

Editorial

Human Factors in Green Building: Building Types and Users' Needs

Zhonghua Gou

School of Engineering and Built Environment, Griffith University, Gold Coast, QLD 4215, Australia;
z.gou@griffith.edu.au

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Abstract: The Special Issue on “Human Factors in Green Building” addresses the design of indoor environment quality for users’ needs. The collected papers cover various building types and the research highlights the different needs of users. In working environments, employees’ stress is the main concern in the workplace design, especially for open plan offices where lack of privacy and over exposure to environmental stress have been reported. In residential environments, residents have great opportunities to adjust their environments to suit their needs; therefore, passive design such as natural ventilation is explored in residential buildings with climates such as cold or humid tropical. In healthcare environments, the papers in this issue are concerned with the needs of patients, especially the older adults who require special care. In learning environments, thermal and visual aspects are investigated for optimal comfort conditions and learning outcomes. The special issue demonstrates insightful critical thinking of indoor environment quality and proposes a new understanding for more practical design solutions. This editorial note is a brief review of the 12 papers, concluding with reflections about design of built environments to meet users’ needs.

Keywords: human factors; green building; indoor environment quality; building types; post-occupancy evaluation

1. Introduction

Buildings serve their users and users adapt to their buildings. The intricate relationship should be addressed in the sustainable or green built environment design [1]. The research challenge is how we understand and measure human factors. In recent years, numerous human factors related studies have been found on the subject of indoor environment quality (IEQ) which includes aspects such as thermal comfort, air quality, noise and visual aspects of a building [2–4]. These studies aimed to define optimal settings for satisfying building occupants. On the other hand, the studies on IEQ have been facing great challenges due to its narrow definition of a physical environment that influences occupants’ perception and satisfaction [5] and also its ignorance of building types and related diverse occupants’ needs [6]. The aim of this special issue is to enrich the understanding of IEQs in relation to building types and users’ needs.

To meet this aim, the special issue collected 12 papers from a variety of perspectives in response to the human factors. The authors come from Australia, China, Indonesia, U.K., U.S., Sweden and New Zealand, and represent worldwide efforts on this topic. These papers provided innovative frameworks theoretically and empirically to measure human-related IEQs in different building types. One of most mature IEQ studies is thermal comfort, a regular topic in this field. This special issue collected papers on measuring thermal comfort in vernacular architecture made of stone in cold climates, thermal comfort in tropical classrooms and thermal comfort and related use behaviors in modern apartment buildings. The contrast makes the special issue interesting to read and compare. The issue also collected papers on visual aspects (outdoor views) for enhancing indoor environment quality

in learning environments. Stress or negative perception in contemporary open plan workplace is an urgent issue for addressing human factors in green building. The special issue collected two papers that aim to propose design solutions in response to workplace stress. Healthcare facilities are intensively researched for occupant health and wellbeing. For such a regular topic in this field, the related design strategies are analyzed in three papers. Last but not least, this special issue invited a special contribution that extended the current understanding of IEQ. The research about human factors is in great variety and covers different types of buildings. Their users have different expectations and needs. To enhance the environmental quality and meet their needs is what the special issue wants to promote for human-oriented design solutions. The following editorial comments on the collected papers are based on the building types and users' needs.

2. Building Types and Users' Needs

2.1. Workplace Environments

In working environments, office workers are exposed to environmental and job stresses. Especially in open plan workplaces, the environmental stress due to loss of privacy and exposure to noise is outstanding. Three papers in this special issue offer design solutions to alleviating the workplace stress and improving indoor environmental conditions. The paper by Felix Kin Peng Hui and Lu Aye [7] established a comprehensive framework about health relevance of both proximal and remote aspects of workplace design. The method is a comprehensive literature review. It covered not only employees' immediate work area and ambient environmental qualities of the work area, but also building organisation, exterior amenities, and site-planning. The paper addressed that occupational stress is a complex phenomenon that is dynamic and evolving over time and developed an improved model relevant to work place design and occupational stress. The proposed improved model is presented with an appropriate causal loop diagram to assist in visualizing how different variables in a system are interrelated. The developed model highlights how connection to nature in workspaces can function as a work resource with a dual effect of improving physical wellbeing and psychological wellbeing.

