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

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 27 January 2025 and was last updated on 27 January 2025.

INTRODUCTION

Review question / Objective The core research question is to develop a more comprehensive understanding of how POS influences user behavior from a dynamic perspective by identifying the key factors that are recurrently mentioned in the scientific literature. Specifically, the study investigates:

- which factors are related to spatial dimensions.
- which pertain to temporal dimensions.
- which encompass both spatial and temporal dimensions.

By exploring the complex interactions between these factors, the study aims to provide new theoretical insights for the design and management of POS and help to develop more effective strategies for addressing climate change challenges in urban environments.

Rationale Climate change increasingly affects the livability and functionality of urban environments, particularly public open spaces (POS), impacting

user behavior in complex ways that require a comprehensive, multi-perspective approach for understanding. This study reviews current progress, methodologies, and findings by proposing a critical analytical framework focused on key spatial and temporal factors that contribute to the design of climate adaptation solutions. Then, these were analyzed through a two-dimensional approach using a co-occurrence matrix to examine interactions. Understanding these influential combinations is essential for advancing POS optimization in response to climate challenges. 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.

Condition being studied Climate change is a global challenge, with urban areas facing increasing climate risks affecting livability and everyday activities, tackling these challenges requires not only improving environmental sustainability but more crucially, strengthening

urban resilience, with public open spaces serving as key nodes where many of these activities occur. Public open space (POS), as a major component of the outdoor environment in the public life of a city, refers to freely accessible parks, green spaces, recreational and sports and leisure facilities, and other spaces that provide opportunities for recreational activities and act as an outdoor gym, social occasion. For instance, in many cities, parks and squares serve as daily spaces for residents while also hosting cultural events, community gatherings, and markets.

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. Studies indicate that well-designed POS can not only improve public health but also foster social interaction and community cohesion.

Despite progress, significant gaps remain in the research. Most studies focus on short-term observations of user behavior, 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, at the same time, user behavior is not static but constantly adapts to dynamic temporal and spatial contexts.

Moreover, spatial considerations in existing studies tend to be limited, with little attention given to users' dynamic behavior within spaces. Ignoring these spatiotemporal interactions can lead to an incomplete understanding of POS usage patterns, limiting their practical application in urban planning and design.

METHODS

Search strategy A systematic literature review was conducted to identify the drivers of user behavior in POS and to identify relevant research, policies, tools, strategies, and practices. The first stage of the review used the PRISMA method to ensure the inclusion of eligible studies. The results aim to provide optimization directions and tools to develop more effective strategies for enhancing urban resilience and sustainability by identifying potential key factors.

The search was performed between May and June 2024: records published after 1st July were not included.

Participant or population The string was searched in the database by topic (title, keywords, and abstract), to answer the research questions posed earlier, it is necessary to clarify the criteria 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: show that there is a correlation between POS and users' behavior.

Intervention The constructed retrieval string is as follows: (influencing* OR con-tributing* OR affecting*) AND factor* (Topic) AND behavio* OR use* (Topic) AND (open* OR public* OR outdoor* OR built*) AND space*.

Comparator For a more refined screening, studies beyond the scope of this study will be excluded. Therefore, a series of filters were set to enhance the reliability of the review results and can be selected at each review step.

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.

Study designs to be included Reviews and articles.

Eligibility criteria Any record considered relevant to the review topic were manually added.

Information sources 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.

Main outcome(s) A total of 74 records were included.

The time distribution of records in the selected decade, with 2020 emerging as a turning point in the number of research. Most studies are research articles, with a minor share of reviews. About the top 10 research institutions in terms of article volume contribution and output, among which 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, Netherlands, Belgium) are also worth highlighting. 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. The journals' top 10 list where studies are published. From the 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 in promoting sustainability, inclusiveness, and quality of urban development.

Data management Tools like Endnote, Bibliometrix, and Vosviewer, are used for text data mining, producing key topic maps and research clusters.

Quality assessment / Risk of bias analysis After selecting 74 records from the 4417 initially identified records for the observations and full-text reading, some preliminary hypotheses can be proposed: research interest in POSs surged in 2020, likely due to the COVID-19 pandemic, which increased attention to health and outdoor environments, this trend suggests an emerging focus on POS designs that prioritize health and adaptability in urban settings. Topic and keyword analyses show evolving research priorities, the research focus has changed over time, reflecting emerging issues and priorities, with studies focusing solely on environmental, spatial, or socioeconomic issues often lacking broad applicability and a unified framework. The growing

interest in POSs and user behavior underscores the potential for interdisciplinary research to 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 and resilience. 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 resilience and user satisfaction, especially in the context of climate adaptation.

Strategy of data synthesis This stage focuses on re-examining the identified significant influencing factors. A blend of quantitative and qualitative analyses is applied. Statistical and programming tools (such as R language, Python, and SPSS) are used to re-examine and validate the hypotheses from new perspectives, ensuring the precision and interpretability of key factors.

Subgroup analysis Analysis will also re-examine these significant influencing factors across spatial and temporal dimensions. However, it is essential to ensure their alignment with the framework of the previously proposed hypotheses and their relevance to the research questions around key factors.

Sensitivity analysis In the final stage, mathematical analysis is used to explore interactive relationships among key factors, such as flow relationships and co-occurrence frequencies. This analysis reveals key interactive factor combinations and provides data-driven insights into deeper patterns and regularities.

Language restriction English.

Country(ies) involved Italy.

Keywords Urban Planning; Climate Change and Urban Environments; Public Open Space (POS); Sustainable Development; Spatio-Temporal Factors; Public space use; User behavior.

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