

Systematic Review

# A Systematic Review of Factors Affecting User Behavior in Public Open Spaces Under a Changing Climate

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**Abstract:** Climate change is increasingly affecting the livability and functionality of urban environments, particularly public open spaces (POSs), impacting user behavior in complex ways that require a comprehensive, multi-perspective approach to understanding. This study reviews current progress, methodologies, and findings in POS research by proposing a critical analytical framework focused on key spatial and temporal factors that contribute to the design of climate adaptive solutions. Overall, 62 significant influencing factors were identified and categorized into four subject areas, environmental factors, spatial attributes, population and society, and behavioral perceptions, which were further divided into 12 themes. These factors were analyzed through a two-dimensional approach using a co-occurrence matrix to examine interactions. The findings reveal that spatial and temporal dimensions do not operate independently but interact in ways that significantly influence POS usability. The findings also indicate that temporal factors such as temperature, solar radiation intensity, and wind speed significantly influence user behavior when combined with spatial factors like site facilities, greenness, and walkability. Understanding these interactions is essential for optimizing POS design to enhance climate adaptability and long-term usability. By promoting climate adaptive design principles based on empirical research, this review offers insights and practical guidance for future urban planning to address climate change.



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**Keywords:** urban resilience; climate adaptation; public open space (POS); spatio-temporal factors; user behavior; sustainable design

## 1. Introduction

Climate change is a global challenge, with urban areas increasingly facing risks to livability and daily activities. Tackling these challenges means reducing the environmental impact of the urban area and improving citizens' well-being [1], with public open spaces (POSs) serving as key nodes where many of these activities occur. POSs are an essential part of the outdoor environment in the public life of a city, encompassing freely accessible parks, green spaces, recreational and sports facilities, and other areas designed for leisure activities. These spaces not only provide opportunities for physical exercise and social interaction but also contribute to urban livability and well-being [2]. For instance, in many cities, parks and squares serve as daily spaces for residents while also hosting cultural events, community gatherings, and markets [3].

In recent years, with accelerated urbanization and changing lifestyles, researchers have increasingly focused on POS usage patterns and their effects on user behavior and health [4]. Studies indicate that well-designed POSs can not only improve public health [5,6] but also

foster social interaction [7] and community cohesion [8]. For example, a study in an urban park with waterbodies found that higher levels of greenery and quality landscape design significantly increased visitation rates and facilitated interaction among diverse community groups [9]. Multiple evaluation indicators, such as landscape quality, vegetation cover, waterbodies, park accessibility, visitation frequency, and activity purposes, have become important references for planners and designers when optimizing POS [10].

Despite progress, significant gaps remain in the research. Most studies focus on short-term observations of user behavior [11], failing to capture long-term usage patterns and neglecting the interaction between spatial and temporal factors. POS usage can vary significantly over time, such as between weekends and weekdays, daytime and nighttime, or across different seasons [4,12]; at the same time, user behavior is not static but constantly adapts to dynamic temporal and spatial contexts [13]. For example, a study on POS in Lhasa found that high summer temperatures significantly reduced outdoor activity, while sunny winter weekends saw a notable increase in park use [14], highlighting how seasonal and climatic factors shape POS usage patterns across the year. Another example is that morning joggers tend to choose less crowded paths, while social activities are more likely to take place in public squares during the afternoon or evening [15]; this indicates that POS design must accommodate diverse needs at different times and settings.

Moreover, spatial considerations in existing studies tend to be limited, with little attention given to users' dynamic behavior within spaces [16]. For instance, some studies have found that areas with higher plant cover and open spaces tend to attract joggers and walkers [15,17], while areas with seating and shade are more suitable for social gatherings and relaxation [18]. Ignoring these spatiotemporal interactions can lead to an incomplete understanding of POS usage patterns, limiting their practical application in urban planning and design.

A growing number of research studies underscores the significance of POS in shaping user behavior. However, most of them examine spatial and temporal factors in isolation, failing to capture their combined effects. As climate change reshapes urban environments, an integrated framework that accounts for both dimensions is essential to ensure POSs remain functional, livable and adaptable. This study aims to address this gap by systematically identifying key factors influencing POS usage and analyzing their mutual interactions. Specifically, the study investigates the following:

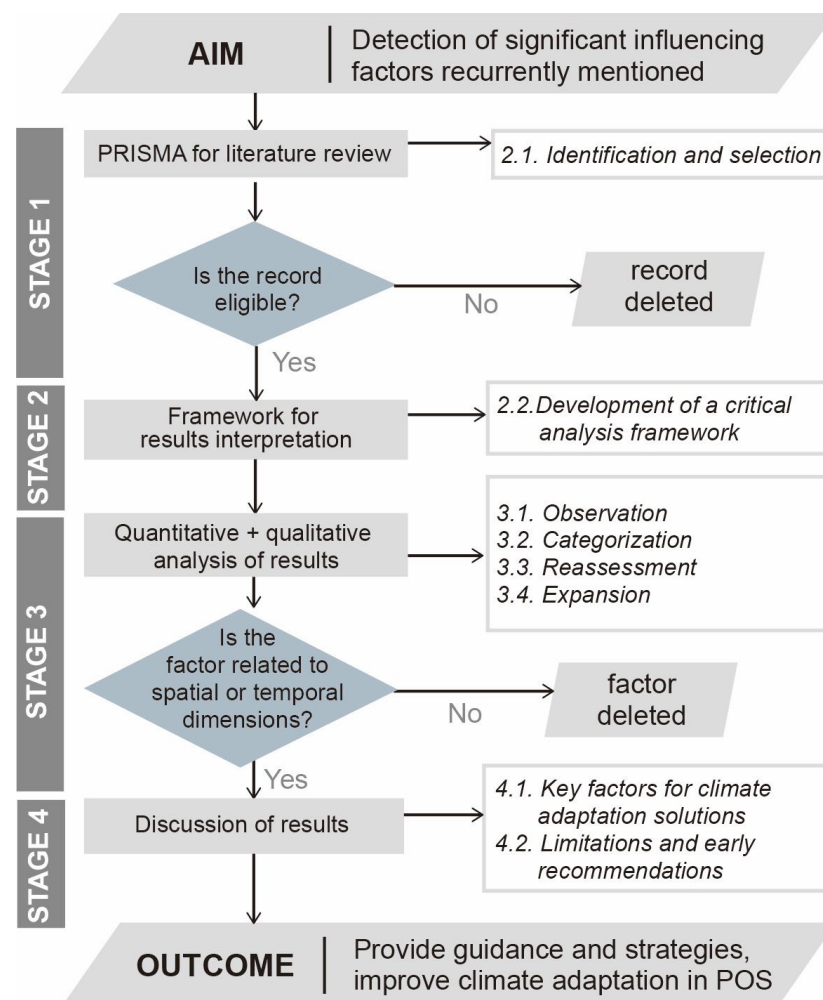
- The factors related to spatial dimensions, such as site facilities, walkability, and landscape characteristics, and how these elements influence user preferences and behavior patterns.
- The factors that pertain to temporal dimensions, including seasonal variations, weather conditions, and users' activity patterns, and their impact on the frequency and type of POS usage.
- The factors that encompass both spatial and temporal dimensions, exploring how the interplay between physical design and dynamic environmental conditions shapes user experiences POS functionality, and long-term adaptability to climate change.

By exploring the interdependencies among these factors, this study develops a theoretical framework for POS analysis, providing valuable insights for urban planners and policymakers. The findings support climate-adaptive urban design strategies, ensuring that POS remains functional, inclusive, and resilient in the face of evolving environmental conditions.

## 2. Methodology

In the first stage, a systematic literature review was conducted following the PRISMA 2020 guidelines to identify the drivers of user behavior in POS and to select relevant studies.

The systematic literature review followed the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure the inclusion of eligible studies; the protocol used for the present systematic review was registered at INPLASY (Registration number: INPLASY202510117), and can be found here at <https://inplasy.com/inplasy-2025-1-0117/> (accessed on 27 January 2025). Reporting according to the PRISMA 2020 checklist is explicitly described in this protocol and can be found in the Supplementary Materials. In the second stage, a critical analysis framework was developed to systematically summarize and categorize the existing research findings. This framework guided the subsequent analysis to ensure a structured and rigorous approach. In the third stage, a combination of quantitative and qualitative analyses was employed to deepen the understanding of key factors and quantitative analysis was used to review the current progress, methodologies, and outcomes, while qualitative analysis reassessed significant factors across spatial and temporal dimensions. The fourth stage, extended discussion, focuses on how the research results can be applied to climate adaptation solutions and explores the limitations of current research to provide directions for future climate adaptation research. Figure 1 illustrates the overall workflow of the research approach, which is further detailed in the following paragraphs.



**Figure 1.** Workflow diagram of the whole methodology.

### 2.1. Identification and Selection of Studies

The PRISMA workflow can be viewed as four phases, namely identification, screening, eligibility check, and inclusion, and relevant data were extracted and collected in an Excel sheet. Figure 2 shows the workflow with the number of records processed at each stage.

