to the research topic, offering valuable insights for future studies [20]. The bibliometrix R-package allows for the calculation of highly cited documents, and we use it to rank the documents based on citation frequency. Hence, R-package can be used to rank the documents according to the citation times. Table 5 presents the 10 most cited papers on this topic. Related co-citation analyses can reveal the structure and context of knowledge in the research area, as well as trends in disciplinary cross-fertilization (Appendix A). Analyzing these papers provides a clear understanding of the key perspectives driving changes in UGS design through satisfaction studies.

Highly cited papers emphasize the close relationship between UGS and factors such as mental health, well-being, social relationships, and place attachment. Geographic Information System (GIS) analysis is a crucial tool for studying the dynamic relationship between UGS and residents' mental health and well-being [55]. White et al. (2013) and Nutsford et al. (2013) found a positive correlation between UGS coverage, reductions in residents' psychological stress, and improvements in well-being. Although research offers high external validity through control variables, the exploration of mechanisms linking green space characteristics to health and well-being remains inadequate [39,40]. The Research identified a non-linear relationship between green space and well-being, with the subjectiveness of 'well-being' being influenced by individual perceptions and cultural background [56,57]. Bertram and Rehdanz (2015) proposed an "inverted U-shaped" effect, indicating that both an excess and a deficiency of green space could affect well-being, highlighting the nuanced relationship between green space and human satisfaction.

This balance suggests that while the availability of green space generally benefits locals by providing recreational opportunities, reducing stress, and improving environmental conditions, an excess of green space may present challenges, such as higher maintenance requirements, noise, traffic, or safety concerns, all of which can lower well-being if poorly managed [56]. Zhang et al. (2017) and Hofmann et al. (2012) emphasized that the subjective assessment of green space quality is more critical than its quantity, and that differences in preferences between residents and planners pose challenges for urban planning [58,59]. Further research has noted that green space structure and biodiversity significantly impact health; however, actual biodiversity enhancement has had limited impacts [60,61]. Lee and Shen (2013) and Ramkissoon et al. (2018) determined through analysis that community participation and place attachment promote residents' emotional connection and quality of life as well as moderate well-being [62,63]. The research methods used in the highly cited literature involved panel data, GIS, self-reporting, literature review, experimental simulation, structural equation modeling analysis, etc. The matrix of detailed analyses is attached in Appendix B.

Table 5. Highly cited documents.

No.	Document	Citations
1	Would You Be Happier Living in a Greener Urban Area? A Fixed-Effects Analysis of Panel Data [40]	1196
2	An ecological study investigating the association between access to urban green space and mental health [39]	690
3	The role of urban green space for human well-being [56]	596
4	Perceptions of parks and urban derelict land by landscape planners and residents [58]	330
5	The greener, the happier? The effect of urban land use on residential well-being [57]	322
6	Linking public urban green space and human well-being: A systematic review [60]	308
7	The influence of leisure involvement and place attachment on destination loyalty: Evidence from recreationists walking their dogs in urban parks [62]	297
8	Quality over Quantity: Contribution of Urban Green Space to Neighborhood Satisfaction [59]	266
9	Social involvement and park citizenship as moderators for quality-of-life in a national park [63]	248
10	Perceived species-richness in urban green space: Cues, accuracy and well-being impacts [61]	245

4. Temporal Keyword Analysis (RQ2)

4.1. Co-Occurrence Analysis on Keywords

Keywords represent the core and essence of an article, and research topics are dynamic and constantly evolving. Research hotspots, emerging trends, connections, overlaps, and changes across disciplines can all be identified with keyword frequency and co-occurrence analysis. CiteSpace can provide keyword co-occurrence frequency statistics. Table 6 lists the top 10 keywords: Health, UGS, Physical Activity, Satisfaction, Quality, City, Benefits, Urban Parks, Mental Health, and Environment. Betweenness Centrality (BC) reveals the structural importance of keywords within the knowledge network and is an effective measure for analyzing knowledge evolution and identifying research frontiers. As shown in Table 6, City (BC = 0.17), Health (BC = 0.14), and Benefits (BC = 0.13) indicate that, with the acceleration of urbanization, research is increasingly focusing on improving urban environments (e.g., green spaces and public facilities) to enhance residents' physical and

mental health, thereby improving overall health outcomes [52,53]. Parks are essential spaces where residents can relax, exercise, and socialize with neighbors, significantly impacting their physical and emotional well-being. The top three keywords highlight the academic focus on the connection between UGS and physical health: UGS provide residents with ideal venues for outdoor activities, promoting physical activity and improving overall well-being [64,65]. These positive effects may stem from the natural ecological elements in UGS, which create a conducive environment for physical activity. Physical activity, health, and mental well-being are core topics in research related to urban environments and quality of life [61,64]. Factors such as the accessibility, size, and design of green spaces are crucial for residents' well-being, stress relief, and social interaction [60,62].

Table 6. Top 10 keywords.

Rank	Count	BC	Mean (Year)	Keywords
1	83	0.14	2009	Health
2	81	0.07	2012	Urban green space
3	80	0.07	2009	Physical activity
4	53	0.1	2012	Satisfaction
5	46	0.07	2011	Quality
6	45	0.17	2007	City
7	43	0.13	2001	Benefits
8	34	0.01	2014	Urban parks
9	32	0.07	2012	Mental health
10	27	0.07	2015	Environment

4.2. Keyword Cluster Analysis

Clustering analysis of keywords provides an objective reflection of the knowledge structure and development dynamics in the research field. Figure 7 displays the clustering of keywords, revealing ten themes that satisfaction research has driven in UGS design transformation. In clustering analysis, the Q value (range 0–1) evaluates the network structure, with values above 0.3 indicating a well-structured network [28]. The S value (range −1 to 1) measures network credibility, with values above 0.7 indicating high credibility [28]. As shown in Figure 7, the Q value (0.4218) and S value (0.7387) confirm that this clustering accurately represents the research themes. Figure 8 illustrates the evolution of the knowledge structure over time. In keyword analysis, the Log-Likelihood Ratio (LLR) measures the association strength between keywords. Positive LLR values indicate higher than expected co-occurrence, while negative values suggest lower than expected co-occurrence, with larger absolute values indicating stronger associations [24,29]. The p value (range 0–1) evaluates LLR significance; values below 0.05 generally indicate statistically significant keyword associations [18,24]. The following provides a detailed analysis of these eleven clusters. The detailed analysis from Table 7 shows that:

Cluster #0 focuses on user satisfaction, a key metric for assessing and guiding urban design since 2009, with a peak in research in 2013. Studies emphasize individual–environment interactions, such as walkability [66], green space access, and environmental equity [64] as pivotal for satisfaction and community well-being [19,52]. Walkable environments promote physical activity, improve access to green spaces, and strengthen community bonds [6,8]. Perceptions of walkability also shape satisfaction and inform urban design strategies [66]. While green spaces enhance physical and mental health [15], access disparities across socioeconomic groups raise environmental justice concerns [57,60]. Therefore, it is crucial to ensure equitable access to UGS to promote satisfaction and sense of community [67]. Research on satisfaction with walkability, equity, and green space access supports sustainable urban design, enhancing public engagement and community cohesion.

