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Editorial

Special Issue on Innovative Circular Building Design and Construction

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1. Introduction

The circular economy, a global movement that seeks an innovative approach to resource management, responds to global challenges such as climate change, decreasing biodiversity, and increasing waste and pollution. Nowadays, the construction and use of buildings account for over half of the total consumption of raw materials and energy globally. Adopting the circular economy in the construction industry allows us to maximize the usage of renewable materials and extend the life of nonrenewable materials. Hence, in the twenty-first century, circular architectural designs and construction techniques have emerged as the primary factors influencing politics, the economy, society, and the environment. The construction industry also acknowledges the significance of sustainable construction for industrial growth and resource efficiency. Therefore, circular architecture has attracted significant research interest, and numerous circular-construction-related technologies, tools, and strategies have been developed and tested globally. The influence of policies and planning on national and international agendas relies on implementing circular construction to promote integrated and sustainable development.

Recently, architecture, construction, environment, and hydraulics are undergoing discipline-wide transformations thanks to advances in computing, networking technologies, big data, and artificial intelligence. Thus, to provide a unified communication platform for researchers on the topics of architecture, construction, environment, and hydraulics, the 3rd IEEE International Conference on Architecture, Construction, Environment and Hydraulics 2021 (IEEE ICACEH 2021, http://www.icaceh.asia, accessed on 23 December 2021) was held during 24–26 December 2021, at National United University, Miaoli County, Taiwan. This conference brought leading researchers, architects, engineers, design professionals, product manufacturers, builders, and developers together in various construction engineering disciplines and offered diverse opportunities to discuss related topics. The conference highlighted various issues to facilitate knowledge exchange, increase practical awareness, and explore new ideas and thinking related to construction engineering, management, technology, and the environment.

The purpose of this Special Issue is to introduce and review research articles presented at the IEEE ICACEH 2021 on the topic of "Innovative circular building design and construction". It also aims to discuss the roles of traditional and new actors in the supply chain to minimize waste and pollution by improving the efficiency of using products and materials in construction.

2. Topics of the Special Issue on "Innovative Circular Building Design and Construction"

For this Special Issue, ten excellent articles about building design and construction were selected. The authors discuss innovative methods applied to the design and construction of the building, such as "Evolutionary Game Theory", "Analytic Hierarchy Process

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method", "Fuzzy logic theory", "Demand–Potential–Constraint Model", and "Deep Learning Techniques in the Field of Artificial Intelligence". In the articles, the evaluation and reuse of buildings were verified, and researchers made in-depth explorations based on the results. We believe that readers will be interested in articles on circular building designs and constructions; preventing building disasters; decreasing the risk of viruses; building environment monitoring technology, green facilities, and ecological amenities; indoor illuminance; building renewals in historic urban areas; and so on. The articles will lead researchers and engineers to extensive discussions. Brief introductions to the articles in the Special Issue are provided as follows.

Wu et al. presented the "Analysis of Behavioral Strategies of Construction Safety Subjects Based on the Evolutionary Game Theory" [1]. The authors demonstrated that the principal contractor and construction employees are important stakeholders in construction safety management. The findings provide an explicit direction for designing effective incentives for safety and their limitations. This study was carried out to establish an evolutionary game model and investigate how to implement the safety behavior of general contractors and construction employees. In this study, evolutionary game theory was applied to construction safety management as an innovative research methodology in the discourse of construction management. Consequently, based on the profit and loss of each participant in the construction process, an evolutionary law of construction workers' safety compliance and behavior was defined to improve construction safety management and support the development of effective incentives and constraints for construction safety management.

Huang et al. described the "Analysis of Risk Factors for Emergencies in the Taipei Dome Complex" [2]. The authors used the analytic hierarchy method (AHP) to determine the emergency risk variables for equipment safety, traffic, staffing, potential public dangers, security management, and disaster events. It was found that the top 14 risk factors accounted for nearly 70% of the Taipei Dome Complex's acceptable risk probability at a moderate level of safety. The factors included insufficient fire facilities, fire, terrorist attacks, earthquakes, unclear escape or fire facilities signage, deficiencies in evacuation guidance, insufficient police resources, firefighting resources, MRT emergencies, deficiencies in a moving line, hypoxia, insufficient medical personnel, and a lack of staff training. Security management was the most important among the 14 risk factors with a recognition rate of 80%, followed by catastrophic events at 75% and personnel at 60%.