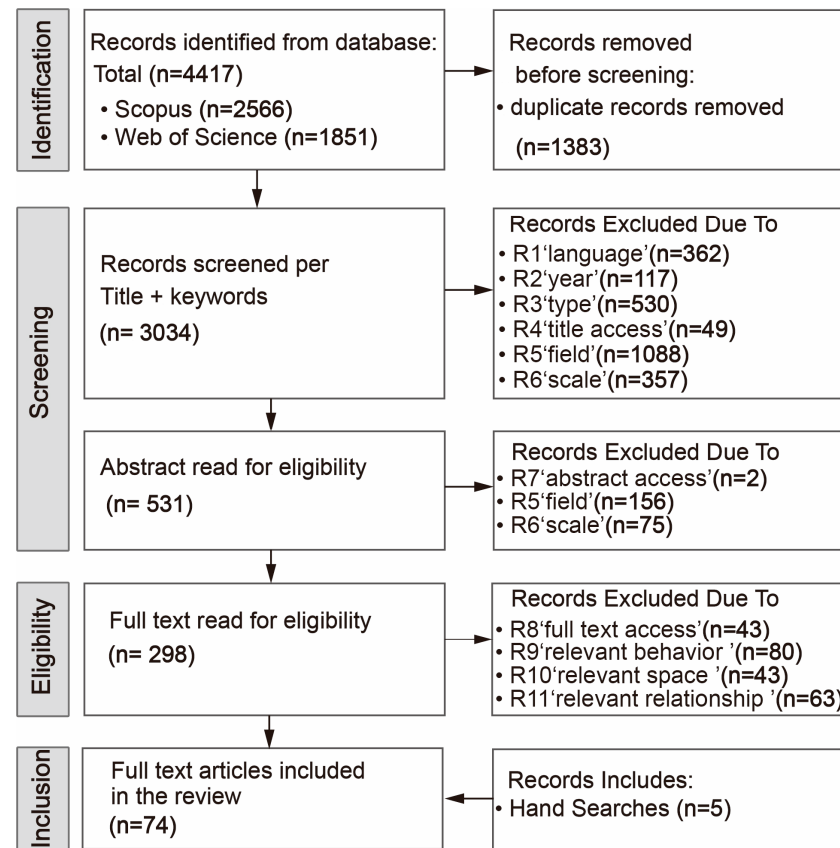


Figure 2. PRISMA flow diagram.

**Identification:** Web of Science (WOS) and Scopus were chosen as the two most dependable and comprehensive databases in the field of architecture and urban design. These two databases are widely regarded as mainstream bibliometrics tools, offering comprehensive coverage of subject fields, and being regularly maintained and updated by professional organizations. They are therefore regarded as significant and reliable search engines. The search was performed between 1 May and 30 June 2024; records published after 1 July 2024 were not included.

**Screening:** The string was searched in the database by topic (title, keywords, and abstract) to answer the research questions posed earlier. The following criteria were critical for the research:

- Location: POS.
- Subjects: users of the POS.
- Content: the relationship between POS and users' behavior.
- Scope: users' behavior on access, use, perception, and evaluation of POS.
- Results: evidence of a correlation between POS and users' behavior.

Based on this, the constructed retrieval string was as follows: (influencing\* OR contributing\* OR affecting\*) AND factor\* (Topic) AND behavio\* OR use\* (Topic) AND (open\* OR public\* OR outdoor\* OR built\*) AND space\*.

To clarify the search rules, the strategy targeted studies that (i) focused on influencing factors by explicitly mentioning "factors" related to user behavior; (ii) examined behavior

or usage patterns, or activity engagement in public spaces; (iii) addressed specific spatial contexts, and ensured that studies focused on POS, excluding those centered on private or indoor spaces.

The identified 4417 records were imported into Endnote (vX9.3.3; Clarivate Analytics, Philadelphia, PA, USA) software, and duplications were excluded through automatic detection by title (1383). Accordingly, 3034 records were selected for the screening process.

**Eligibility check:** For more refined screening, studies beyond the scope of this study were excluded. Therefore, a series of filters was set to enhance the reliability of the review results and could be selected at each review step; the details can be found in Table 1.

**Table 1.** Filters for the eligibility check.

Filter Name	Content	Reason
R1	Language	Not written in English
R2	Year	Articles published not between 2004 and 2024
R3	Type	No reviews or articles
R4	Title access	Title and keywords not retrieved, or not open access
R5	Field	The content is not from the social sciences, engineering, environmental sciences, or arts and humanities field
R6	Scale	The scale of the study is too large or too small (e.g., whole city or regional level), or limited (e.g., single building or limited activity radius)
R7	Abstract access	Abstract not retrieved, or not open access
R8	Full-text access	Full text not retrieved, or not open access
R9	Relevant behavior	Focuses only on subjective feedback (e.g., perception or evaluation), without considering the user's specific activity type, activity action, or activity trend
R10	Relevant space	Focuses only on the overall information of the space or the traffic situation, without considering the specific environmental characteristics of the space
R11	Relevant relationship	Focuses only on the user's behavior, without considering the relationship with the environment of the space

The first consistency screening was by title and keywords. The records were categorized as “consistent” or “not consistent” by the following selected reasons for exclusion: R1, R2, R3, R4, R5 and R6. At the end of the first screening phase, 531 records were selected for the following stage. To adhere to open-science principles, only open access records were selected, after checking the metadata of paywalled articles to verify that there were no relevant omissions in trends and directions. The second screening phase consisted of reading the abstract to check for other excluding reasons. The selected reasons for exclusion are as follows: R5, R6 and R7. At the end of the second screening phase, 298 records were selected. The third phase of screening included the full text of the records. As the 298 records still posed a great challenge in ensuring the quality contribution and homogeneity of the review results, further refinement and filters were set up at this stage, mainly from the following three aspects:

- Users: studies were filtered out that did not deeply analyze specific users' behavior.
- POS: studies were filtered out that did not deeply research the specific features of the POS.

- Relationship between the two: studies were filtered out that did not consider the interactive relationship between users' behavior and the POS in which they were located.
- The selected reasons for exclusion include R8, R9, R10, and R11. Of these, 43 were discarded as the file was not fully accessible and 186 were deemed as not relevant to this study.

**Inclusion:** In addition, 5 records considered relevant to the review topic were manually added. A total of 74 records were included in this study.

## 2.2. Development of a Critical Analysis Framework for Selected Studies

Before the formal analysis steps, a critical analysis framework was developed and introduced. This repeatable process is adaptable to most review studies, to ensure both clarity and logical flow throughout the research. The framework provides a structured basis for the critical analysis in this study, progressing gradually from broad observation to specific assessment and ultimately to interactive expansion. The core goal is a thorough and systematic understanding of key factors and their interrelationships, as outlined below:

**Observation:** In this stage, trends, themes, and clusters within the selected studies were identified using bibliometric tools, supporting the formulation of the subsequent analysis [19]. Specifically, Endnote (vX9.3.3) was used for reference management and duplicate removal. Bibliometrix (v4.1.3; University of Naples Federico II, Naples, Italy) [20] facilitated bibliometric analysis, including keyword co-occurrence mapping and citation analysis. VOSviewer (v1.6.20; CWTS, Leiden University, Leiden, The Netherlands) [21] was employed to generate network visualizations and clustering of research themes.

**Categorization:** Building on observations, potential categories were proposed. Qualitative methods were used to review each selected study to code and cluster the common characteristics, including according to research context, research methods, case studies, and key findings, and then contribute to a preliminary understanding of the key factors. By grouping studies with similar clusters, this coding process helps systematically identify shared factors across multiple studies, facilitating the clustering of recurring themes.

**Reassessment:** This stage focuses on re-examining the identified significant influencing factors. A blend of quantitative and qualitative analyses was applied. For statistical and computational analysis, R (v4.3.2; R Foundation, Vienna, Austria) [22] was applied for data preprocessing and statistical analysis. Python (v3.12.0; Python Software Foundation, Wilmington, DE, USA) [4] was used for text data mining and visualization.

**Expansion:** In the final stage of the critical analysis framework, mathematical analysis was conducted to explore interactive relationships among key factors, such as flow relationships [23] and co-occurrence frequencies [4]. Specifically, R was used for data preprocessing and statistical analysis to construct the co-occurrence matrix and the network D3, html widgets and other packages were utilized, allowing for the representation of relationships between influencing factors, while SPSS (v29.0.1; IBM, New York, NY, USA) supported statistical validation to ensure the interpretability of key factors. These analyses revealed key interactive factor combinations and provided data-driven insights into deeper patterns and regularities. For example, in this study, special attention was given to key factors related to climate adaptation solutions.

## 3. Results

### 3.1. Observation and Quantitative Analysis of the Selected Studies

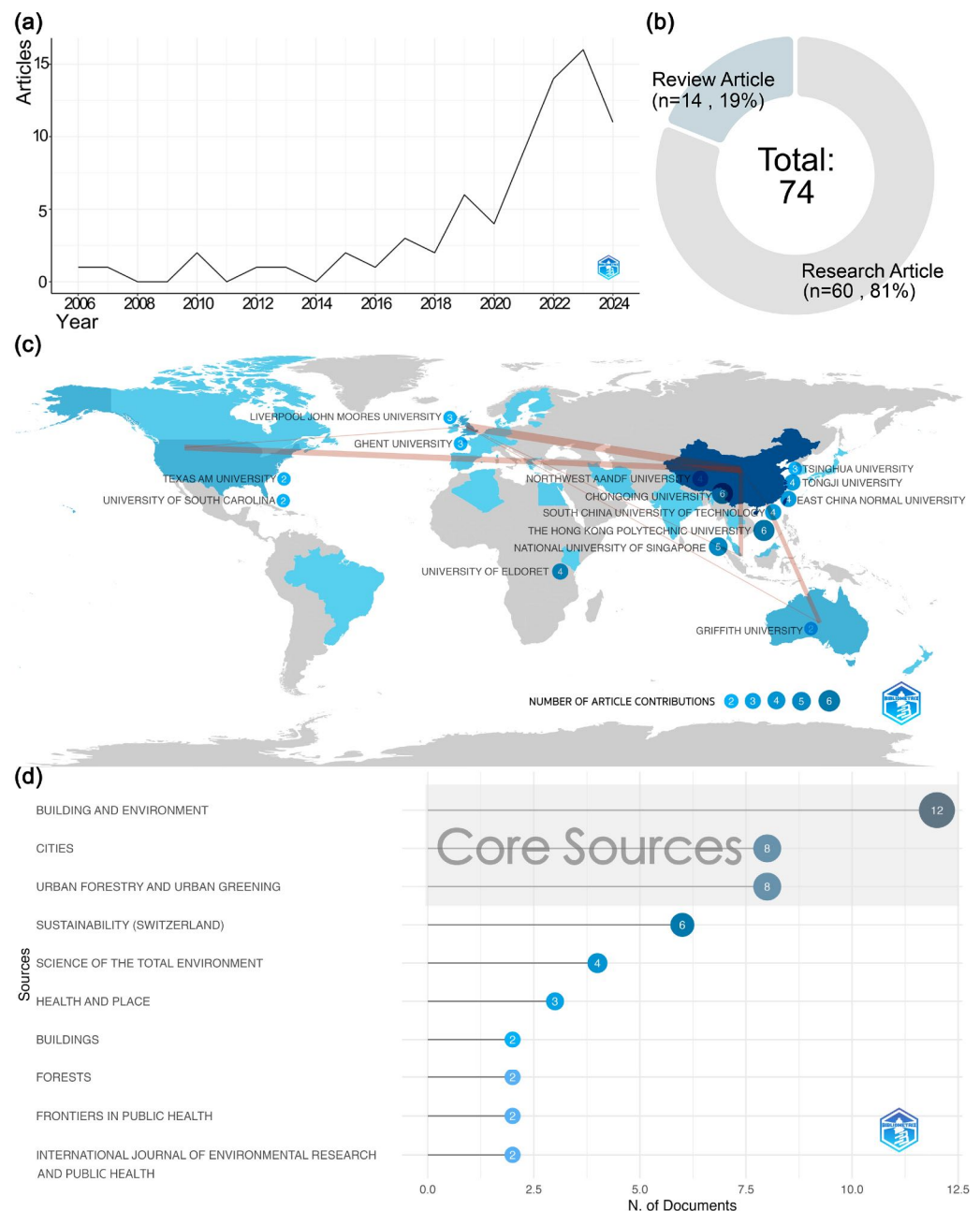
Table 2 and Figure 3 shows the results of importing 74 studies from Bibliometrix, which helped us to systematically observe and identify general trends in the research. Figure 3a illustrates the time distribution of records in the selected decade, with 2020 emerging as a turning point in the number of research. Figure 3b shows that most studies are research