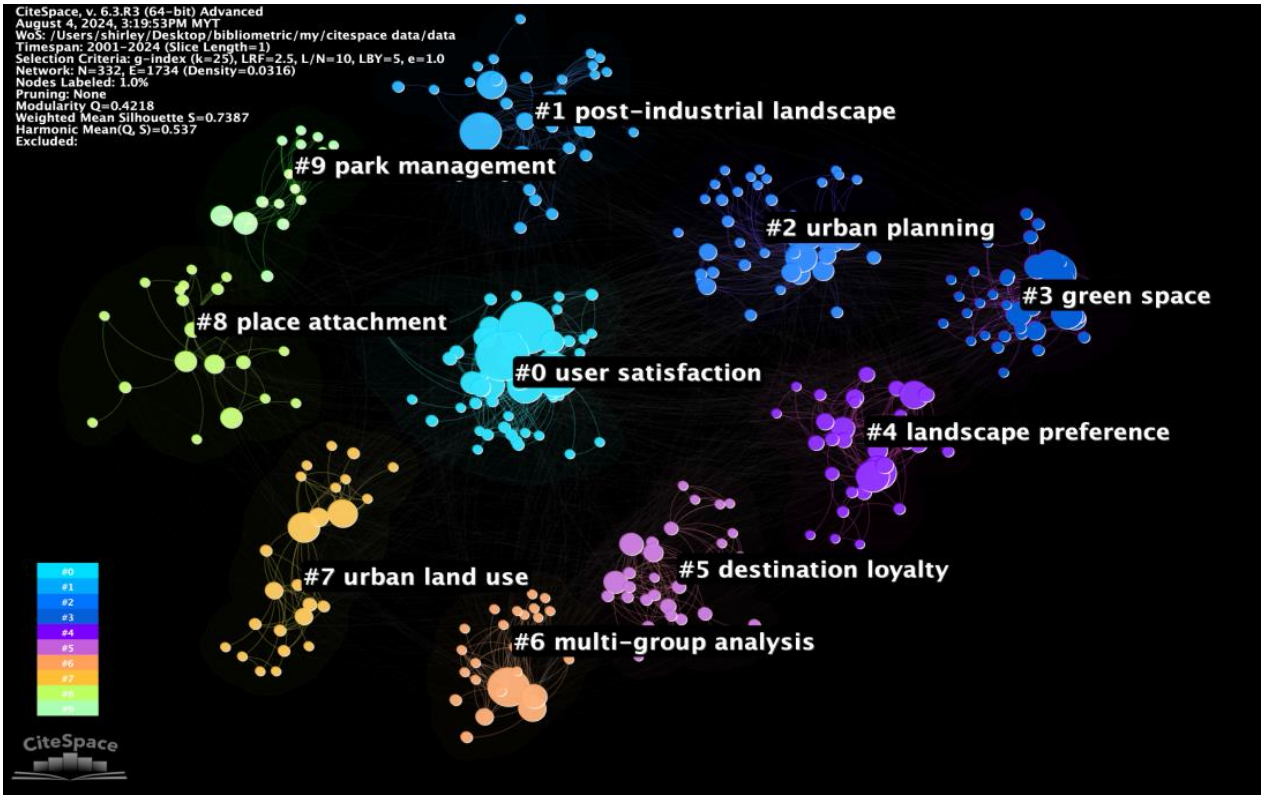


Figure 7. Cluster of keywords about the topic from CiteSpace.

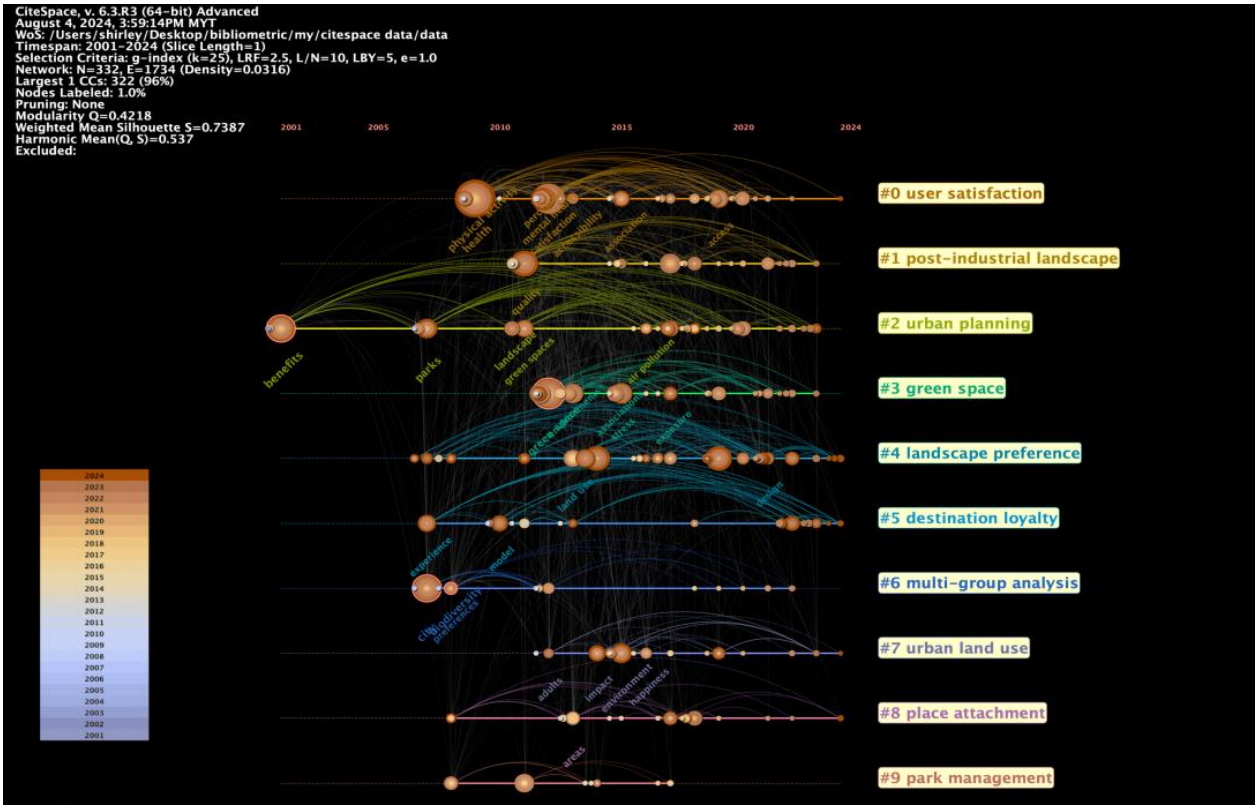


Figure 8. Keyword timeline visualization map about the topic from CiteSpace.

Table 7. Cluster of keywords about the topic.

Cluster	Size	Silhouette	Mean (Year)	Top Terms (Log-Lihood, Ratio-Level)
#0 user satisfaction	48	0.712	2016	user satisfaction (9.51, 0.005); urban design (6.34, 0.05); walkability (6.34, 0.05); environmental justice (6.34, 0.05);
#1 post-industrial landscape	39	0.756	2017	post-industrial landscape (9.25, 0.005); urban parks (6.36, 0.05); combined effects (5.64, 0.05); perceptions (5.15, 0.05); sound perception (4.61, 0.05)
#2 urban planning	39	0.619	2013	urban planning (7.48, 0.01); Beijing (4.66, 0.05); crowdsourcing (4.03, 0.05); perceived well-being benefits (4.03, 0.05); residence immediate environment (4.03, 0.05)
#3 green space	38	0.715	2016	green space (18.65, 0.005); leisure satisfaction (7.83, 0.01); restorative environments (7.83, 0.01); urban density (7.83, 0.01); health (5.82, 0.05)
#4 landscape preference	37	0.649	2018	landscape preference (11.3, 0.001); urban parks (10.3, 0.005); landscape perception (7.79, 0.01); urban green space (4.42, 0.05); tourist walking satisfaction indicator (3.99, 0.05)
#5 destination loyalty	33	0.882	2017	destination loyalty (17.45, 0.001); social media (13.07, 0.001); industrial heritage (11.61, 0.001); city park (11.61, 0.001); tourist satisfaction (7.9, 0.005)
#6 multi-group analysis	25	0.82	2011	multi-group analysis (5.1, 0.05); urban rocky habitats (5.1, 0.05); planning (5.1, 0.05); feelings in green spaces (5.1, 0.05); small urban green space (5.1, 0.05)
#7 urban land use	25	0.75	2017	urban land use (10.25, 0.005); happiness (6.48, 0.05); Switzerland (5.12, 0.05); indicators (5.12, 0.05); machine learning (5.12, 0.05)
#8 place attachment	21	0.71	2016	place attachment (9.96, 0.005); outdoor recreation (6.36, 0.05); high-density community green roofs (6.36, 0.05); public services (6.36, 0.05); cluster analysis (6.36, 0.05)
#9 park management	17	0.919	2013	park management (14.17, 0.001); urban park (12.34, 0.001); soundscape quality (10.41, 0.005); citizen survey (7.06, 0.01); User profile information (7.06, 0.01)

Cluster #1 examines post-industrial landscapes, focusing on the transformation of industrial sites into green spaces during urban development. As industries decline, many abandoned sites have been repurposed, with respondents valuing environmental and aesthetic improvements and favoring redevelopment over new land use [68]. However, balancing the historical value of sites with modern design remains crucial. Research highlights that public participation in planning these spaces enhances community identity, promotes social equity, and fosters sustainable development [69]. Additionally, the quality of the acoustic environment in urban parks significantly influences users' emotional responses and their willingness to engage with these spaces [13]. Research suggests that carefully designed soundscapes in green spaces can reduce perceived urban noise, helping to alleviate stress for residents in densely populated areas [13,14]. By integrating soundscape design principles, urban planners can create more enjoyable and relaxing environments, promoting social interaction and physical activity and further optimizing post-industrial landscapes.

