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A Dynamic Urban Environmental Comfort Framework: Integrating Spatial, Social, and Environmental Factors

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Extended Abstract

Urban Environmental Comfort (UEC) is a crucial field of study that examines the complex interactions between environmental, social, and spatial factors influencing well-being in urban settings [1], [2]. Although previous research has primarily emphasized thermal comfort as the key determinant of environmental comfort, a more comprehensive approach is needed to fully capture the multifaceted nature of UEC. This includes considerations of urban morphology, spatial configuration, and socio-demographic characteristics that shape individuals' experiences of UEC [1], [3], [4], [5].

This research, therefore, advocates for an expanded conceptualization of UEC, in which environmental sensory experiences, including air quality perception and soundscape conditions, are integrated with spatial and social determinants. To achieve this, a system dynamics (SD) approach [6] and causal loop diagrams (CLDs) [7] are employed to identify causal relationships among key components. This dynamic qualitative analysis reveals how changes in land use, activity patterns, social interactions, soundscapes, and air quality influence UEC.

Findings from the cross-sectoral examination of three subsystems, the air-soundscape, the human-social, and the spatial, while considering the thermal system as an external element demonstrate the complex interrelationships between environmental quality, human dynamics, and spatial context. Spatial syntax and land-use configurations act as fundamental drivers shaping mobility patterns, social interactions, and environmental conditions. While increased accessibility fosters urban vitality and social engagement, it also creates pressures on environmental quality, particularly air and noise pollution. The feedback loops between these subsystems underscore the need for integrated planning approaches that balance infrastructural improvements with environmental sustainability. Green spaces, mixed-use developments, and pedestrian-friendly designs contribute positively to both environmental and social well-being, yet their effectiveness is contingent on spatial integration and mitigation strategies. Furthermore, thermal conditions modulate urban comfort perceptions, influencing mobility behaviours and pollution exposure levels.

This study contributes to the field by providing a new definition of UEC and lays the groundwork for creating more thorough models for assessing outdoor environmental comfort. The study's findings provide useful information for environmental scientists, policymakers, and urban planners who want to create resilient, sustainable cities that enhance human well-being. This study's primary shortcomings, nevertheless, is that it lacks scientific backing and a quantitative assessment, consequently rendering it subjective in nature. The lack of objective data limits the ability for assessing the strength of these interactions, despite the fact that CLDs are a helpful tool for mapping causal relationships [7]. Future research should focus on integrating empirical data collection, real-world case studies, and cutting-edge technologies like artificial intelligence and smart sensors in order to validate and enhance the proposed framework. By expanding this study to include a range of urban contexts and interdisciplinary approaches, its applicability and impact on sustainable urban development will be further enhanced.

By bridging the gap between environmental perception and urban planning, this study underscores the importance of incorporating social and sensory dimensions into environmental assessments. A more holistic understanding of UEC can facilitate the design of urban spaces that are not only environmentally efficient but also socially inclusive and perceptually enriching [8], ultimately improving the quality of life for urban dwellers.

Keywords: Environmental Comfort, System Dynamics, Environmental Integrated Framework, Sustainable Urban Development

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