The paper by Zhonghua Gou, Jian Zhang and Leigh Shutter [8] presents an empirical study about the individual environmental control, especially its benefits on self-reported health status in open-plan work environments where often occupants reported loss of privacy and negative feelings of their health status. The research combined three systematic occupant survey tools and collected responses on 12 selected individual controls. The results showed that half of the 12 individual controls were negatively associated with adverse perceptions. Among all controls, non-mechanical ones, such as windows and blinds, were more effective than mechanical ones such as fans and air-conditioning in alleviating adverse perceptions in open-plan offices. The research provides some interesting findings to workplace and interior design.

One paper in this special issue reported an experiment in a laboratory with workplace settings. It is different from other field studies of real offices mentioned above. It aims to investigate human factors in a controlled condition. This paper is contributed by Mattias Holmgren and Patrik Sörqvist [9]. Their experiment explored whether green building certification could make people favor that office environment over than the non-certified building. Through two rigorously deployed experiments, the author suggested the complexity of the green effect on influencing occupants' preference on indoor environmental conditions. The research had important implications for using green certification to improve office workers' satisfaction.

2.2. Healthcare Environments

Healthcare environmental design, especially for the elderly, have attracted intensive research attention in recent years. In this special issue, there are three papers relevant to this topic.

The paper by Hing-wah Chau, Clare Newton, Catherine Mei Min Woo, Nan Ma, Jiayi Wang and Lu Aye [10] focused on the specific group of people with dementia. This paper investigated three recently

constructed dementia support facilities in Victoria, using fieldwork observation, design evaluation and space syntax analysis. The results provided evidence and critical analysis concerning the design of these three facilities on how the built environment can best accommodate residents with dementia.

Yisong Zhao and Monjur Mourshed [11] conducted an interesting study about the hospital outpatient area using a survey of patients. This study is in response to the increasing interest in 'patient-centred' design of health and care facilities, especially the hospital waiting areas. The research randomly selected outpatients in two hospitals in Qingdao, China for the survey. Five principal factors, respectively on sensory, lighting and thermal, facilities, spatial, and seating design, were identified. A variety of demographic data were correlated with these factors.

Another article on aged care facilities by Masa Noguchi, Nan Ma, Catherine Mei Min Woo, Hing-wah Chau and Jin Zhou [12] aimed to incorporate indoor environment quality into the architectural practice of aged cared facilities through the proposed environmental experience design framework. The method is case study. The authors extended their previous case study on the collective spatial analysis and IEQ monitoring results to apply the framework to the aged care facility in Victoria, Australia. This study helped to engage the subjectivity and objectivity of end users' expectations, desires, and requirements in the architectural design thinking process.

2.3. Learning Environments

Compared to working and residential environments, learning environments have attracted less research attention due to the group of people who may be under age to participate in the research. The special issue is lucky to have two important contributions, respectively concerning visual and thermal environments for learning activities. The paper by Zhonghua Gou, Maryam Khoshbakht and Behnam Mahdoudi [13] reported a case study of outdoor views in a university library in the south hemisphere. The study surveyed the students' seat preference in the selected library and addressed the importance of outdoor views in their seat selection. Furthermore, the study quantified the outdoor view in terms of sky view, tree view and shading view. The three views correlated with the seat preference to different extents.

In the other paper about learning environments by Baharuddin Hamzah, Zhonghua Gou, Rosady Mulyadi and Samsuddin Amin [14], the thermal comfort level of students in secondary schools in the tropical city of Makassar was measured and analyzed. It is a large-scale study with 1594 students in 48 classrooms under natural ventilation. It turned out that the air temperatures ranged from 28.2 °C in the morning to 33.6 °C in the midday, which is out of the normal comfort zone defined in many building standards. Nevertheless, the students did not report much discomfort; instead, most of them accepted the thermal conditions. Neutral temperatures were identified for the group of students in Indonesia. This paper echoed another paper [15] in this special issue which was concerned with residential environments in tropical climates and pointed out that the tropical people could adapt to temperatures higher than the normal accepted comfortable temperature.