Lai et al. explained the "Contact-Free Operation of Epidemic Prevention Elevator for Buildings" [3]. In this study, a contact-free elevator travel system was proposed by combining intelligent voice recognition, contact-free perceptual buttons, gesture recognition sensors, and a web page browser activated by quick response codes. This system decreased the risk of viral infection induced by contact in the elevator, thus preventing the spread of a pandemic and protecting the health of individuals. Facial recognition and RFID recognition were incorporated into the system based on the results of this study. In facial recognition, captured facial features were compared to registered facial features. This technology increased the RFID's accuracy. After authentication, the passenger's assigned floor was retrieved from the database. Via this authentication, the system automatically identified the floor to which the passenger was traveling, preventing them from making contact with the surface of the elevator car.

Sung et al. proposed a "Strategy for Improving the Indoor Environment of Office Spaces in Subtropical Cities" [4]. The authors focused on a regularly used office space in Taiwan that included a seating area, a document storage area, and a photocopying machine area. To avoid pollution caused by the inflow of outside air, which harms the quality of the inside air, an air conditioning system was implemented in the office space. Environmental monitoring technologies were introduced to examine the relationship of the architectural form with the indoor and outdoor air quality, and solutions were provided to improve the air quality by addressing the indoor temperature, relative humidity, and air quality. The test and analysis result of this study indicated that the execution of the upgraded

procedures considerably improved the indoor air quality and minimized the formation of suspended particles. This solution can be used as a reference for other relevant offices to improve the indoor environment and air quality of their office spaces. Monitoring and improving the environment in the building for human activities contributed to circular building design and construction significantly.

Hsueh et al. reported the "Decision-Making Model Based on Discriminant Analysis Fuzzy Method for Low-Carbon and Eco-Friendly Residence Design: Case Study of Conghua District, Guangzhou, China" [5]. The authors discussed the discourse on low-carbon and circular buildings. Combining the Delphi method, analytical hierarchy process (AHP), and fuzzy logic theory (FLT), a DAFuzzy model was developed. In the Delphi technique, the opinions of experts were reflected in three dimensions and nine factors. AHP was then used to determine the relative weight of each element. Using FLT, the output value of each factor was determined in the optimal scenario as an affecting factor. The result of the study demonstrated that green facilities were the most crucial for designing eco-friendly residential areas, followed by community participation and ecological amenities. The best scenario among 45 possible models was to incorporate green and ecological facilities and community engagement. Taking into account the dimensions and elements of the optimal scenario, the proposed DAFuzzy model suggested the necessary elements for a low-carbon and eco-friendly development, proper regulations, and a substantial investment. The findings of this study indicated that the construction of a low-carbon and eco-friendly home requires government support as well as public understanding and engagement in eco-friendly development. The proposed model allowed for the understanding of the aspects of the eco-friendly design of the residential building and provided a basis for policies and decisions to seek a low-carbon and eco-friendly society. The low-carbon and eco-friendly homes are an excellent reference for future sustainable designs of smart, low-carbon communities.

Matin et al. discussed "the Effect of Smart Colored Windows on the Visual Performance of Buildings" [6]. In this study, photochromic coatings for window glass were developed, and the influence of such intelligent technologies on the visual comfort of occupants was assessed. The authors investigated the visual performance of building facades containing windows with various photochromic coatings. The visual performance metrics of three window types coated with nine distinct photochromic color shades were analyzed and compared to discover which photochromic colors and window types provided the most appropriate interior visual metrics. The results indicated that the daylight glare probability and the useful daylight illuminance of photochromic window glass were increased with multicolor coatings. In terms of energy efficiency, the results showed that windows coated with photochromic materials offered a superior option to those without a coating. The optimal color proportions and color distributions in multicolor windowpanes must be researched further.