articles, with a minor share of reviews. Figure 3c shows the geographical distribution by country with the top 10 research institutions in terms of article volume contribution and output, where East Asian countries have a clear lead in terms of article output (China, Japan), followed by major English-speaking countries (United States, United Kingdom, Canada, Australia), and European countries (Sweden, The Netherlands, Belgium). In general, most of the research is concentrated in East Asia, the east and west coasts of North America, Western Europe, and other regions, and the international cooperation between scientific research institutions is mainly concentrated in the above regions, while the output and cooperation in other regions are relatively small. Figure 3d shows the journals' top 10 locations where studies are published. From fourth place, multidisciplinary journals began to appear, such as in the field of public health and environmental science. The scope of these journals covers the study of cities and sustainable development, providing vital information to promote environmentally responsible practices, inclusiveness, and quality of urban development.

Before conducting research on the evolution of topic terms, a cleaning phase was also performed, checking the totality of considered words and adding a thesaurus file, which forced the system to exclude terms that were not relevant to avoid duplications (i.e., singular and plural words), double counting (i.e., with abbreviations), and synonyms and near-synonyms (i.e., elderly and aged). This thesaurus file is also applicable to the next step of keyword visualization.

**Table 2.** Results of the biblioshiny importation of the file of references.

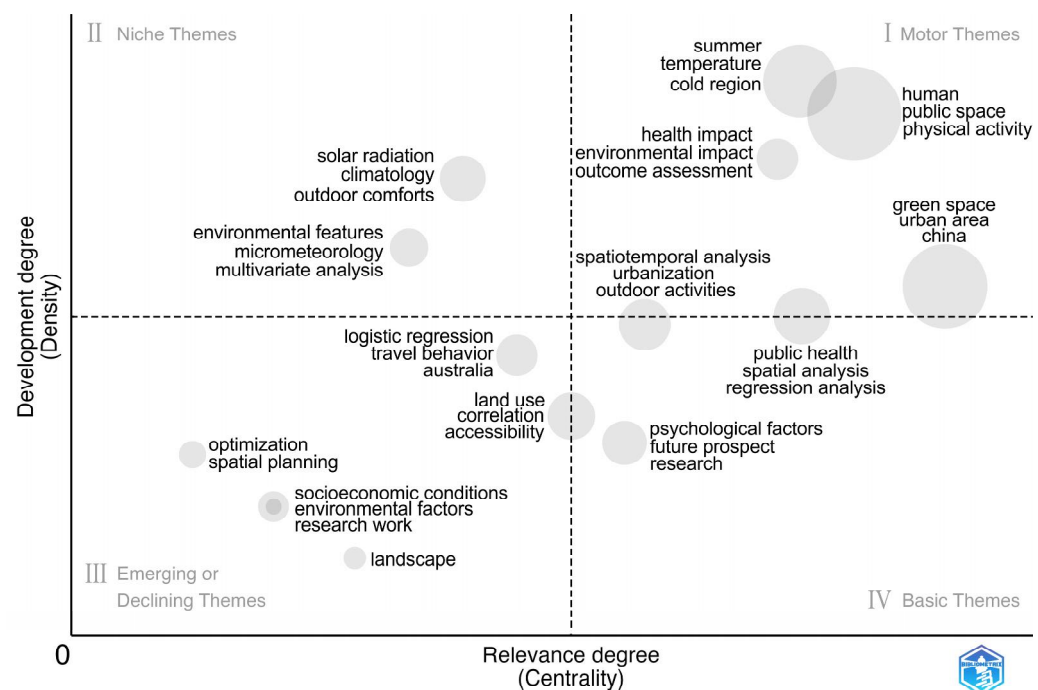
Description	Results
Main Information About Data	
Timespan	2006:2024
Sources (Journals, Books, Etc.)	35
Documents	74
Annual Growth Rate %	14.25
Document Average Age	3.54
Average Citations Per Doc	43.65
References	5698
Document Contents	
Keywords Plus (Id)	618
Author's Keywords (De)	292
Authors	
Authors	285
Authors Of Single-Authored Docs	2
Author Collaboration	
Single-Authored Docs	2
Co-Authors Per Doc	4.64
International Co-Authorships %	37.84
Document Types	
Research Article	60
Review Article	14



**Figure 3.** Overview of the included records: (a) time distribution of records, (b) distribution per typology, (c) distribution per geographic area; (d) most relevant sources and core sources by Bradford's law.

Figure 4 illustrates the thematic map of research topics (including titles, keywords, and abstracts) for the filtered records since the selected year. The thematic map divides different research topics into four quadrants based on two dimensions: development degree (density) and relevance degree (centrality). Density reflects how established and specialized a topic is within its research domain; as the values increase along the vertical axis, topics become more developed and specialized within their respective domains. Centrality measures the topic's connection with other research areas; as the values increase along the horizontal axis, topics become more central and relevant to a wider range of research areas, suggesting broader interdisciplinary significance. Each topic is represented by a circle, where the size indicates the frequency of occurrence in the literature. Larger circles represent topics that appear more frequently in the analyzed records. The first quadrant is the key topics

(I motor themes), such as “public space”, “human”, “physical activity”, “temperature”, “summer” and “cold region”; these themes are both important and well-developed, and they occupy a core position in current research. The second quadrant is very specialized or domain topics (II niche themes), including “solar radiation”, “climatology”, “outdoor comforts”, etc. These topics are highly developed in their respective professional fields but have limited connections to broader research discussions. The third quadrant is emerging or disappearing topics (III emerging or declining themes), including “optimization”, “spatial planning”, “socioeconomic conditions” and “environmental factors”; these themes have not received widespread attention or further development recently. The fourth quadrant is the fundamental topics (IV basic themes), such as “urban area”, “public health”, and “spatiotemporal analysis”; while these topics are crucial to the research field, their classification in “IV basic themes” suggests that they are still evolving and have not yet reached the same level of development as key “I motor themes”. However, their overlap with the “I motor themes” highlights their growing importance and potential for future integration into the core research discussions.

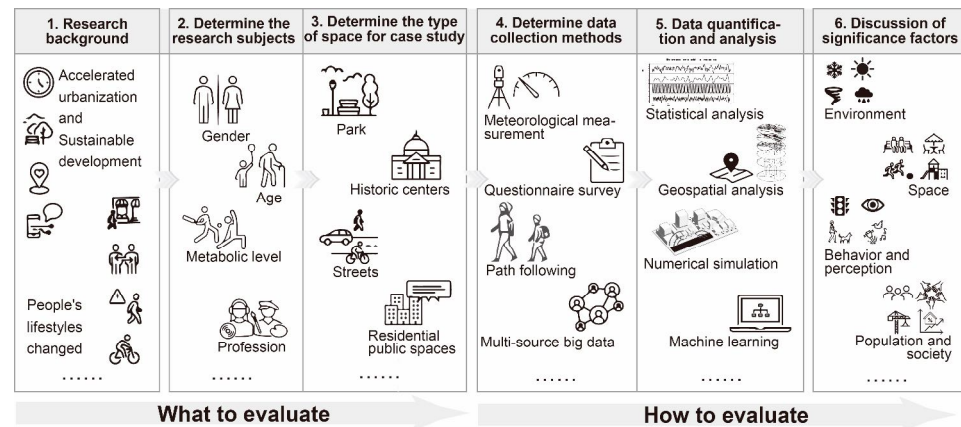


**Figure 4.** Thematic map of research topics.

Afterward, the selected studies were analyzed for word co-occurrence with keywords. The normalization was performed with the association strength method, optimizations were performed on the scale of visualization to obtain the best possible results, and the weights were performed with the total link strength. The results are shown in Figure 5; keywords are divided into the following four clusters (red, gray, blue, and yellow): the red cluster—mainly terms related to the space usage dimension or some specific areas, such as “urban area”, “green space”, “environmental factor”, “parks”, “China”, “Hong Kong” and “Shanghai”, etc., reflecting attention to environmental factors and space utilization within a specific area; the gray cluster—more related to the time dimension or climate perception and contains terms such as “thermal comfort”, “perception”, “psychology”, “comfort”, “temperature”, “summer” and “cold region”, embodying the study of the impact of climate and seasonal changes on human behavior; the blue cluster—more related to population health and disparities and highlights the strong link relationship with “human” as the core, with terms such as “physical activity”, “child”, “safety”, and “socioeconomic



drive development. Keyword co-occurrence analysis emphasizes the importance of specific geographic context and dynamic factors, such as seasonal and climate variations, in enhancing POS usability. Trends also indicate that a “human-centered” design approach, in which user needs and preferences guide POS planning, is gaining importance; this perspective could be critical for promoting adaptive capacity and user satisfaction, especially in the context of climate adaptation.