Cluster #2 focuses on democratized urban planning, incorporating crowdsourcing and crowdfunding as emerging participatory models. Beijing's urban planning, for example, illustrates how crowdsourcing, paired with Public Participatory Geographic Information

Systems (PPGIS), facilitates planners' understanding of community needs, enhancing well-being [70,71]. However, the effectiveness of crowdsourcing relies on data quality and inclusivity, which strengthen legitimacy and promote environmental justice by ensuring equitable UGS access [72,73]. Future research must address the balance between democratic input and effective design outcomes.

Cluster #3 emphasizes green spaces as essential urban design elements, focusing on their roles in recreational satisfaction, restorative environments, and health. UGS designs that maximize recreational access improve health and foster emotional connections with nature [74]. The interplay between urban density and green space satisfaction emphasizes the need for sufficient green spaces in densely populated areas to support life satisfaction and mitigate the adverse effects of urbanization [75]. Advocates for green space restoration call for a balanced approach that enhances public health without triggering gentrification [76], enabling planners to create restorative environments that improve urban quality of life.

Cluster #4 examines landscape preferences, emphasizing the importance of diversity and complexity. Landscape design addresses diverse social needs and aesthetics across age, gender, and education levels [14,58,77]. Studies on preferences assess whether urban park walking spaces meet visitor needs, guiding design improvements [78,79]. Different user groups, including tourists and residents, hold varied expectations for green spaces, posing challenges for inclusive design.

Cluster #5 emphasizes the connection between destination loyalty and social media. Visitor satisfaction is crucial for loyalty, with positive social media feedback increasing trust and return intentions [80]. Future research may examine how design can enhance visitor loyalty, considering social media's role in promoting tourism [81]. Industrial heritage, while valuable, faces preservation challenges. Incorporating it into urban parks raises awareness and fosters emotional connections, thereby enhancing destination loyalty [82]. Additionally, strong destination imagery in UGS design elevates perceived value and satisfaction, thus sustaining loyalty and guiding ongoing UGS optimization [82].

Cluster #6 examines multi-group analysis, a widely used method in social sciences to compare demographic groups' perceptions of UGS [83]. This approach helps identify distinct needs and perceptions of green spaces, particularly regarding niche elements like "urban rock habitats" and "small green spaces" [82–84]. Such analysis reveals how cultural and economic backgrounds influence user experiences with spatial layout and visual elements, helping designers create more inclusive and equitable spaces [83].

Cluster #7 focuses on technological trends in UGS management, primarily through big data and machine learning, marking a shift toward intelligent urban planning. Machine learning enables predictive models to assess land use impacts on well-being, such as converting industrial spaces into parks [85,86]. However, data privacy and bias issues require careful handling. To ensure comprehensive well-being, UGS design should consider key factors like community cohesion, social involvement, and accessibility [66,68,87].

Cluster #8 addresses place attachment, describing residents' emotional bonds with specific spaces. Scannell and Gifford's framework explains this attachment through personal, social, and environmental dimensions, which are integral to environmental satisfaction and protection [88]. Green space design strengthens these connections, particularly under urban density and stress [77]. Civic engagement and environmental awareness are vital for sustainable communities. Accessible and well-maintained green spaces deepen residents' place attachment, fostering community and belonging [89]. Future research should ensure that innovative designs meet residents' needs and reinforce place attachment.

Cluster #9 focuses on park management, with keywords like "soundscape quality" and "citizen surveys" highlighting a strong focus on management and service quality in modern park design [51]. Parks are recreational spaces, as well as spaces for education and community connections [26]. Designers can improve management and design by assessing community needs through interactions between park administration and residents [70,84]. However, further research is still required to encourage park participation, promote in-

trinsic self-management, and maintain high management and user satisfaction levels in expansive parks.

5. Thematic Evolution and Hotspot Analysis

5.1. Thematic Evolution

The research theme is a dynamic evolving process. To better understand the trends and thematic evolution of research hotspots, this research will be divided into three phases based on the time trend of annual publications (Figure 3): The first phase is the Inception and Exploration Phase (January 2001–December 2016), spanning 16 years, during which annual publications increased from 1 to about 7, indicating a relatively low overall volume. Hence, this stage represents the initial exploration phase. The second phase is the Intensive Research and Breakthrough Phase (January 2017–December 2020), where the number of publications increased to about 20 annually, showing significant growth compared to the previous phase. The third phase is the Rapid Advancement and Expansion Phase (January 2021–July 2024), during which the publication volume increased by 2–3 times over the previous phase and continues to grow. A more detailed analysis of keyword evolution during these phases will be conducted to understand the dimensions that drive the transformation trajectory of UGS through satisfaction studies (Figure 9).

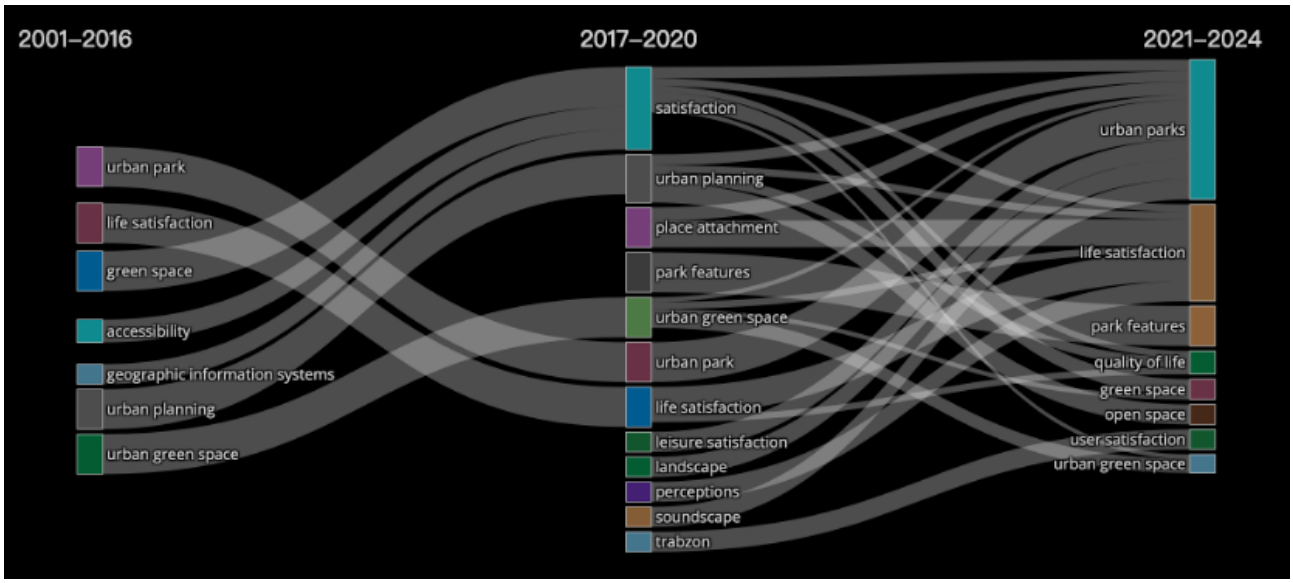


Figure 9. Thematic evolution of keywords from R-Bibliometrix.

