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Editorial
Indoor Environmental Quality and Occupant Comfort

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1. Introduction

Positive indoor environments can improve occupant comfort and well-being by inducing positive perceptual outcomes. Uncomfortable environments, including noise, improper temperature, humidity, dim lighting [1,2], poor air quality, and unpleasant smells [3,4], may impede the quality of life and negatively affect occupants' experiences [5,6]. Furthermore, prolonged exposure to suboptimal indoor environments may lead to adverse changes in individual health conditions. In order to ensure positive indoor environments for occupants, perceptual quality assessment has been introduced and extensively studied in recent years. Influenced by indoor environmental quality (IEQ), it is necessary and beneficial to explore how humans perceive and what effects the environment brings. While there is still a limited understanding of the intrinsic neurological and biological mechanisms of human perception, it is still worthwhile to investigate indoor environmental quality from this perspective.

Despite ongoing research efforts in this area, the underlying mechanisms linking environmental factors and their perceptual effects on users still need to be fully understood. Furthermore, as researchers explore these relationships, additional challenges emerge in terms of psychological and sociological methodologies. It is necessary for researchers and practitioners in built environments to address these issues. Therefore, this Special Issue aims to gather articles that discuss indoor environmental quality and occupant comfort. The articles in this Special Issue encompass different research categories, ranging from conceptual analyses and reviews to research papers. The studies presented here investigate the characterization and perception of both individual indoor environments as well as complex environmental interactions, along with their management and design implications. The focuses of these investigations include both theoretical aspects (including the relationships between environmental quality and psychological or physiological effects) and methodological aspects (including protocols and procedures for gathering objective and subjective data).

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2. Research Themes

Considering the broad scope of this Special Issue's call, the topics and research questions addressed by the submissions are diverse. We have identified common themes and clustered all published papers under three categories: (1) design-based optimization of indoor environment performance, (2) comfort evaluation of IEQ, and (3) the impact of IEQ on psychophysiology. These contributions help to advance the scientific conversation concerning these important issues.

2.1. Design-Based Optimization of Indoor Environment Performance

Improving indoor environmental performance and reducing building energy consumption through active and passive design has become an important research field. The articles published in this Special Issue are representative of this research field. Scholars focus on how to effectively improve indoor thermal comfort [7], air quality [8], lighting performance [9–12], and sound insulation performance [13], and reduce building energy consumption by optimizing building equipment [7–9], interior spaces [10–12], and building structures [13]. In addition, the functional types and geographical locations of the research objects are different. Zhang et al. [8] studied a new ventilation system for rural houses in severely cold regions of China in winter. Piraei et al. [10], Ma et al. [11], and Jia et al. [12] explored the optimal design of daylighting performance of heritage buildings in high-latitude areas and classrooms in mid-latitude areas. Qu et al. [13] conducted a study on the sound insulation performance of interior partition structures for a hotel. These studies have provided a reference and evaluation basis for architectural design to improve indoor environmental performance.

2.2. Comfort Evaluations of IEQ

The articles published on this topic are representative of the exploration of comfort evaluations, and researchers have found that the positive design of the environment can significantly improve comfort. They cover a diverse range of occupant types, including studies on the elderly [14], visually impaired individuals [15], and infants [16]. The examined architectural types and geographic locations also vary, including historical residents in Zanzibar [17], school buildings under both severely cold areas in China [18] and mild climate areas in Japan [16], and office buildings in North China and America [19]. These articles have investigated the impact of acoustic [15,20], lighting [14], and thermal [16–19] indoor environmental quality on comfort.

2.3. Impact of IEQ on Psychophysiology

IEQ has significant impacts on occupants, both psychologically and physiologically. Researchers have conducted studies on public buildings, such as offices [21], schools [22,23], shopping malls [24], hotels [25,26], and elderly facilities [27], by using a variety of methods, including field measurements, simulations, behavioral observations, questionnaires, and interviews, as well as tools such as virtual reality (VR) and electroencephalography (EEG). Some interesting findings deserve attention: interior natural lightscapes can influence physiological indicators [21], whereas colors can impact emotional indicators [22,25]. These findings potentially provide supporting data for further developments in the therapeutic effects of indoor environments on health.