**Figure 6.** Recurrent research steps adopted in the selected records.

### 3.2. Categorization and Common Characteristics of Selected Studies

Coding and clustering methods were used in this stage to identify shared characteristics among the selected studies. For example, scholars such as Lu used street view images and face-to-face interviews to assess the relationship between street greening and the cycling behavior of Hong Kong residents, and the findings highlighted the significant impact of road density, topography, and greenness on user behavior across age [24] by applying the framework from Section 2.2; the study was coded under “China”, “Hong Kong”, “residents”, “street”, “street view image”, “face-to-face interview”, “road density”, “topography”, “age” and “greenness”. Therefore, the coding results of the selected 74 studies can be found in Figure 7 and Table A1 accordingly.

The case study investigated in the selected studies includes 42 cities distributed all over the world. It is worth noting that the research is mainly concentrated in temperate and subtropical regions (10° N~50° N, 50° W~150° E), and there are fewer studies on extreme climate areas. There is a high level of attention to Asian cities, especially Chinese cities, but relatively few studies on Africa, South America, or other regions. Specifically, Hong Kong is the most studied city, with eight studies. In addition, several research involve case sites in multiple cities [25–27], including extensive studies of multiple international cities covering different regions from Asia to Europe [25], or a comparative study with two cities in Kenya [27].

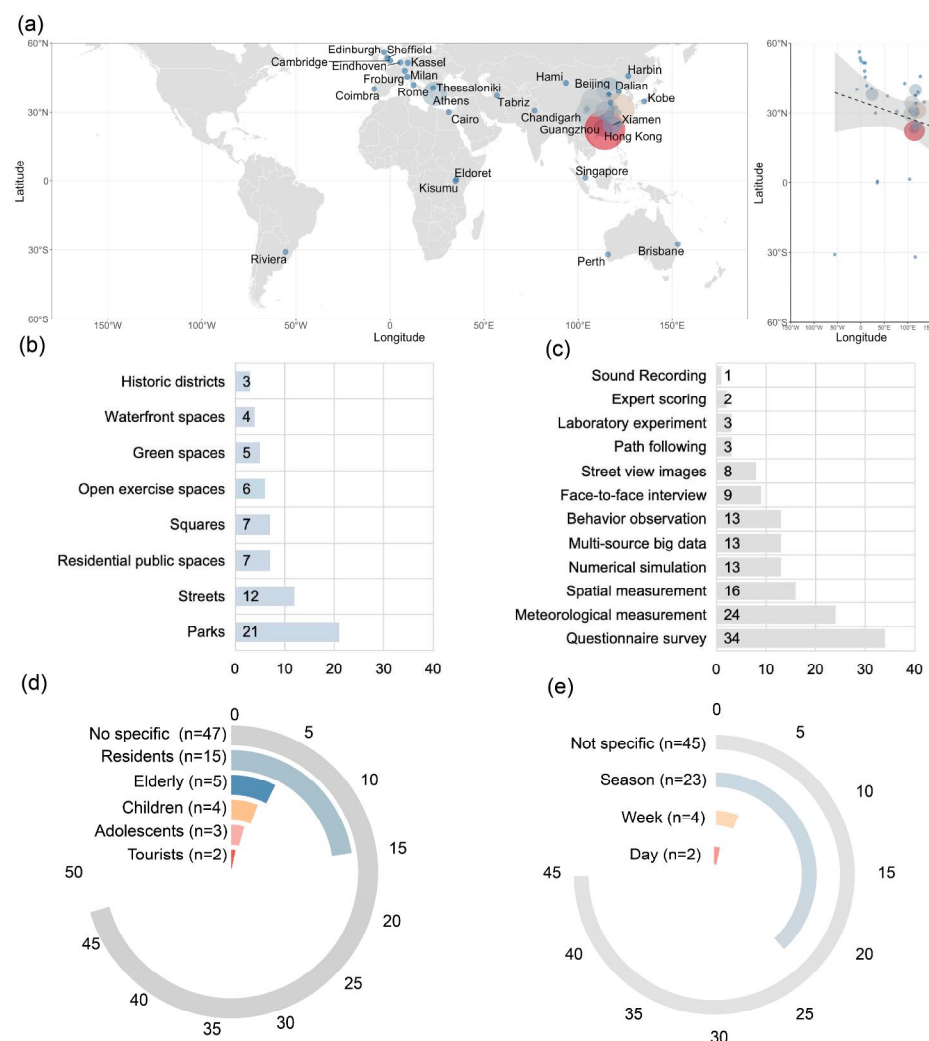
For the types of POS in the case study area investigated in the selected studies, most of them include parks ( $n = 21$ ), followed by streets ( $n = 12$ ). In addition, some studies focused on residential public spaces ( $n = 7$ ) and squares ( $n = 7$ ), while waterfront spaces, and historic city centers were less studied. In addition, several studies explored the use of space under different environmental conditions [1,17,25,27–30]. For example, some works studied both squares and historic city centers [25], or studied multiple types of POS, including streets, residential public spaces, squares, and open sports spaces [29].

Data collection methods included questionnaires, meteorological measurements, spatial measurements, numerical simulations, multi-source big data, behavioral observations, face-to-face interviews, street view images, path tracking, laboratory experiments, expert ratings, and sound recordings. Among them, the most used method was questionnaires,

which were used 35 times, while sound recordings were the least used (only used once). In addition, most of the research used multiple collection methods, generally using meteorological measurements together with spatial measurements, or using behavioral observation methods in combination with questionnaires to collect data, to obtain more comprehensive and multi-dimensional data.

The research subject is the user of the POS, but not all studies explicitly mention the specific research subjects. About less than half of the studies involve specific research subjects, among which residents are the most studied group ( $n = 15$ ), the second is the elderly ( $n = 5$ ), and the least is tourists ( $n = 2$ ).

Not all studies are limited to a specific period. About 45 studies did not specify the research periods, 23 studied specific seasons or used seasons as the time unit for research, another 4 studies used weeks as the research cycle, and 2 studies used one day as the unit to investigate the daily changes in POS and users' behavior.



**Figure 7.** Characteristics of the selected studies: (a) case study location, (b) type of public open space, (c) data collection methods, (d) specific study subjects (if mentioned); (e) specific study period (if mentioned).

Significant influencing factors from the selected studies are summarized in Table 3, Figures 8 and 9 through frequency analysis. Through systematically analyzing these studies, a total of 62 significant influencing factors were extracted. Based on the general classification of work from the type of reviews in the selected studies, these factors were grouped into four subject areas (environment [31,32], space [31–33], behavior and percep-

tion [4,34] and society and population [35,36]) and twelve underlying themes (climate conditions [7,32,33], built environment [32,35,37], urban environment quality [7,37], space design [2,5,35,38], architectural environment [31,37,39], transportation [2,7,33], usage preferences [31,34,35,40], physiological conditions [16,34], psychological conditions [16,34,41], personal background [5,35,42], socio-cultural background [2,16,42,43] and socio-economic background [2,16,42]). Specifically, it is most common to examine the key factors affecting users' behavior through climatic conditions and built environment in POS. Space design is another focused area, and in terms of behavior and perception, usage preferences are the main focus of research. For the social and demographic factors, the influence of personal background on users' behavior has been extensively studied.

Notably, some influencing factors are repeatedly mentioned in the selected studies.

Greenness ( $n = 19$ ) includes plants and landscape design [1,18,24,44], and landscape quality ( $n = 18$ ) involves the aesthetic and functional quality of the landscape, which are key to improving the attractiveness and environmental quality of POS [8,44–46]. Temperature ( $n = 17$ ) [10,47–49] and solar radiation intensity ( $n = 16$ ) involve sunlight exposure and the availability of shaded areas, which is an important climatic condition that affects user comfort and time spent outdoors [1,46,48,50]. Wind speed ( $n = 15$ ) [1,46,47,50] and relative humidity ( $n = 10$ ) [1,10,48,51] significantly affect usability, especially in open areas or near water bodies. Season ( $n = 14$ ) [25,48,49,52] and climate zone ( $n = 10$ ) [15,44,48,53] highlight the impact of climate conditions in different seasons on the type and frequency of user activities.

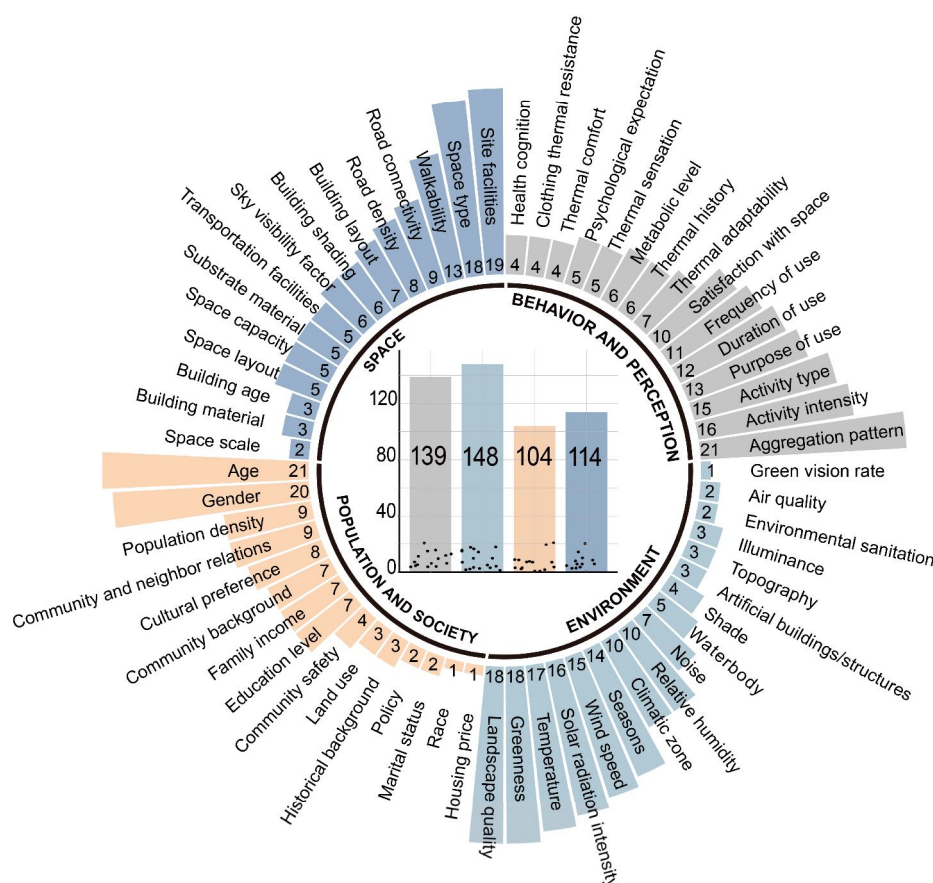


Figure 8. Summary of the significant factors mentioned in the selected studies (elaborated by the authors through R).