5.1.1. Inception and Exploration Phase (January 2001–December 2016)

Between January 2001 and December 2016, the annual publication volume remained relatively low (Figure 3), marking the early stage of research on green space satisfaction. The keyword co-occurrence network in Figure 10 reflects the growing recognition of the multiple benefits of UGS, particularly those related to health, biodiversity, and physical activity [65,90,91]. This phase represents a significant shift in urban planning and public health discourse, emphasizing the integration of green spaces into urban environments to improve overall quality of life [90,92]. Studies have shown that proximity to green spaces is linked to improved physical and mental health outcomes [90]. The quantity of green spaces in residential areas strongly correlates with perceptions of health, underscoring the role of urban greening in promoting well-being [92]. Physical activity is another key aspect of green space satisfaction research. Some scholars suggest that residents, particularly children, are more likely to engage in physical activity in parks and playgrounds, especially when these areas are well-connected and easily accessible [93]. Song et al.'s research supports this finding, documenting the physical and psychological benefits of walking in

urban parks and reinforcing that green spaces are important venues for promoting active lifestyles [65].

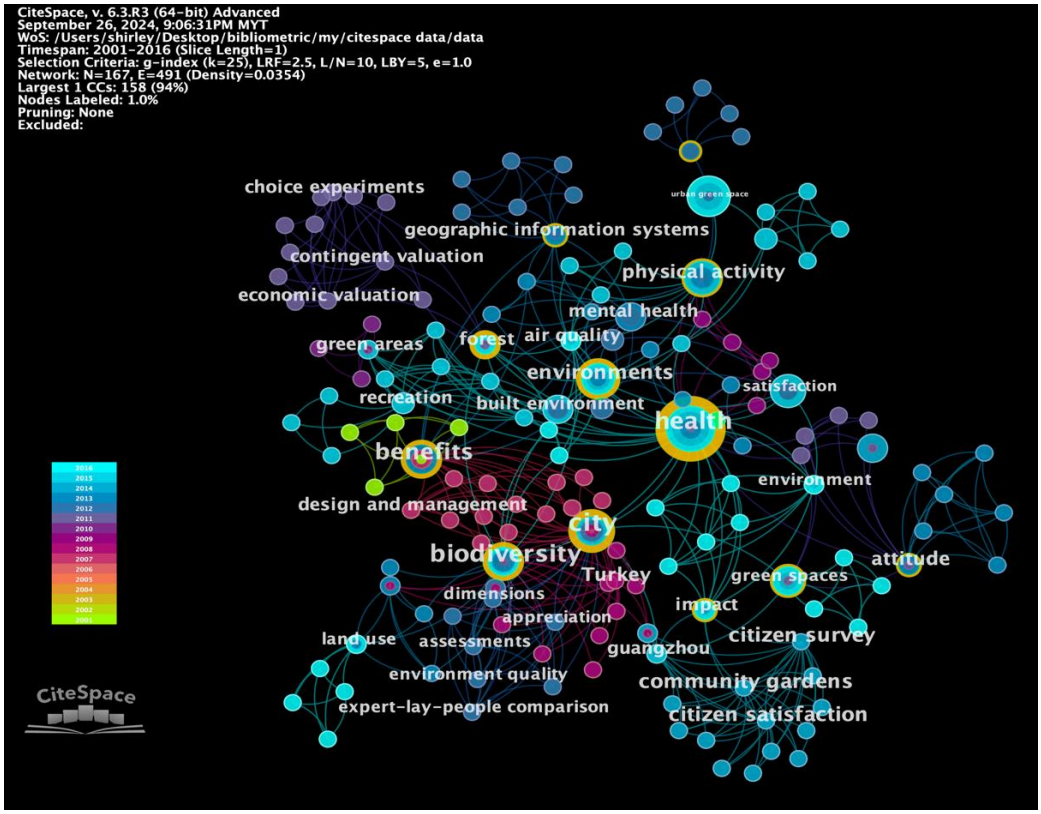


Figure 10. Keyword network analysis between 2001 and 2016 from CiteSpace.

Beyond health benefits, scholars have also paid considerable attention to the role of biodiversity in UGS. The psychological benefits of green spaces increase with higher biodiversity [91], indicating that just providing green spaces is insufficient. To optimize human health and well-being, these spaces must possess high quality and natural diversity [39,94]. However, urban expansion and land-use changes have threatened urban biodiversity. Consequently, many studies during this phase have advocated for greater consideration of ecological factors in green space design [39].

As urbanization intensifies, effective management and maintenance of UGS have become critical issues. Research indicates that collaboration between government, communities, and private institutions is an effective way to ensure the long-term benefits of UGS [95]. Additionally, the concept of public participation in planning has gradually gained attention. Studies show that involving residents in green space planning not only improves satisfaction but also strengthens community cohesion [13,96,97]. However, it remains in the conceptual introduction stage without significant advancement.

Green space satisfaction research has evolved from focusing on health and physical activity to exploring biodiversity and technological applications from a multi-dimensional perspective. Researchers have increasingly recognized the positive impact of green spaces on residents' physical and mental health, particularly by improving mental health through physical activity and contact with nature. However, as urbanization progresses, the decline in biodiversity has become a key challenge in UGS design, requiring designers to balance ecological benefits with resident satisfaction. Additionally, the number of publications during this phase was limited, and keyword analysis was somewhat constrained, indicating relatively shallow research at this stage. These early explorations laid the groundwork for future improvements in UGS design but have not yet led to large-scale practices.

5.1.2. Intensive Research and Breakthrough Phase (January 2017–December 2020)

The period from January 2017 to December 2020 marked a critical phase in the exploration of UGS satisfaction research. During this period, the number of publications increased rapidly. In 2020, the sharp decline in publications was attributed to the COVID-19 pandemic, which disrupted industries and delayed publication cycles. Research on UGS expanded and deepened further. As shown in Figure 11, this phase saw a notable increase in research on the emotional perception of UGS, alongside studies on health, physical activity, and green spaces, in contrast to the previous phase. Satisfaction research began to tackle complex issues such as environmental equity and sustainability. The research predominantly employed mixed methods, including questionnaires, interviews, and surveys to gather segmented user opinions and preferences regarding green spaces.

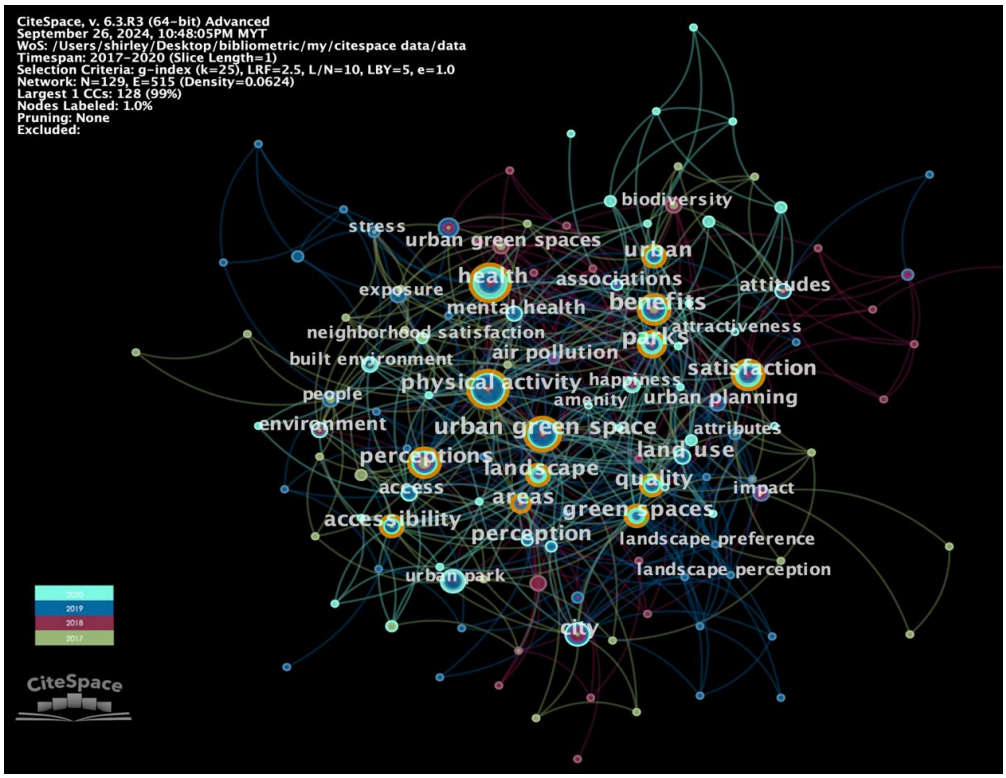


Figure 11. Keyword network analysis between 2017 and 2020 from CiteSpace.