Matin et al. proposed "A Novel Framework for Optimizing Indoor Illuminance and Discovering Association of Involved Variables" [7]. The authors investigated the relationships between design aspects and the visual performance of a responsive façade system. Initially, they proposed a data-driven method for investigating the practical elements of illuminance optimization for responsive facades. In this method, indoor illuminance data and location information were collected hourly to construct an objective function. This function was then used to evaluate the visual effectiveness of responsive façade systems by matching various angles of the façade to the hourly sunlight pattern. Then, a statistical analysis was conducted to evaluate the significance of design variables in various scenarios. The results provided thorough information on design variables and their effects on visual comfort. On average, the angles, configurations, orientations, and placements of the façade showed significant degrees of 100, 41, 87, and 45%, respectively, in feasible scenarios/variable combinations.

Wang et al. presented the results of "Sustainable Renewal of Historical Urban Areas: A Demand–Potential–Constraint Model for Identifying the Renewal Type of Residential

Buildings" [8]. The renewal and protection of historic buildings in urban areas are a global issue and enable the sustainable development of urban cultural texture. Therefore, a framework was proposed to identify the renewal type of old residential buildings. The created framework was used to build a demand–potential–constraint model with assessment indicators in three dimensions: renewal demand, development potential, and preservation constraint. In addition, discriminant matrices were adopted to categorize the residential building renewal into four modes and six subtypes. The old urban district of Suzhou was studied as the research area. Urban renewal planners could establish renewal models with high-referential values based on the results of renewal type identification and optimize resource allocation. The presented method offers significant theoretical and practical insights into the assessment of the renewal of buildings in historic urban areas. In addition, the authors examined how historical preservation limited such renewal and intervened in ecological and topographical constraints, as the research area is located in an ecological preservation zone. In future research, the addition of specific ecological restrictions is necessary to improve the framework's applicability to all historical metropolitan cities in China.

Wu et al. presented the results of "Research on Environmental Suitability Evaluation of the Transfer Spaces in Urban Subway Stations" [9]. Deep learning technology and artificial intelligence were used to identify the characteristics of the underground space design and provide a solid scientific foundation for the optimal design of the transfer area in the subway system. The transfer areas in eight subway lines in the central urban area of Shanghai were investigated to establish an evaluation system for the suitability of the space for subway transfer. Five first-level indicators and seventeen second-level indicators were defined to develop a method for the environmental suitability evaluation of the space. The environmental statuses of the transfer areas in the subway stations were also examined and studied. The results of this study serve as a guide for the future development of the transfer areas in the subway station.

Li et al. defined "Spatial Heterogeneity and Influence Factors of Traditional Villages in the Wuling Mountain Area, Hunan Province, China Based on Multiscale Geographically Weighted Regression" [10]. Research on the ecological protection of traditional settlements contributes to the sustainable development of the built environment. The authors focused on 462 traditional villages in the Wuling Mountains, Hunan, China, to simulate the spatial distribution mechanism of traditional villages, using the multiscale geographical weighted regression (MGWR) model and finding the spatial distribution characteristics of traditional villages of various ethnic minority groups. The result showed the availability of a spatial analysis with a geographical information system (GIS) to investigate the geographical distribution patterns of the traditional villages from various angles. The development of an influencing factor index system and the spatial distribution simulation of the traditional villages using the MGWR model were the other achievements of this study. To validate the applicability of the MGWR model, various simulation techniques were presented, such as open loop simulation (OLS) and traditional GWR. The study results were applied to study the spatial distribution characteristics and their influencing mechanisms in the traditional villages in the Wuling Mountain region of Hunan Province, China. The platform for cross-regional conservation and the sustainable development of traditional communities can be developed further based on this study result.

3. Summary

Building design and construction require diverse knowledge and considerations related to the use and recycling of resources and their eventual deconstruction. Therefore, this Special Issue is dedicated to discussing current building and construction issues from various scientific and engineering perspectives. The research results presented in this Special Issue deal with different topics, including building construction, design, implementation, and their effects, particularly how resources are saved, reused, and recycled in building construction. We would like to acknowledge the experts and scholars who provided in-

novative academic research results for this Special Issue. These selected articles provide important references for future studies relating to building design and construction.

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