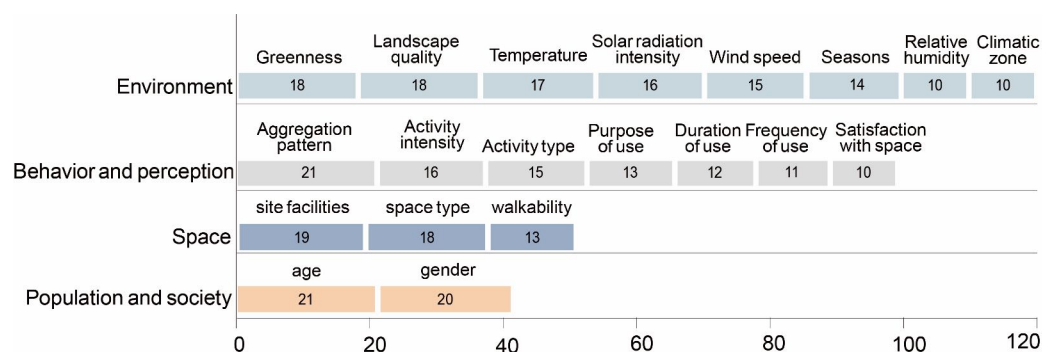


Figure 9. Repeatedly mentioned significant factors.

Gathering patterns ( $n = 21$ ), activity intensity ( $n = 16$ ), activity type ( $n = 15$ ), purpose of use ( $n = 13$ ), duration of use ( $n = 12$ ), and frequency of use ( $n = 11$ ) reflect the dynamic usage preferences of users in POS [1,8,11,18,54,55], including how users gather and their periodic changes. Space satisfaction ( $n = 10$ ) as part of psychological perception highlights users’ overall evaluations of POS [15,54]. Site facilities ( $n = 19$ ) [15,18,54], space type ( $n = 18$ ) [24,44,56,57], and walkability ( $n = 13$ ) [50,56,58] are key design elements influencing POS use and attractiveness. Age ( $n = 21$ ) and gender ( $n = 20$ ) are key personal background factors shaping user behavior and preferences [10,40,49,54], Different groups may have significant differences in space use preferences and behavior patterns.

Table 3. Summary of the significant factors mentioned in the selected studies and description.

Underlying Themes	Significance Factors	Count	Description	References
<b>Environment</b>				
Climatic conditions	Seasons	14	Defined by the cyclical changes in climate conditions, it significantly influences the usage patterns and experiences in public spaces [59].	[25,29,30,48,49,51,52,59–65]
	Temperature	17	The variation in temperature affects outdoor thermal comfort and health [61].	[10,13,26,29,30,47–49,51,52,56,61–64,66,67]
	Wind speed	15	Wind speed impacts thermal perception and outdoor activity comfort [29].	[1,29,46–52,56,61,63,64,66,68]
	Solar radiation intensity	16	The intensity of sunlight influences thermal comfort and the degree of UV exposure [30].	[1,29,30,46,48,50–52,56,60–64,66,67]
	Relative humidity	10	The relative humidity affects perceived temperature and comfort levels [10].	[1,10,29,48,51,61–64,67]
	Illuminance	3	Light intensity influences visual comfort and psychological perception [47].	[25,48,67]
	Climatic zone	10	The climate type determined by geographic location affects overall climatic conditions and environmental characteristics [34].	[15,17,29,44,48,49,53,60,63,69]
Built environment	Shade	4	The proportion of sunlight shading affects outdoor thermal comfort and the willingness to use the space [30].	[13,18,30,66]
	Topography	3	The topography and surface undulation affect the landscape and usage requirements [15,24].	[12,15,24]
	Water body	5	Water bodies such as rivers and lakes provide aesthetic value and microclimate regulation [59].	[9,39,51,59,70]
	Green vision rate	1	The proportion of green vegetation in view influences mental health and landscape aesthetics [18,71].	[18]

Table 3. Cont.

Underlying Themes	Significance Factors	Count	Description	References
	Greenness	18	The proportion of green coverage affects microclimate regulation and psychological comfort [24].	[1,12,13,17,18,24,39,44,51,57,66,67,69,70,72–75]
	Landscape quality	18	The aesthetic quality and diversity of the landscape influence residents' visual pleasure and mental health [9].	[8–10,12,15,17,26,44–46,54,67–70,72,76,77]
	Artificial buildings/structures	3	Man-made buildings and structures provide functional spaces, impacting visual and user experience [78].	[29,44,78]
Urban environmental quality	Air quality	2	The level of airborne pollutants directly impacts health and quality of life [7,8].	[8,72]
	Noise	7	Environmental noise levels affect comfort and mental health [68].	[8,10,25,68,72–74]
	Environmental sanitation	2	The cleanliness of the environment affects public health and user experience [8].	[8,73]
<b>Space</b>				
Space design	Space type	18	The specific type of space influences its usage and the user demographic [5,27].	[1,15,25,27,29,30,39,44,47,57,58,61,63,65,66,74,75,77]
	Space layout	5	The design and layout of a space impact its ease of use and functionality [58].	[11,12,57,58,73]
	Space scale	2	The size and proportion of the space affect the user experience and types of activities [79].	[73,79]
	Site facilities	19	Public facilities and amenities provide convenience and services [11].	[4,9,11,12,15,18,29,39,50,51,54,58,60,67,70,73,75,78,79]
	Space capacity	5	The overall area of public space affects capacity and activity diversity [39,76].	[18,28,39,45,80]
	Sky visibility factor	6	The degree of openness in space affects ventilation, lighting, and user experience [18].	[18,44,48,73,74,76]
	Substrate material	5	The type of ground material affects walking comfort and the thermal environment [1].	[1,29,50,60,67]
Architectural environment	Building layout	7	The arrangement of buildings affects ventilation, shading, and views [78].	[1,44,45,58,73,76,78]
	Building material	3	The materials used in buildings impact the thermal environment [1].	[46,50,76]
	Building shading	6	The shading provided by buildings affects indoor and outdoor temperature and comfort [56].	[1,46,51,53,56,60]
	Building age	3	The construction time of buildings reflects their historical significance and aesthetic value [76].	[28,58,76]
Transportation	Walkability	13	The ease of walking to a destination affects travel modes and health [33].	[12,15,17,28,39,45,48,55–57,67,77,81]
	Road connectivity	9	The connectivity of the road network affects transport convenience and travel efficiency [17].	[17,24,39,57,73,77,78,80,81]
	Road density	8	The number of roads per unit area affects traffic flow and pedestrian convenience [79].	[24,57,58,72,73,78–80]
	Transportation facilities	5	Public transport and other support facilities affect travel convenience and transport options [41].	[24,28,55,78,81]

Table 3. Cont.

Underlying Themes	Significance Factors	Count	Description	References
<b>Population and society</b>				
Usage preferences	Aggregation pattern	21	Patterns of people gathering and activity, including daily and weekly variations, affect space usage and social interaction [30,62,67].	[1,8–10,12,13,15,18,25,29,30,50,52,54–56,63,65,67,69,75]
	Frequency of use	11	The frequency of space usage reflects its popularity and intensity of use [78].	[8,11,17,25,27,39,54,55,64,69,78]
	Activity intensity	16	The intensity of activities affects energy expenditure and health outcomes [11].	[11,12,17,29,48–50,54,55,60,63,65–67,69,75]
	Activity type	15	The type of activities reflects the function and usage of the space [34].	[12,13,17,30,39,46,49,50,52,54,63,64,67,69,72]
	Purpose of use	13	The purpose of using space affects the type of activities [65].	[17,25,27,39,47,55,57,61,64,65,77,78,81]
	Duration of use	12	The duration of stay in space reflects its attractiveness [11,50].	[46,47,50,53,55,59,61–65,69]
Physiological conditions	Metabolic level	6	Individual metabolic rate affects thermal perception and adaptation [11,80].	[29,47,51,61,65,80]
	Health cognition	4	Awareness and understanding of health affect health behaviors and space usage [17].	[17,47,61,80]
	Thermal history	6	Past heat exposure experiences affect current levels of thermal adaptation [29,46].	[29,48,52,63,65,69]
	Clothing thermal resistance	4	The thermal resistance provided by clothing affects perceived temperature and comfort [48].	[29,48,49,65]
Psychological conditions	Thermal adaptability	7	The ability to adapt to the thermal environment affects tolerance to temperature variations [29,63].	[29,47–49,52,60,63]
	Psychological expectation	5	Expectations and perceptions of the environment influence comfort and satisfaction [47].	[30,47,48,61]
	Thermal comfort	4	Subjective thermal comfort affects the willingness to engage in activities and overall health [34].	[52,66,67,74]
	Thermal sensation	5	Actual sensations of the thermal environment influence behavior and space usage [65].	[48,62,63,69,74]
	Satisfaction with space	10	Satisfaction with a space affects the willingness to engage in activities and space usage [65,73].	[9,15,47,48,55,56,65,68,74,77]
<b>Behavior and perception</b>				
Individual background	Gender	20	The gender of users influences space usage preferences and needs [49].	[11,17,24,25,27,46,48,49,51,52,54,57–59,61,65–67,69,81]
	Age	21	The age of users affects the type of activities and modes of use [11,32].	[11,13,17,24,25,29,30,46,48,51,54,57–60,65–67,69,80,81]
	Education level	7	The educational background of users affects space requirements and usage behaviors [46].	[25,27,46,48,65,69,80]
	Family income	7	The economic status of users influences activity choices and space usage [39].	[17,24,25,39,48,57,81]
	Marital status	2	The marital status of users affects the type of activities and space requirements [27].	[27,80]

Table 3. Cont.