An increasing number of scholars recognize that UGS is a vital component of sustainable urban environments. Integrating green spaces into urban design is not just an aesthetic choice but a necessity for promoting public health and well-being [98,99]. More in-depth studies show that green spaces contribute to stress reduction, mood improvement, and enhanced mental health [9,64,98]. They also examine how modern lifestyles—such as sedentary behavior, walking, and cycling—require green spaces for adjustment and compensation [100]. Pedestrian streets and cycling paths integrated with green spaces promote physical activity and contribute to improving residents' well-being [61]. The quality of UGS is a crucial determinant of user satisfaction. Perceptions of green space quality significantly influence residents' satisfaction, often outweighing the impact of green space quantity [59].

Various factors, including accessibility, quality, and available activities, influence users' perceptions and satisfaction with UGS. Studies suggest that community participation in green space design and planning can significantly improve user satisfaction and foster a sense of ownership [101]. Children's mental health is positively correlated with the availability and quality of green spaces in their communities, highlighting the need for inclusive design to cater to the needs of diverse groups [102]. Additionally, Li et al. explored

gender differences in the perception of UGS, finding that men and women experience and value green spaces differently, which has important implications for urban planning strategies [103].

The outbreak of COVID-19 led to a sharp rise in public demand for healthy environments, making UGS an essential resource. This public health crisis exposed the imbalance between green space supply and demand, particularly in high-density urban areas where green resources were insufficient and outdoor activity spaces limited [104]. Studies found that people living near green spaces reported a significant reduction in psychological stress during the pandemic. Green spaces became crucial for alleviating social anxiety and isolation [76]. This necessitates a post-pandemic reassessment of green space distribution and usage equity.

Thus, research on green space satisfaction underwent a crucial phase of exploration and deepening between 2017 and 2020. Researchers gradually shifted from focusing solely on the singular effects of green spaces (e.g., health or ecological benefits) to comprehensive analyses of their multiple values, including economic, social, and ecological dimensions. The pressures of the pandemic also accelerated the shift in urban planning toward public participation and data-driven approaches [104]. Public participation GIS (PPGIS) research found that broad public involvement helps planners better understand community needs and enhance residents' well-being [70]. The quality and representativeness of crowdsourced data directly affect planning outcomes, particularly during the pandemic, when analyzing community green space needs became especially important [37,104]. These research trends reflect that UGS planning and management are moving toward more human-centred and refined approaches, providing essential theoretical support for the improvement of residents' quality of life.

5.1.3. Rapid Advancement and Expansion Phase (January 2021–July 2024)

The period from January 2021 to July 2024 marks the accelerated development phase of UGS satisfaction research. Influenced by factors such as the pandemic, research on UGS demand and satisfaction has reached a peak publication period. As shown in Figure 12, the scope of the field has expanded, and the focus has become more diverse and significant.

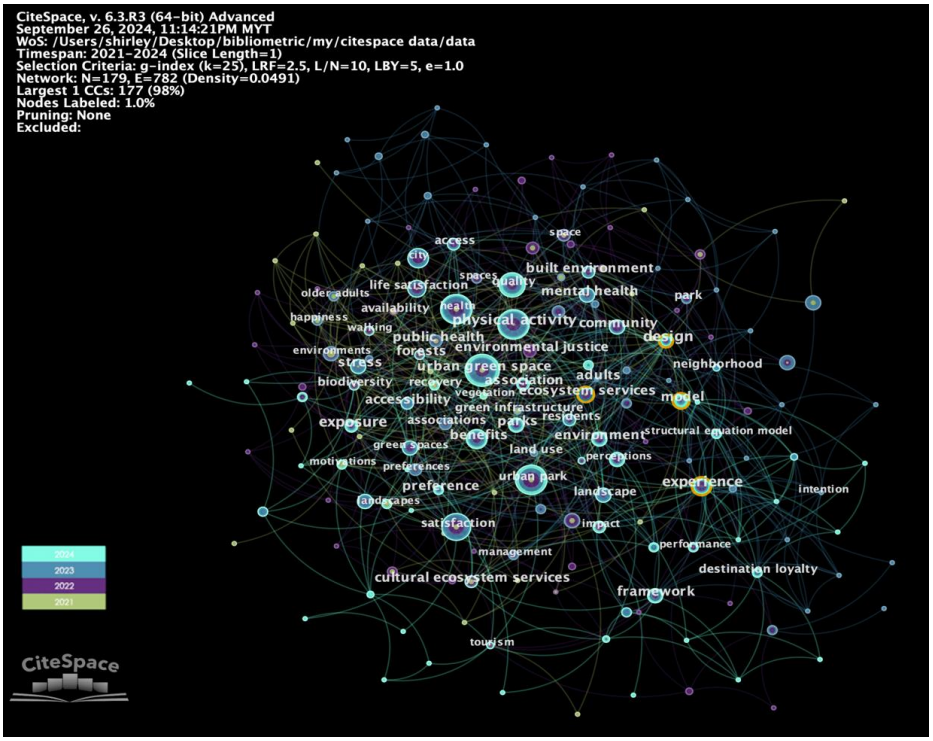


Figure 12. Keyword network analysis between 2021 and 2024 from CiteSpace.

Satisfaction research has increasingly adopted digital technologies and analytical frameworks. Increasingly, studies are using Geographic Information Systems (GIS) and remote sensing technologies to assess the spatial distribution and accessibility of UGS [55]. Advances in GIS offer more detailed insights into how park attributes influence user satisfaction and revisit intentions. Participatory methods, such as Public Participation Geographic Information Systems (PPGIS), have been employed to gather community opinions on green space design, ensuring that user preferences are incorporated into the planning process [105–107].

At this stage, the importance of urban parks and green spaces in promoting well-being has become more widely recognized, especially during the COVID-19 pandemic. The pandemic highlighted the role of urban parks as essential spaces for recreation and social interaction, with green spaces serving as havens for city residents coping with lockdowns and isolation [38]. The pandemic exposed deficiencies in public health infrastructure and spatial design in some parks, prompting adjustments such as increasing open space and optimizing crowd management [36]. Importance–Performance Analysis (IPA) is increasingly used to assess the effectiveness of park management and design, particularly in evaluating the relationship between user satisfaction and revisit intention [108]. At this stage, green space design must meet daily recreational needs and serve as a critical resource for addressing public health emergencies.

Multi-group analysis reveals further differences in green space needs among various groups, particularly during the pandemic. Designing inclusive green space solutions for different groups can enhance user satisfaction and reduce social inequity [85]. Meanwhile, the application of machine learning and big data technologies in UGS management has advanced. Activity restrictions during the pandemic increased residents' dependence on digital technologies. Predictive models developed through spatial data analysis enable more accurate predictions of how various green space designs impact well-being [86].

Therefore, data-driven approaches and social media engagement characterize green space satisfaction research during this phase. The COVID-19 pandemic, in particular, led to lifestyle changes, and satisfaction research has adapted more effectively to the unique demands of UGS in this context. Data-driven planning methods have helped designers better understand green space usage patterns, especially in coordinating supply and demand during pandemic responses.

Over the past 20 years, research on UGS satisfaction has evolved from initial exploration to rapid development, driving continuous innovation in green space design. The period from 2001 to 2016 was an exploratory phase, with research focusing on the impact of green spaces on health and physical activity, gradually recognizing their potential to improve mental health. However, much of the research focused on single effects, with insufficient attention to the impacts of biodiversity and urbanization. Although there were few publications, this phase laid the theoretical foundation for subsequent studies. From 2017 to 2020, the research entered a breakthrough phase, focusing on the multiple values of green spaces, including health, economic, social, and ecological benefits, with public participation and data-driven approaches gradually integrated into urban planning. However, issues with the representativeness of crowdsourced data limited its practical utility. From 2021 to 2024, big data and social media further advanced green space research, especially during the pandemic, when shifting demands led to technology-driven planning models optimizing the balance between design and usage. However, over-reliance on data may overlook the value of biodiversity and natural aesthetics. Overall, research has shifted from qualitative to quantitative approaches, enhancing scientific rigor and public participation; however, future efforts must find a balance between residents' needs, ecological benefits, and technological applications.