3. Concluding Remarks

Although the three themes discussed above do not comprehensively cover all the aspects of IEQ and occupant comfort, they highlight some "hot topics" relevant to researchers. It is worth noting that as a research area examining the impacts of the environment on occupants, this field is still evolving and expanding to a certain extent, particularly with the integration of research methods from fields such as neuroscience, computer science, psychology, and sociology into architectural research. Examples of such methods include virtual reality techniques, Heart Rate Variability (HRV) and EEG measurement, on-site investigation, and behavioral observation. The interdisciplinary nature of these approaches helps researchers to better understand how the built environment affects human perception, as well as how architectural design can support better human experiences. In future research, it is important to engage a wider range of stakeholders in the discussion, including the general public, government, investors, building professionals, designers, and artists.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Kong, Z.; Utzinger, D.M.; Freihoefer, K.; Steege, T. The impact of interior design on visual discomfort reduction: A field study integrating lighting environments with POE survey. *Build. Environ.* **2018**, *138*, 135–148. [CrossRef]

2. Kong, Z.; Jakubiec, J.A. Evaluations of long-term lighting qualities for computer labs in Singapore. *Build. Environ.* **2021**, *194*, 107689. [CrossRef]
3. Wu, Y.; Kang, J.; Mu, J. Assessment and simulation of evacuation in large railway stations. *Build. Simul.* **2021**, *14*, 1553. [CrossRef]
4. Zhang, S.; Zheng, J.; Wu, Y. Field study of air environment perceptions and influencing factors in waiting spaces of general hospitals in winter cities. *Build. Environ.* **2020**, *183*, 107203. [CrossRef]
5. Zhang, H.; Liu, Z. Influence of winter natural ventilation on thermal environment of university dormitories under central heating mode in severe cold regions of China. *Archit. Sci. Rev.* **2023**, *66*, 226–241. [CrossRef]
6. Kong, Z.; Liu, Q.; Li, X.; Hou, K.; Xing, Q. Indoor lighting effects on subjective impressions and mood states: A critical review. *Build. Environ.* **2022**, *224*, 109591. [CrossRef]
7. Zhu, X.; Liu, J.; Zhu, X.; Wang, X.; Du, Y.; Miao, J. Experimental Study on Operating Characteristic of a Combined Radiant Floor and Fan Coil Cooling System in a High Humidity Environment. *Buildings* **2022**, *12*, 499. [CrossRef]
8. Zhang, B.; Cai, X.; Liu, M. Study on a New Type of Ventilation System for Rural Houses in Winter in the Severe Cold Regions of China. *Buildings* **2022**, *12*, 1010. [CrossRef]
9. Budhiyanto, A.; Chiou, Y.-S. Prototyping a Lighting Control System Using LabVIEW with Real-Time High Dynamic Range Images (HDRis) as the Luminance Sensor. *Buildings* **2022**, *12*, 650. [CrossRef]
10. Piraei, F.; Matusiak, B.; Lo Verso, V.R.M. Evaluation and Optimization of Daylighting in Heritage Buildings: A Case-Study at High Latitudes. *Buildings* **2022**, *12*, 2045. [CrossRef]
11. Ma, J.; Yang, Q. Optimizing Annual Daylighting Performance for Atrium-Based Classrooms of Primary and Secondary Schools in Nanjing, China. *Buildings* **2023**, *13*, 11. [CrossRef]