Underlying Themes	Significance Factors	Count	Description	References
Sociocultural background	Cultural preference	8	The cultural background and preferences of users affect space usage and design requirements [14].	[11,25,28,29,54,70,72,75]
	Community background	7	The background of the community affects social interaction and space usage [68].	[15,29,55,57,68,72,80]
	Historical background	3	The historical and cultural background of a space influences its value and modes of use [14].	[70,75,76]
	Community and neighbor relations	9	Relationships and interactions within the community influence social support and space usage [8].	[8,10,17,25,30,44,55,72,79]
	Community safety	4	The safety status of a community affects space usage and psychological comfort [11].	[8,11,12,17]
Socioeconomic background	Housing price	1	Real estate prices in the area influence residential choices and community characteristics [4,45].	[45]
	Policy	2	Government policies and regulations affect space usage and management [45].	[44,45]
	Population density	9	The number of residents per unit area affects space pressure and service demands [75].	[8,24,28,39,45,57,58,75,77]
	Race	1	The racial background of users influences cultural needs and space usage [14,54].	[54]
	Land use	3	Land use and planning affect the function and usage patterns of space [37,57].	[29,57,64]

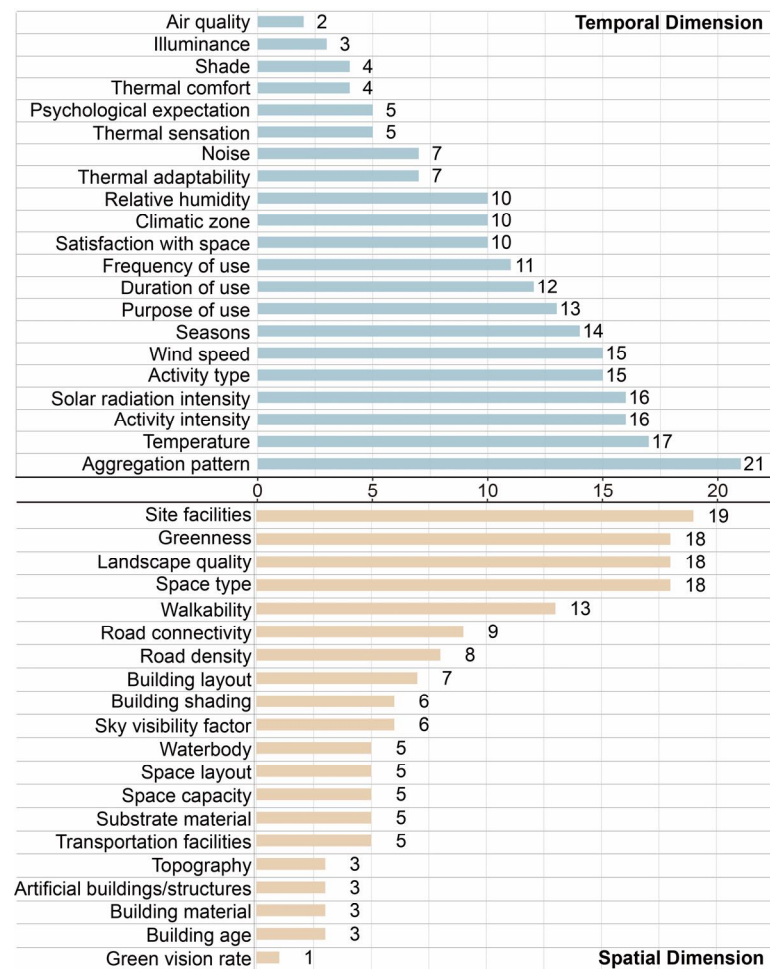
### 3.3. Reassessment Significant Factors Across Spatial and Temporal Dimensions

Through the above analysis, it can be found that certain significant influence factors indicate a clear pattern in spatial and temporal dimensions. For example, factors such as site facilities, space type, and landscape quality are usually closely related to spatial dimensions and have high stability and persistence, with changes in these factors usually taking a long time to show significant effects. Factors such as temperature, solar radiation intensity, and wind speed reflect the dynamics and variability in the time dimension and are significantly affected by short-term environmental conditions. This distinction highlights how different factors may affect user behavior differently across these two dimensions [16]. Before reassessing these significant influencing factors across spatial and temporal dimensions in the follow-up phase of this study, certain factors are excluded not due to lack of importance, but because they cannot be incorporated for the following reasons:

Reason 1 is weak correlation with spatial or temporal dimensions, where some factors primarily reflect individual physiological or psychological differences, such as gender, age, and metabolic level, while frequently studied, but lack direct relevance to POS' spatial or climate-related factors. Reason 2 is the inability to quantify spatial or temporal properties and certain factors entail complex social backgrounds and individual variability, i.e., cultural preference or community background indirectly influence space use but are challenging to categorize within spatial or temporal attributes. Reason 3 is divergence from research objectives and factors like housing price, policy, and land use have been omitted to maintain research clarity. The specific situation is shown in Table 4 and Figure 10.

**Table 4.** Summary of the significant factors mentioned in the records from the spatial and temporal dimensions.

Significance Factors	Count	References
<b>Temporal dimension</b>		
Aggregation pattern	21	[1,8–10,12,13,15,18,25,29,30,50,52,54–56,63,65,67,69,75]
Temperature	17	[10,13,26,29,30,47,48,51,52,56,60–64,66,67]
Solar radiation intensity	16	[1,29,30,46,48,50–52,56,60–64,66,67]
Activity intensity	16	[11,12,17,29,48–50,54,55,60,63,65–67,69,75]
Wind speed	15	[1,29,46–52,56,61,63,64,66,68]
Activity type	15	[12,13,17,30,46,49,50,52,54,63,64,67,69,72,79]
Seasons	14	[13,25,26,29,30,48,49,51,52,62,64–66,81]
Purpose of use	13	[10,17,27,47,48,55,57,61,64,65,77,78,81]
Duration of use	12	[12,46,47,50,53,55,59,61,62,64,65,69]
Frequency of use	11	[8,11,17,25,27,54,55,64,69,78,79]
Relative humidity	10	[1,10,29,48,51,61–64,67]
Climatic zone	10	[15,17,29,44,48,49,53,60,63,69]
Satisfaction with space	10	[9,15,47,48,55,56,65,68,74,77]
Noise	7	[8,10,25,68,72–74]
Thermal adaptability	7	[29,47–49,52,60,63]
Psychological expectation	5	[30,47–49,61]
Thermal sensation	5	[48,62,63,69,74]
Shade	4	[13,18,30,66]
Thermal comfort	4	[52,66,67,74]
Illuminance	3	[48,49,67]
Air quality	2	[8,72]
<b>Spatial dimension</b>		
Site facilities	19	[5,9,11,12,15,18,25,27,29,33,50,51,54,58,60,67,73,75,79]
Greenness	18	[1,12,13,17,18,24,44,51,57,66,67,69,70,72–75,79]
Landscape quality	18	[8–10,12,15,17,26,44–46,54,67–70,72,76,77]
Space type	18	[1,15,25,27,29,30,44,47,57,58,61,63,65,66,74,75,77,79]
Walkability	13	[12,15,17,28,45,48,55–57,67,77,79,81]
Road connectivity	9	[17,24,55,57,73,77,78,80,81]
Road density	8	[24,57,58,72,73,78–80]
Building layout	7	[1,44,45,58,73,76,78]
Sky visibility factor	6	[18,44,48,73,74,76]
Building shading	6	[1,46,51,53,56,59]
Waterbody	5	[9,39,51,59,70]
Space layout	5	[11,12,57,58,73]
Space capacity	5	[18,28,39,45,80]
Substrate material	5	[1,29,50,60,67]
Transportation facilities	5	[24,28,55,78,81]
Topography	3	[12,15,24]
Artificial buildings/structures	3	[29,44,78]
Building material	3	[46,50,76]
Building age	3	[28,58,76]
Green vision rate	1	[18]