5.2. Evolution of Keyword Hotspot and Emerging Research Trend

The evolution of keywords reflects the continuous development of the field of UGS satisfaction research, with keyword emergence and shifts indicating changes in research

trends. Table 8 presents the most prominent keywords in terms of citation bursts from 2001 to 2024, along with their duration. Keywords are categorized into three main phases based on their burst patterns.

Table 8. Top 32 keywords with the strongest citation bursts.

	Keywords	Strength	Begin	End	2001–2024
1st Phase	biodiversity	3.01	2008	2018	
	national park	1.38	2008	2018	
	forest	1.91	2011	2018	
	attitude	1.59	2011	2019	
	geographic information systems	1.31	2012	2013	
	diversity	1.53	2013	2018	
	management	1.55	2014	2017	
	guangzhou	1.32	2014	2015	
	land use	1.69	2016	2017	
	impact	1.36	2016	2018	
	areas	2.91	2017	2018	
	perceptions	2.1	2017	2018	
	urban green space	1.62	2017	2018	
2nd Phase	urban planning	1.97	2018	2019	
	antecedents	1.54	2018	2019	
	subjective well-being	2.19	2019	2022	
	access	2.03	2019	2020	
	environmental justice	3.23	2020	2022	
	ecosystem services	2.48	2020	2022	
	environments	2.24	2020	2021	
	space	2.16	2020	2022	
	restoration	2	2020	2021	
	cultural ecosystem services	1.83	2020	2022	
	walking	1.78	2020	2022	
	behaviour	3.1	2021	2022	
	quality of life	2.02	2021	2022	
	responses	1.54	2021	2022	
	forests	1.31	2021	2022	
3rd Phase	residents	2.07	2022	2024	
	framework	1.86	2022	2024	
	visitors	1.55	2022	2024	
	social media	1.3	2022	2024	

PS: Light blue indicates that the keyword has not emerged; dark blue indicates that the keyword is beginning to emerge; and orange indicates a burst of the keyword.

As shown in Table 8, the first phase highlights keywords such as “biodiversity”, “perception”, and “area”, which were the most prominent. These keywords reflect the significance of biodiversity in UGS, addressing various aspects like ecological status assessment, stakeholder attitudes, and management strategies, thereby demonstrating its critical role in promoting sustainable development. The keyword “biodiversity” (3.01), which appeared and lasted the longest between 2008 and 2018, drove the shift in design from traditional aesthetics and recreational functions to a deeper integration of ecological value and social welfare [3,39,66]. Research shows that the surge in biodiversity research highlights ecosystem stability and has long-lasting positive impacts on urban residents’ mental health and satisfaction. Before exploring the unique benefits of biodiversity in UGS and expanding their understanding of its mechanisms, researchers progressively recognized the inherent connection between biodiversity and green spaces [91]. Subsequently, scholars attempted to integrate biodiversity with green space perception and other aspects of UGS management, further enriching research depth through the introduction of ecosystem services, public participation, and remote sensing technology [70]. Research on green space perception focuses on residents’ subjective perceptions, use, and satisfaction with green spaces, exploring the influence of individual characteristics and spatial attributes on perception [80]. From 2017 to 2019, studies related to “areas” and “perceptions” experienced a surge in interest lasting around three years, closely linked to urban planning. In urban planning, the perception of green spaces in various areas and their uneven distribution directly affect residents’ usage frequency and satisfaction [64].

The second phase of keyword bursts occurred primarily between 2018 and 2022. This phase can be categorized into three types: keywords related to UGS attributes (e.g., “environments”, “space”, “access”, “urban planning”, “forests”), where “environments”

(2.24) shows the strongest burst; keywords reflecting residents' subjective experiences (e.g., "behavior", "subjective well-being", "quality of life", "responses"), with "behavior" (3.10) also showing the strongest burst; and keywords related to ecological services (e.g., "environmental justice", "ecosystem services", "restoration", "cultural ecosystem services", "antecedents"), where "environmental justice" (3.23) is the strongest. Between 2019 and 2022, research on UGS satisfaction explored how green spaces impact residents' quality of life and behavior. Studies during this period indicate that the accessibility of green spaces and ecological services is crucial for residents' well-being [60,61]. Additionally, the restorative functions of green spaces and environmental quality directly influence residents' physical and mental health. During the COVID-19 pandemic, designing resilient green spaces became particularly important [104,109]. Physical and mental health have always been closely tied to UGS. The research during this phase revealed the multidimensional roles of green spaces, particularly in residents' lives and behavior [110]. The emerging keywords also emphasize the need to enhance public participation while improving environmental quality and ecological services, ensuring the accessibility and user experience of green spaces to foster community awareness and promote sustainable development [110]. However, the unequal distribution of green spaces often leads to environmental justice issues. Low-income groups, particularly in disadvantaged communities, frequently face barriers in accessing quality green spaces, which exacerbates social inequality and stratification [64,67]. This exacerbates social inequality and stratification. Therefore, green space design must prioritize ecological benefits, environmental perception, and social equity.

Since 2022, research on UGS satisfaction has highlighted four key trends: residents, visitors, frameworks, and social media. These trends have been influenced to some extent by the COVID-19 pandemic. Due to social isolation and restrictions during the pandemic, urban residents' demand for green spaces significantly increased. Green spaces offered essential physical and psychological restorative functions, playing a crucial role in alleviating stress while facilitating social distancing [37]. Adopting a people-centered development model that prioritizes residents' preferences and needs is vital for enhancing satisfaction. During the pandemic, residents' usage patterns and preferences gained prominence in design research, as heightened demands emerged for more frequent use of spaces, higher quality environments, and greater emphasis on public health safety. This has directly driven changes in UGS design [104]. Moreover, the pandemic restricted people's movement, drawing attention to green space activities in their immediate surroundings, particularly in local areas like community or city parks [49]. This shift contributed to an increased focus on "residents" as a keyword, reflecting ongoing research trends emerging since 2022. Developing comprehensive frameworks to understand UGS is essential for addressing the complexity of urban environments and demonstrates the rise of research hotspots. These frameworks facilitate the integration of ecological, social, and economic factors into green space design and management [26,111]. For example, applying a landscape sustainability framework allows for a detailed analysis of how UGS promote carbon budgets and overall environmental health [112]. This integrated approach enhances the ecological functions of UGS while aligning with residents' expectations and satisfaction [113]. Meanwhile, social media has become a key platform for residents to express their satisfaction with green spaces. By integrating social media, big data analysis, and machine learning models, researchers can more accurately capture real-time public feedback and needs, thereby overcoming the limitations of traditional surveys [51,114]. In today's information-driven era, the widespread use of social media enables rapid collection of large amounts of user perception data, revealing differences in expectations among social groups and fostering designs that better accommodate diverse resident needs [115]. Consequently, the rise of social media and the heightened demand from residents have prompted a shift in UGS design from conventional physical enhancements to more sophisticated, data-driven approaches, addressing potential future health crises and environmental challenges.

5.3. How Can UGS Satisfaction Research Contribute to the Optimization of UGS?

The analysis of research themes and hotspots shows that studies on UGS satisfaction have shifted from a singular focus to a more diversified approach. After organizing and reviewing the literature, it becomes clear that UGS satisfaction is primarily analyzed through four dimensions: resident need, ecological function, management strategy, and research strategy, all of which contribute to the optimization of UGS.

5.3.1. Resident Needs Dimension

Resident requirements, which represent the interaction between UGS and residents, particularly in terms of their perception, frequency of usage, preferences, and overall satisfaction, are a fundamental component of research on UGS satisfaction. Since 2001, keywords such as "perception", "areas", "residents", "preference", and "visitors" reflect a consistent focus on residents' subjective perceptions and behaviors when using green spaces. However, these needs have evolved and increased with economic development and improved living standards. Researchers have increasingly recognized that residents from diverse socioeconomic backgrounds, age groups, genders, education levels, and cultural customs exhibit varied needs for green spaces. Additionally, the health benefits of UGS have been long emphasized, with studies indicating that their use enhances physical activity levels and reduces the incidence of chronic diseases [14,64,103]. Psychological needs emerged as a concern, and green spaces considered crucial for stress reduction and psychological restoration [9,91]. The impact of the pandemic heightened attention to safety needs, particularly the role of green spaces in promoting social distancing and providing safe outdoor environments [37,114]. Green spaces serve as essential places for physical and psychological restoration while fulfilling social needs, particularly in high-density urban environments where they provide significant opportunities for social interaction [63]. A strengthened sense of community further promotes sustainable community development. Cultural needs have gradually gained attention, with researchers exploring how design can reflect the cultural identity of different social groups. Green spaces have become crucial for promoting community cohesion, place attachment, and place identity [116]. Overall, as urbanization accelerates and social environments change, residents' needs for green spaces have become increasingly diverse, and research has shifted from focusing on single functional needs to addressing multi-dimensional, comprehensive needs. Therefore, future UGS planning should comprehensively address residents' physical and mental health, safety, social, cultural, and aesthetic needs.