12. Jia, Y.; Liu, Z.; Fang, Y.; Zhang, H.; Zhao, C.; Cai, X. Effect of Interior Space and Window Geometry on Daylighting Performance for Terrace Classrooms of Universities in Severe Cold Regions: A Case Study of Shenyang, China. *Buildings* **2023**, *13*, 603. [CrossRef]
13. Qu, T.; Wang, B.; Min, H. Lightweight Composite Partitions with High Sound Insulation in Hotel Interior Spaces: Design and Application. *Buildings* **2022**, *12*, 2184. [CrossRef]
14. Fu, Y.; Wu, Y.; Gao, W.; Hui, R. The Effect of Daylight Illumination in Nursing Buildings on Reading Comfort of Elderly Persons. *Buildings* **2022**, *12*, 214. [CrossRef]
15. Wu, Y.; Huo, S.; Mu, J.; Kang, J. Sound Perception of Blind Older Adults in Nursing Homes. *Buildings* **2022**, *12*, 1838. [CrossRef]
16. Genjo, K. Assessment of Indoor Climate for Infants in Nursery School Classrooms in Mild Climatic Areas in Japan. *Buildings* **2022**, *12*, 1054. [CrossRef]
17. Liu, C.; Xie, H.; Ali, H.M.; Liu, J. Evaluation of Passive Cooling and Thermal Comfort in Historical Residential Buildings in Zanzibar. *Buildings* **2022**, *12*, 2149. [CrossRef]
18. Zhang, J.; Li, P.; Ma, M. Thermal Environment and Thermal Comfort in University Classrooms during the Heating Season. *Buildings* **2022**, *12*, 912. [CrossRef]
19. Wang, X.; Mu, T.; Zhang, L.; Zhang, W.; Zhang, L. A Simplified Thermal Comfort Calculation Method of Radiant Floor Cooling Technology for Office Buildings in Northern China. *Buildings* **2022**, *12*, 483. [CrossRef]
20. Glean, A.A.; Gatland, S.D., II; Elzeyadi, I. Visualization of Acoustic Comfort in an Open-Plan, High-Performance Glass Building. *Buildings* **2022**, *12*, 338. [CrossRef]
21. Kong, Z.; Hou, K.; Wang, Z.; Chen, F.; Li, Y.; Liu, X.; Liu, C. Subjective and Physiological Responses towards Interior Natural Lightscape: Influences of Aperture Design, Window Size and Sky Condition. *Buildings* **2022**, *12*, 1612. [CrossRef]
22. Tao, W.; Wu, Y.; Li, W.; Liu, F. Influence of Classroom Colour Environment on College Students' Emotions during Campus Lockdown in the COVID-19 Post-Pandemic Era—A Case Study in Harbin, China. *Buildings* **2022**, *12*, 1873. [CrossRef]
23. Hamida, A.; Eijkelenboom, A.; Bluyssen, P.M. Profiling Students Based on the Overlap between IEQ and Psychosocial Preferences of Study Places. *Buildings* **2023**, *13*, 231. [CrossRef]
24. Deng, H.; Xu, Y.; Deng, Y. Is the Shortest Path Always the Best? Analysis of General Demands of Indoor Navigation System for Shopping Malls. *Buildings* **2022**, *12*, 1574. [CrossRef]
25. Xu, J.; Li, M.; Cao, K.; Zhou, F.; Lv, B.; Lu, Z.; Cui, Z.; Zhang, K. A VR Experimental Study on the Influence of Chinese Hotel Interior Color Design on Customers' Emotional Experience. *Buildings* **2022**, *12*, 984. [CrossRef]
26. Xu, J.; Li, M.; Huang, D.; Wei, Y.; Zhong, S. A Comparative Study on the Influence of Different Decoration Styles on Subjective Evaluation of Hotel Indoor Environment. *Buildings* **2022**, *12*, 1777. [CrossRef]
27. Wang, H.; Hou, K.; Kong, Z.; Guan, X.; Hu, S.; Lu, M.; Piao, X.; Qian, Y. "In-Between Area" Design Method: An Optimization Design Method for Indoor Public Spaces for Elderly Facilities Evaluated by STAI, HRV and EEG. *Buildings* **2022**, *12*, 1274. [CrossRef]