**Figure 10.** Summary of the significant factors mentioned in the records from the spatial and temporal dimensions.

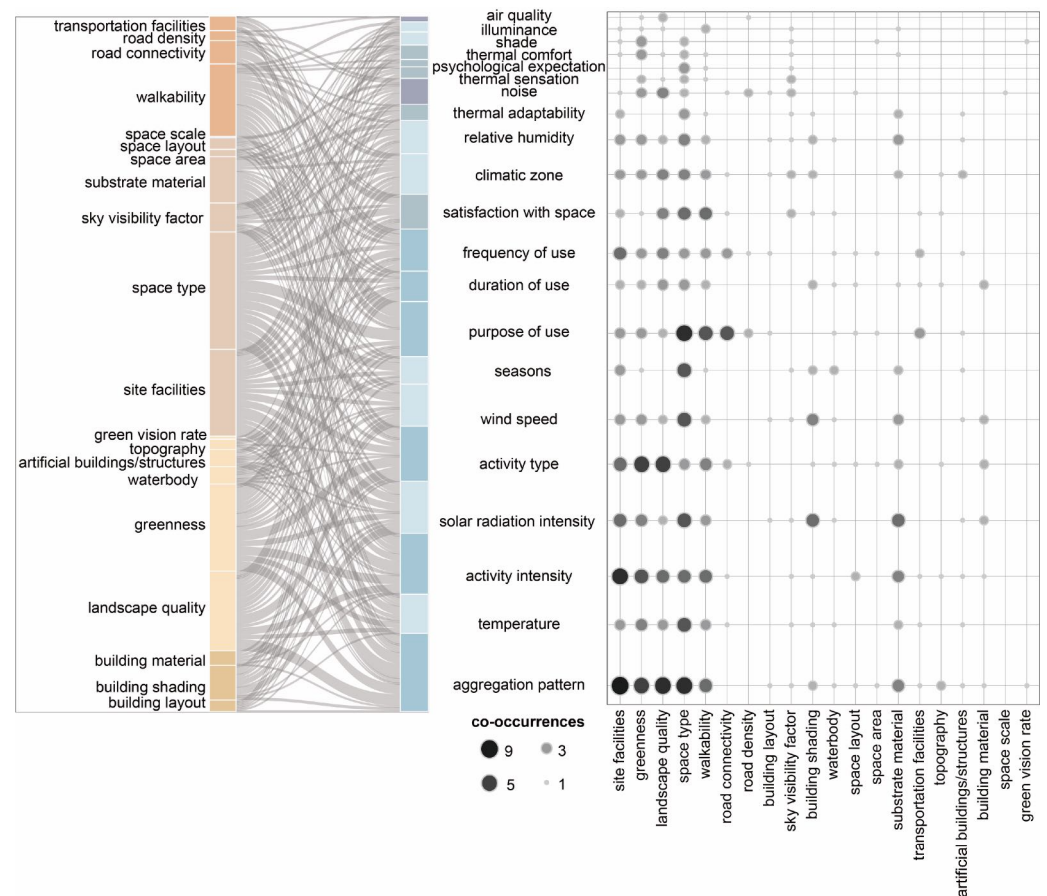
Among the influencing factors in the spatial dimension, they can be mainly divided into three categories (space design, built environment, and transportation), which can be connected to long-term benefits for urban development. For example, site facilities and space types, as core elements of space design, can significantly affect user behavior by attracting users [12,18,25,27,44,76]. Greenness, landscape quality, and waterbody, as important indicators of environmental aesthetics and ecological benefits, not only directly enhance the users' visual and psychological experience but also improve the overall environmental quality by adjusting the microclimate [9,51,68,72]. In addition, walkability, as an important factor affecting users' behavior, has a profound impact on users' accessibility and space utilization efficiency [57,58,81]. As the space elements that interact most directly with users, the persistence and stability of these factors make them occupy an important position in the spatial dimension and become an important basis for optimizing the design and management of POS.

Influencing factors in the temporal dimension are mainly divided into two categories, factors related to climate conditions and those related to users' behavior perception, both of which show the characteristics of dynamic and short-term changes. For example, factors such as temperature, solar radiation intensity, wind speed, and season reflect the impact of changes in environmental conditions on users' behavior in different periods [30,49,59,62]; strong seasonality and timeliness have a significant impact on the user experience within a specific time frame. In addition, aggregation patterns, activity intensity, activity types, purpose of use, and so on, as dynamic factors in the temporal dimension, are often im-

diately affected by users' behavior, perception, and needs [7,11,15,17,24]. These temporal factors provide key insights into understanding the usage patterns of POS over different periods and help optimize the design and management strategies of POS to better suit the needs of users.

### 3.4. Expansion Analysis of Significant Factors Across Spatial and Temporal Dimensions

The calculation results of the significant interaction between the spatial dimension and the temporal dimension are shown in Figure 11, including a bubble diagram on the right, where the size of the dots indicates the frequency of co-occurrences, and a Sankey diagram on the left, which illustrates the strength of correlations between two-dimensional factors through the thickness of the streamlines. It is worth noting that not all factors are mentioned in both dimensions at the same time; for example, when the influencing factor of "building age" in the spatial dimension is mentioned, no corresponding temporal dimension factor is mentioned, so this factor will not be mentioned in the following part.



**Figure 11.** Distribution of considering the significant factors from spatial–temporal dimension at the same time.

An analysis of the reviewed studies indicates that aggregation patterns strongly correlate with site facilities, landscape quality, and space type, critical for climate adaptive design. Activity intensity shows similar correlations with spatial factors like site facilities, greenness, and walkability, directly reflecting user experience [50,67,75]. Previous research has also found that wind speed correlates with building shading, space type, and walkability, influencing POS usability [29,48,49]. Additionally, several studies suggest that climate zone significantly impacts greenness, landscape quality, and seasons, reflecting their role in shaping landscape types and plant growth [15,44,69].

Findings from the reviewed literature further indicate that space type closely relates to temporal factors like purpose of use, season, and temperature [28,30,47,61], with parks, squares, and green spaces often associated with specific purposes and conditions [44]. Similarly, walkability links to activity type, intensity, and frequency [67,77], with well-designed pedestrian environments supporting diverse activities and increasing usage frequency. Moreover, research suggests that greenness correlates with health-related factors like aggregation patterns, activity intensity, psychological expectations, and thermal sensation [75], with abundant plants enhancing user satisfaction. Finally, multiple studies highlight the importance of substrate material selection, which aligns with factors such as solar radiation intensity, relative humidity, and wind speed [29,60,67], for example, anti-slip, cold-resistant materials suit colder climates [82], while high-permeability materials prevent water accumulation in rainy conditions [60].

Some low co-occurrence factor combinations imply that the correlation between these two-dimensional factors is weak and may not be often mentioned at the same time. Examples include psychological expectations and road density or relative humidity and building materials.

In summary, the complex interactions between spatial and temporal factors not only influence the functionality and usability of public spaces but also reveal critical strategies for responding to climate change. The strong correlation between these factors reveals several key research themes: first, the interplay between space design and use preferences, second, the key role of landscape environment in promoting psychological and physical health, finally, the relationship between the built environment and coping with the challenges of different climatic conditions.

## 4. Discussion

### 4.1. Key Factors for Climate Adaptation Solutions

By examining their interactive effects, this discussion identifies how spatial and temporal dimensions jointly influence POS usability.

Aggregation patterns are critical to climate adaptive design. Strategically placing seating, shade structures, and landscape installations enhances thermal comfort and increases space usage frequency [9,11,54]. For instance, a study about children's parks in Uruguay reveals that shaded, well-equipped urban parks attract higher user engagement, especially in the afternoon and evening [11]. In Mediterranean climates, shaded areas see peak attendance in cooler evening hours during summer, highlighting microclimatic impacts on gathering behavior [30]. Thus, enhancing user experience in public spaces requires careful attention to spatial characteristics that effectively support activity clustering, ensuring designs that are both climate-adaptive and conducive to social interaction [56]. However, existing studies are predominantly limited to specific climate zones, failing to provide a holistic understanding of how aggregation patterns vary across diverse climatic and cultural contexts.

Activity intensity is also shaped by greenness, landscape quality, and walkability, enhancing physical activity through comfortable environments [6]. For instance, utilizing shade or green cover effectively regulates thermal comfort, supporting moderate to vigorous activity even in hot-humid climates [67]. Community parks designed for elderly thermal needs promote physical and social activity, especially in subtropical climates [63]. Using SOPARC (System for Observing Play and Recreation in Communities), a widely adopted tool for exploring the relationship between environmental features and physical activity, studies also found that organized and well-equipped POS boost activity levels among children and adolescents [11]. These examples underscore the importance of integrating users' needs considerations into POS design to support diverse activity needs

and encourage sustained use, which in turn contributes positively to public health and adaptability in urban environments facing climate challenges. Despite these insights, while most studies assume stable activity patterns, extreme weather events and temperature fluctuations can significantly disrupt POS usability.

Wind speed significantly influences air quality and microclimate regulation, affecting user comfort and space usage. Key factors include building shading, substrate materials, and greenness [29,30]. For example, a study in Hong Kong showed that combining wind speed with shaded structures reduced thermal stress, lowering PET (Physiological Equivalent Temperature, a measure of human thermal comfort based on the body's heat balance) and UTCI (Universal Thermal Climate Index, a comprehensive index assessing the impact of weather conditions on human thermal perception) values to enhance outdoor comfort [29]. Similarly, in Mediterranean climates, optimizing wind flow and adding shade areas in summer effectively mitigated thermal discomfort [61,74]. These findings underscore the importance of designing POS with adaptive wind flow strategies to support diverse climatic conditions and user needs. This suggests that future research should integrate real-time wind speed monitoring with user perception surveys to assess the impact of varying wind conditions on POS usability, while exploring the potential of vegetation buffers to enhance POS quality and user comfort.

Climate zones influence microclimates and user behavior by determining vegetation types, shading, cooling, and comfort levels [15,44,46,69]. In temperate zones, landscape design often incorporates seasonally adaptive elements, like varied planting schemes to balance shading and sunlight. By contrast, arid climates rely on drought-resistant flora and low-maintenance hardscapes to reduce water use and promote long-term environmental balance [59]. On the other hand, hot climates, like those in Singapore [17], India [46] and Egypt [1], require climate-sensitive spatial arrangements with strategic materials and shading to enhance thermal comfort [82,83]. Therefore, future research needs to consider incorporating long-term monitoring of POS performance under diverse climate conditions. Cross-regional comparative studies can help identify context-specific best practices tailored to unique climatic and socio-cultural settings.

Space type plays a pivotal role in defining its functional purpose and shaping user activities, with environmental variables such as seasons, solar radiation, and temperature exerting significant influence [49,52]. For instance, in warmer conditions, relatively open spaces support social and leisure activities, as users seek sunlight and ventilation, while relatively enclosed or semi-enclosed spaces become more suitable for colder conditions, offering shelter from lower temperatures and wind [14,59]. These distinctions underscore the necessity of implementing tailored solutions for different space types; such targeted approaches enhance the usability and adaptability of POS across diverse climatic conditions. Optimizing POS requires tailored solutions that address the unique characteristics of different space types. For instance, historical plazas attract users for their aesthetic and cultural value, but nowadays, these must balance preservation with functional adaptation to ensure livability [84] by integrating climate-responsive features like shaded seating or permeable paving. Similarly, waterfront spaces can leverage natural elements, such as vegetation buffers, to enhance thermal comfort.