5.3.2. Ecological Function Dimension

Ecological function is another key aspect in studying UGS satisfaction, particularly regarding biodiversity, ecosystem services, and their impact on residents' well-being. Keywords such as "biodiversity", "ecosystem services", "environmental justice", "restoration", "cultural ecosystem services", and "landscape" between 2008 and 2024 indicate a shift from single-focused ecological protection to multi-dimensional ecological functions. This shift has gradually encompassed aspects such as ecological aesthetics, noise control, air quality improvement, microclimate regulation, biodiversity conservation, and recreational functions. Early research on ecological aesthetics emphasized the visual appeal of green spaces. However, in recent years, ecological aesthetics has been developed to balance ecological and social needs [116]. The acoustic quality of urban parks plays a crucial role in shaping users' emotional responses and engagement with these spaces [13]. Evidence suggests that well-designed soundscapes within green spaces can reduce the perception of urban noise, thereby alleviating stress for residents, particularly in densely populated areas [59,78,117]. Furthermore, noise control research indicates that UGS reduces noise pollution and improves psychological comfort by integrating natural elements such as birdsong and flowing water, creating a restorative environment that supports mental well-being [117]. Enhancing air quality is a vital ecological service provided by green spaces. Plants absorb pollutants and filter particulate matter, significantly enhancing the

air experience of urban residents [116]. Additionally, microclimate regulation research shows that UGS adjusts local temperature and humidity, mitigates urban heat island effects, and improves residents' environmental satisfaction [75]. Biodiversity conservation has evolved from focusing on local species to the overall stability of ecosystems. Recent studies have found that biodiversity enhances ecosystem resilience and is closely linked to residents' mental health and social well-being [91]. The issue of environmental justice has garnered attention, as research shows that uneven distribution of green spaces often prevents low-income groups from fairly enjoying ecological services, leading to social inequities [64]. Recreational functions have expanded from traditional sports and leisure activities to include more socially interactive and culturally rich events. Green spaces have become important venues for strengthening community cohesion and promoting cross-cultural exchange [97]. Overall, UGS has gradually shifted from traditional aesthetics and functionality to an integrated approach that combines ecological, social, and cultural dimensions, providing residents with richer ecological services and cultural experiences, thus promoting the sustainable development of green spaces [2].

5.3.3. Management Strategies Dimension

Managing and maintaining UGS is also a crucial aspect of optimizing satisfaction. From 2001 to 2024, keywords such as "urban planning", "management", "environmental justice", and "responses" demonstrate that research on the management strategies of UGS has gradually focused on equity in urban planning, public participation, and collaborative governance. This emphasizes the importance of multi-dimensional management models to enhance residents' satisfaction. Equity in green space distribution within urban planning has become one of the core issues. Studies indicate that UGS are often unevenly distributed geographically and socioeconomically, preventing residents of low-income communities from equitably accessing green space resources. This inequity exacerbates social inequality and environmental justice issues [67]. Therefore, ensuring equitable spatial distribution of green spaces has become essential in urban planning. Meanwhile, public participation in green space management has become increasingly important. Through community involvement, managers can better understand residents' needs and design green spaces that meet public expectations. Public participation and a sense of belonging are closely linked to residents' satisfaction with urban spaces [97,118]. Collaborative governance emphasizes the joint management of government, communities, and other stakeholders. It promotes the social benefits and management utility of green spaces while supporting sustainable development and efficient use of resources [101]. The use of modern smart technologies has also effectively supported management efforts. This collaborative governance model makes green space management more flexible and adaptable, responding to evolving social demands and ecological challenges.

5.3.4. Research Strategies Dimension

In the ongoing study of UGS, research methods have diversified alongside scientific and technological advances. With technological progress, GIS and remote sensing have been widely applied, allowing researchers to analyze the spatial distribution, accessibility, and ecosystem services of UGS, thereby improving spatial accuracy in research [55]. In the 2010s, the rise of big data and social media analysis enabled researchers to gather real-time data through social media platforms, combining it with machine learning and data mining technologies to reveal residents' feedback and usage patterns of UGS [70,115]. Moreover, multi-dimensional data integration methods have emerged, combining quantitative and qualitative data to analyze ecological functions, management strategies, and social needs, providing a more comprehensive perspective for UGS research [7]. Machine learning models and predictive analysis techniques have also been gradually introduced to better address complex urban environmental issues. Another emerging trend is the use of longitudinal studies to assess changes in satisfaction over time. By tracking residents' perceptions and experiences of UGS over different periods, researchers can identify satisfaction trends and

changes related to urban development and policy shifts [119]. This approach is essential for rapidly urbanizing areas, where green space supply and community needs constantly change. The evolution of these methods has enhanced the scientific rigor and breadth of research and improved decision-making in optimizing and managing UGS.

6. Conclusions, Limitations, and Prospects

6.1. Conclusions

Satisfaction research continues to drive the evolution and transformation of UGS design. Diverse and multi-perspective satisfaction research can promote UGS design's continuous optimization and updating. This study systematically reviews the development trends of this research topic using bibliometric methods, analyzing trends in publication volume, high-productivity countries/institutions, highly cited journals, and the evolution of key themes. The conclusions based on the bibliometric analysis are summarized as follows:

(1) Satisfaction research on UGS has been rapidly developing. Especially in recent years, influenced by epidemics, lifestyle changes, and increased demand for green space by residents have received the attention of scholars. Hence, the number of articles published related to this topic has peaked. Some core journals (Urban Forestry and Urban Greening, Sustainability, International Journal of Environmental Research and Public Health, etc.) have emerged with large publication volumes in this field. Major nations and regions (South Korea, China, the United States, etc.) and scholars show plenty of interest. Furthermore, highly cited documents reveal the main ideas and innovations in the field. These are the core forces in the research field of the topic.

(2) The keyword clustering analysis (post-industrial landscape, urban planning, green space, landscape preference, destination loyalty, multi-group analysis, urban land use, place attachment, park management, and user satisfaction) highlights that the UGS satisfaction research consists of a variety of topics and emphasizes the significance of green spaces as essential indicators in urban planning and design. First, research on user satisfaction emphasizes the value of walkability, accessibility to green areas, and environmental equality in fostering community cohesion, mental health, and physical activity. Research on post-industrial landscapes highlights the turn of abandoned buildings into green spaces, emphasizing the necessity for public participation to balance contemporary architecture and historical preservation. Particularly in highly populated places, well-designed soundscapes within natural spaces can reduce urban noise, relieving locals' stress. The growing trend of democratizing urban planning through crowdsourcing and participatory methods reflects a shift toward inclusive, data-driven approaches aimed at enhancing residents' well-being. Additionally, green space research emphasizes the relationship between urban density, restorative environments, and public health, advocating for optimizing green spaces in densely populated areas. The function of aesthetic diversity and complexity in satisfying the demands of diverse users is further investigated by research on landscape preferences. According to studies that relate social media involvement with destination loyalty, positive user experiences in green spaces promote tourism and urban sustainability. These themes collectively illustrate the multifaceted approaches to enhancing UGS satisfaction through equitable design, public participation, and innovative planning strategies.