2.4. Residential Environments

Different from institutional building types such as office and school buildings, residential buildings are designed to meet demographic needs of residents. Therefore, the research focus is usually in a great diversity. The special issue collected three papers in residential environments. The paper by Zhonghua Gou, Wajishani Gamage, Stephen Siu-Yu Lau and Sunnie Sing-Yeung Lau [15] is a pilot study of thermal comfort and adaptive behaviors of occupants who live in naturally ventilated dormitories at the campus of the National University of Singapore. The research used a longitudinal survey and field measurement to measure thermal comfort, adaptive behaviors and indoor environment qualities. Although occupants living in naturally ventilated buildings in tropical climates were exposed to higher operative temperatures than what comfort standards recommend for naturally conditioned spaces, they still felt that such conditions were acceptable. This finding echoes the adaptive thermal comfort theory

proposed by de Dear and Brager [16]. The study also found two important behavioral adjustments that contributed to the acceptance: increasing the indoor air velocity and reducing clothing insulation.

The paper concerning residential environments in cold climates is contributed by Bin Cheng, Yangliu Fu, Maryam Khoshbakht, Libin Duan, Jian Zhang and Sara Rashidian [17]. Different from the other one that is focused on modern apartment buildings, this paper focused on traditional residential building made of stone. The research conducted thermal comfort measurements in winter. The majority of surveyed residents voted “slightly cool” for temperature, and “slightly dry” for humidity. The available adaptive opportunities for the residents included adjusting clothing, drinking hot beverages, blocking air infiltration through windows, and changing activities.

Yukiko Kuboshima, Jacqueline McIntosh and Geoff Thomas [18] used a qualitative case study approach to investigate the rental housing design for the elderly. The method consisted of a detailed documentation of the physical environment, followed by interviews with and full-day observations of the residents and their caregivers, to examine the living experiences of six old people who lived in local-authority rental housing in New Zealand. The authors found that the design of housing that improves their life quality requires solutions to accommodate the various conflicting needs derived from the diversity in the user’s preferences and impairments. Particularly, there was greater need for additional or reorganized space to accommodate caregivers and visitors while to maintain residents’ independence, privacy, and other aspects important for their life quality.

2.5. Theory Attempts to Fill the Gap

Most research on indoor environment quality is based on survey, field or laboratory experiments or case study; few explored its theories or related arguments. The paper contributed by Linda Pearce [19] fills in the gap. The paper used a theoretical method. The paper highlights the pleasure of interior environments. Specifically, the paper proposed a sequential mixed methods research process allowing subjective and objective research methods integration. The methods integrated interior architecture and architectural science disciplines by coding interior architecture perspectives into possible measurable variables which would likely be more inclusive of the lived experience and agency of occupants of interior spaces. The paper had important implications for expanding indoor environment quality indicators.

3. Concluding Remarks

The traditional understanding and measuring of human factors are based on quantitative studies of IEQs to identify the optimal range of indoor environmental settings that can satisfy users. However, the reality is that building users and their needs are different; the quantitative understanding of IEQs might be flawed. The special issue contains both traditional quantitative measurement of IEQs on thermal comfort and visual aspects, and newly proposed IEQ frameworks that contain spatial experience, facilities and even aspects superseding the physical boundary of a building. More importantly, these papers diversify the needs of IEQs according to building types: workplace, residential, learning and healthcare environments. These papers addressed important IEQ and design issues for the specific building types and users’ needs. An important message from this special issue is that the future study of IEQ requires going beyond the discipline of building or architectural sciences to include and integrate other disciplines such as interior design, healthcare design, workplace design and environmental psychology.

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