Walkability is crucial, as frequent use and high-intensity activities require well-designed, safe, and comfortable walking environments [76]. Organized layouts, accessible routes, and robust safety measures enhance user experience. Studies in Brisbane show that while subjective and objective walkability evaluations may differ, infrastructure improvements still enhance perceived and actual walkability [81]. This highlights the importance of optimizing routes to improve health outcomes and overall user satisfaction, especially in response to climate challenges [73]. Therefore, further exploration of psychological

and sensory factors, such as perceived safety, noise exposure, and aesthetic quality, can help ensure equitable and climate-resilient pedestrian environments while providing more comprehensive design guidelines.

Greenness regulates thermal conditions, influencing the type and duration of outdoor activities, thus benefiting mental and physical health [6]. With rising temperatures, optimizing greenery is critical for thermal comfort and mitigating the urban heat island effect [50]; this is further supported by findings that greenness, especially when measured at eye level [24], can positively influence outdoor physical activities like cycling, promoting a healthier, more sustainable urban environment. On the other hand, the advancement of new technologies, such as machine learning applied to street view imagery, offers opportunities to enhance greenness assessment at the pedestrian scale in POS, enabling a more nuanced understanding of user experiences.

The selection of substrate materials is pivotal in developing climate adaptation solutions, as these choices enhance user experience while significantly contributing to adaptive capacity and climate adaptation [71]. For instance, studies highlight that different landscape configurations, such as varying green coverage, water areas, and substrate reflectance, impact the thermal comfort of users across seasonal climates, suggesting specific configurations for optimal comfort [60]. These findings underscore substrate choices that not only enhance usability but also support broader climate adaptation goals by reducing extreme temperature effects in POS. However, while reflectivity and permeability are frequently analyzed, studies often overlook subjective comfort factors, such as how different substrates influence perceived walkability, tactile experience, or psychological well-being. Additionally, the multifunctionality of substrates and their interactions with other urban elements, such as vegetation, water management systems, and spatial devices, remain underexplored.

Understanding how these factors interact is essential for enhancing user experience and providing practical guidelines for the sustainable optimization of POS in response to climate challenges [83], and urban resilience [3].

#### *4.2. Limitations and Early Recommendations for Future Studies*

To address the research questions, a series of critical analyses identified key factors. Important spatial factors include site facilities, space type, greenness, and walkability, alongside temporal factors like temperature, season, aggregation pattern, and activity intensity. Interactions between these dimensions, such as aggregation patterns with landscape quality or site facilities with activity intensity, are crucial for optimizing POS to meet diverse user needs.

Several noteworthy limitations are inherent in this field. Current POS research often focuses on spatial or temporal factors independently, neglecting their combined impacts on user behavior and overlooking dynamic interactions, such as how seasonal changes intersect with site-specific features to shape usage patterns and satisfaction [85]. Furthermore, discrepancies between subjective and objective measures of POS attributes are frequently noted but rarely addressed through integrated approaches, and most studies rely heavily on either quantitative or qualitative data but lack balanced mixed-method approaches, which could provide a more comprehensive understanding of user behavior [86]. Then, many case studies are concentrated in temperate and subtropical regions, with fewer studies in extreme climates, reducing generalizability and underrepresenting critical climate adaptation needs [26]. In addition to spatial and temporal factors, the historical character of POS plays a crucial role in shaping their cultural and emotional significance; historical POSs, such as historical city centers or ancient plazas, often serve as landmarks that foster emotional attachment among residents and attract tourists [84], while the current study primarily considers the buildings with POS, the historical character of POS itself has not been extensively explored.

Based on these insights, this study recommends several directions for future research. First, integrating spatial–temporal interactions can enhance POS usability and thermal comfort year-round, particularly in climate-sensitive zones. Second, expanding research to diverse climate zones can inform adaptation strategies tailored to local conditions. Third, future research could explore how the preservation of historical POS contributes to urban cultural landscapes and enhances their socio-cultural value. Fourth, advancing data standardization and methodologies, including digital mapping tools and high-resolution climate models, can refine POS assessments and enable accurate cross-regional comparisons. Fifth, long-term data monitoring and multi-period behavioral observations combined with climate data can reveal temporal dependencies and guide forward-looking designs. Last, by adopting user-centered and context-specific solutions and by matching behavioral data with climate-adaptive design factors, this can enable dynamic spatial configurations, optimizing resource efficiency in POS and maintaining their attractiveness to users over time.

## 5. Conclusions

This study presents a systematic review of public open space (POS) and user behavior, identifying essential spatial and temporal factors critical for designing environments that are adaptable to climate change and meet the needs of diverse users. By analyzing 74 research articles, this review highlights how spatial elements, such as site facilities, greenness, and walkability, interact with temporal factors like seasonal variations, temperature, and activity intensity to shape user behavior and experience. The findings reveal that spatial and temporal dimensions are not isolated but rather form an interconnected network that directly impacts POS usability, particularly as cities face rising environmental stress.

From a practical perspective, this study provides actionable insights. The results suggest that integrating dynamic climate-adaptive design strategies, such as flexible shading systems, seasonally responsive infrastructure, and adaptive landscape planning, can enhance the usability and adaptability of POS across different climate conditions. Furthermore, findings highlight the importance of employing long-term data monitoring, GIS-based spatial analysis, and predictive modeling to refine POS design and management, enabling more precise and adaptive urban planning decisions. Stakeholders, including urban planners and designers, can leverage the findings to create more climate-resilient and user-centric POS, while policymakers can use the evidence-based recommendations to inform regulations and investments in POS, which then benefits urban residents by promoting healthier, more comfortable, and socially engaging environments, improving overall well-being and quality of life.

In this study, research has been analyzed through a critical framework that integrates spatiotemporal dimensions into POS research. This research perspective not only aims at bridging the gap between urban planning, climate science, and behavioral research but also sets a foundation for future studies to explore the nuanced relationships between urban spaces, user behavior, and environmental change. In summary, this study underscores the critical role of POS in urban climate adaptation. Through thoughtful, adaptive design, POS can not only address immediate climate change challenges but also provide sustained support for the sustainable development of cities and the health and well-being of residents.

**Supplementary Materials:** The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/su17062724/s1>, PRISMA 2020 checklist [87].

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

**Table A1.** Study characteristics.

Case Study Location					
City Name	Count	References	City Name	Count	References
Hong Kong	8	[8,24,51,55–57,64,68]	Changzhou	1	[50]
Shanghai	5	[18,25,28,58,62]	Froburg	1	[25]
Xi'an	4	[26,29,48,60]	Mianyang	1	[64]
Chongqing	4	[15,41,52,88]	Fuzhou	1	[13]
Beijing	3	[25,26,76]	Nanjing	1	[80]
Athens	3	[30,61,78]	Chengdu	1	[12]
Guangzhou	2	[10,44]	Perth	1	[77]
Xiamen	2	[67,75]	Hami	1	[26]
Wuhan	2	[9,45]	Rome	1	[53]
Kobe	1	[78]	Harbin	1	[49]
Cambridge	1	[25]	Sheffield	1	[25]
Ningbo	1	[79]	Xuzhou	1	[52]
Dalian	1	[73]	Tabriz	1	[74]
Taipei	1	[72]	Thessaloniki	1	[25]
Dezhou	1	[59]	Coimbra	1	[39]
Milan	1	[25]	Brisbane	1	[81]
Edinburgh	1	[54]	Cairo	1	[1]
Riviera	1	[11]	Chandigarh	1	[46]
Eindhoven	1	[47]	Kassel	1	[25]
Singapore	1	[17]	Kisumu	1	[27]
Eldoret	1	[27]	Huangshan	1	[63]

Type of Public Open Space in the Case Study		
Type	Count	References
Parks	21	[9,13,15,26,28,39,45,51,52,54,55,59,60,62–65,68–70,74]
Streets	12	[1,24,26,29,31,37,44,47,49,56,57,72]
Residential public spaces	7	[8,10,18,29,77,78,80]
Squares	7	[1,25,28–30,46,53]
Open sports spaces	6	[11,12,29,50,66,67]
Green spaces	5	[11,27,72,74,75]
Waterfront spaces	4	[1,9,17,30]
Historic city centers	3	[48,76,79]

Data Collection Methods		
Method	Count	References
Questionnaire survey	34	[1,8,9,17,25–27,29,39,46,48–52,55,58–69,72–74,77,78,81]
Meteorological measurement	24	[10,13,26,29,30,46–53,56,60–67,69,74]
Spatial measurement	16	[12,18,25–27,29,39,59,60,63,66,68,72,73,76,78]
Numerical simulation	13	[1,26,29,52,60–64,66,69,73,75]
Multi-source big data	13	[9,15,17,24,28,45,54,57,58,75,77,80,81]
Behavior observation	13	[10–12,27,28,53,54,56,62,64,67,69,76]
Face-to-face interview	9	[8,18,24,30,45,47,55,57,76]
Street view images	8	[24,44,57,58,69,70,79,81]
Path following	3	[13,28,76]
Laboratory experiment	3	[9,25,70]
Expert scoring	2	[18,58]
Sound recording	1	[52]

Table A1. Cont.

Case Study Location		
Study Subjects	Specific Study Subjects (If Mentioned) Count	References
No specific study subjects	47	[1,2,4,5,7,9,13,15,16,25,27,28,30–44,47,49–54,56,57,61,62,64,68,70,74,77–79,88,89]
Residents	15	[8,10,17,18,24,26,29,46,48,59,67,69,73,75,80]
Elderly	5	[55,58,63,65,72]
Children	4	[11,12,60,66]
Adolescents	3	[11,45,81]
Tourists	2	[48,76]
Specific Study Period (If Mentioned)		
Specific Study Period	Count	References
Not specified	45	[1,2,4,5,7–10,12,16,17,24,25,27,31–38,40–45,55,57,58,63,68–70,72,73,76–81,88,89]
Season	23	[13,15,26,29,30,46–53,56,59–62,64–67,74]
Week	4	[11,18,28,54]
Day	2	[39,75]

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