(3) Green space design innovation has been fueled by the evolution of UGS satisfaction research over the last 20 years, which began with preliminary investigation and progressed to systematic deepening and then to accelerated development. In the initial exploratory phase, research focused on green spaces' health and ecological benefits (e.g., promoting physical activity and biodiversity). Still, it did not thoroughly examine complex issues such as public health outbreaks. During the development phase, the research expanded into crucial topics such as environmental equity, community participation, and sustainability. The pandemic revealed the issue of unequal distribution of green space resources, prompting public participation and data-driven

planning methods. After 2021, digital technology and big data analytics accelerated research development. Tools like machine learning and importance–performance analysis improved the precision of design. Since 2022, the pandemic has triggered four key research hotspots: "residents", "social media", "frameworks", and "visitors." Social media data analysis has revealed shifts in residents' needs and differentiated expectations for space design, promoting a shift towards smart, data-driven designs that emphasize social equity and adaptability to public health crises. Residents and visitors reflect a human-centred design philosophy and the pursuit of enhanced well-being. Framework-based studies on UGS have increased, aiming to understand how satisfaction in UGS drives design optimization and evolution through detailed, multi-dimensional analysis. Analysis of these evolving research themes and hotspots reveals that UGS satisfaction research has shifted from a singular focus to a more diversified approach, contributing to the optimization of UGS from four key areas: resident needs, ecological functions, management strategies, and research strategies. Based on the above conclusions, this study offers practical value for the continued development of green spaces. It identifies trends and research hotspots, builds a framework for UGS satisfaction research, and contributes to the optimization of UGS, providing a reference for scholars, urban planning authorities, and designers.

6.2. Limitations and Future Research

Some important limitations should be noted in our research. First, only three core databases from Web of Science provided the bibliometric data for the study, which would have limited the scope of the analysis. The option of more comprehensive databases can fill in the gaps. In addition, although this study used specialized software for quantitative analysis, subjective interpretation may still influence data analysis, making it difficult to present entirely objective conclusions. However, we believe that the bibliometric approaches used in this research continue to offer insightful information and valuable sources for further research. In future studies, we should expand the scope of literature searches to comprehensively capture the latest research trends and emerging topics in this field, e.g., Scopus database could offer a broader but potentially different dataset, as Scopus covers more journals overall, especially in the sciences and social sciences, and includes some unique sources that Web of Science (WOS) may not. Additionally, we could keep abreast of the prospective views and insights through conferences or experts. In this way, we can grasp the latest development trend in the field as comprehensively as possible and provide a solid foundation for the subsequent research work.

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Appendix A. Top 10 Co-Cited Reference

Rank	Document	Reference	Count	BC	Mean (Year)
1	Characteristics of urban parks and their relation to user well-being	Ayala-Azcárraga C, 2019, LANDSCAPE URBAN PLAN, V189, P27, https://doi.org/10.1016/j.landurbplan.2019.04.005	19	0.07	2019
2	Factors affecting users' satisfaction with urban parks through online comments data: Evidence from Shenzhen, China	Liu RX, 2021, INT J ENV RES PUB HE, V18, P0, https://doi.org/10.3390/ijerph18010253	13	0.03	2021
3	How is quality of urban green spaces associated with physical activity and health?	Akpinar A, 2016, URBAN FOR URBAN GREE, V16, P76, https://doi.org/10.1016/j.ufug.2016.01.011	12	0.11	2016
4	Recreational visits to urban parks and factors affecting park visits: Evidence from geotagged social media data	Zhang S, 2018, LANDSCAPE URBAN PLAN, V180, P27, https://doi.org/10.1016/j.landurbplan.2018.08.004	11	0.02	2018
5	Citizens' perception of and satisfaction with urban forests and green space: Results from selected Southeast European cities	Ostoic SK, 2017, URBAN FOR URBAN GREE, V23, P93, https://doi.org/10.1016/j.ufug.2017.02.005	10	0.00	2017
6	Relationships among satisfaction, noise perception, and use of urban green spaces	Gozalo GR, 2018, SCI TOTAL ENVIRON, V624, P438, https://doi.org/10.1016/j.scitotenv.2017.12.148	10	0.01	2018
7	Characteristics of urban green spaces in relation to aesthetic preference and stress recovery	Wang RH, 2019, URBAN FOR URBAN GREE, V41, P6, https://doi.org/10.1016/j.ufug.2019.03.005	10	0.00	2019
8	Quality over quantity: Contribution of urban green space to neighborhood satisfaction	Zhang Y, 2017, INT J ENV RES PUB HE, V14, P0, https://doi.org/10.3390/ijerph14050535	9	0.01	2017
9	Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas	Carrus G, 2015, LANDSCAPE URBAN PLAN, V134, P221, https://doi.org/10.1016/j.landurbplan.2014.10.022	9	0.06	2015
10	The relationship between social cohesion and urban green space: An avenue for health promotion	Jennings V, 2019, INT J ENV RES PUB HE, V16, P0, https://doi.org/10.3390/ijerph16030452	9	0.06	2019

Appendix B. Highly Cited Documents

No.	Document	Author	Year	Journal	Citations	Keywords	Research Method	Key Findings
1	Would You Be Happier Living in a Greener Urban Area? A Fixed-Effects Analysis of Panel Data	White, M. P., Alcock, I., Wheeler, B. W., and Depledge, M. H.	2013	Psychological science	1196	well-being, life satisfaction	Panel data analysis	Green space is positively associated with higher well-being and lower psychological stress
2	An ecological study investigating the association between access to urban green space and mental health	Nutsford, D., Pearson, A. L., and Kingham, S.	2013	Public health	690	Green space, Mental health, Geographic Information Systems, Urban Planning, Accessibility	GIS analysis, Negative Binomial Regression Model	Green space coverage is positively associated with residents' mental health
3	The role of urban green space for human well-being	Bertram, C., and Rehdanz, K.	2015	Ecological economics	596	life satisfaction, urban ecosystem services, urban green space, well-being	Self-reporting, GIS analysis	There is an inverted U-shaped relationship between green space size and well-being
4	Perceptions of parks and urban derelict land by landscape planners and residents	Hofmann, M., Westermann, J. R., Kowarik, I., and Van der Meer, E.	2012	Urban forestry and urban greening	330	Biodiversity. Expert-lay-people comparison; Naturalness; Preferences. Urban green space; Wasteland	Questionnaire Survey Classification Analysis	Residents focus more on green space accessibility; planners focus on naturalness
5	The greener, the happier? The effect of urban land use on residential well-being	Krekel, C., Kolbe, J., and Wüstemann, H.	2016	Ecological economics	322	Life Satisfaction, Mental Health, Physical Health, Urban Land Use, Green Areas, Greens, Forests, Waters, Abandoned Areas, GIS, Spatial Analysis	fixed effects model GIS Spatial Analysis	Green space positively affects well-being, brownfield land negatively affects it
6	Linking public urban green spaces and human well-being: A systematic review	Reyes-Riveros, R., Altamirano, A., De La Barrera, F., Rozas-Vásquez, D., Vieli, L., and Meli, P.	2021	Urban forestry and urban greening	308	Benefit, Green infrastructure, Green space, Human health, Urban ecosystem	Systematic Literature Review	Green space structure and biodiversity enhance health and social relationships
7	The influence of leisure involvement and place attachment on destination loyalty: Evidence from recreationists walking their dogs in urban parks	Lee, T. H., and Shen, Y. L.	2013	Journal of Environmental Psychology	297	Destination loyalty, Leisure involvement, Park Place attachment Walking a dog	structural equation model (SEM)	Leisure participation and place attachment as predictors of destination loyalty
8	Quality over Quantity: Contribution of Urban Green Space to Neighborhood Satisfaction	Zhang, Y., Van den Berg, A. E., Van Dijk, T., and Weitkamp, G.	2017	International journal of environmental research and public health	266	urban green spaces; health; green space availability; neighborhood satisfaction; quality of life; happiness	Quantitative data analysis	Perceived green space quality is important for neighborhood satisfaction, but not related to happiness
9	Social involvement and park citizenship as moderators for quality-of-life in a national park	Ramkissoon, H., Mavondo, F., and Uysal, M.	2018	Journal of Sustainable Tourism	248	Quality-of-life, place satisfaction, place attachment, park, citizenship, social involvement, moderated mediation	Experimental simulation	Perceived biodiversity is associated with site satisfaction
10	Perceived species-richness in urban green spaces: Cues, accuracy and well-being impacts	Southon, G. E., Jorgensen, A., Dunnett, N., Hoyle, H., and Evans, K. L.	2018	Landscape and Urban Planning	245	Biodiversity, Cultural ecosystem services, Urban green-space Nature connectedness, Wellbeing	structural equation model (SEM)	Place attachment mediates the relationship between place satisfaction and quality of life

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