A comparison study of Taiwanese He-Yuan Architecture between the ethically spatial order and the condition of physical environment

Yin-Hao Chiu1 (✉), Neng-Weng Huang2, Chih-Chia Wang2

1. Department of Urban Development, University of Taipei, No.101, Sec. 2, Zhongcheng Rd., Shilin Dist., Taipei, Taiwan, China
2. Department of Architecture and Urban Design, Chinese Culture University, Taiwan, China

Abstract
Since the 21st century, problems such as global warming and energy depletion have become important issues to scientists and architects. The architectural design nowadays often relies on large amount of mechanical equipment to create a comfortable environment for the users. However, it burdens and deteriorates the nature. On the other hand, some of the traditional architecture in the past can cope with the local humid and hot climate, achieving good passive heat control for the environment. Therefore, this study explores the relation between traditional residents in Taiwan’s use of space and the external environment and climate through modern environment measurement technique, restores and conducts quantitative analysis on the interior thermal environment and light environment of Lin-An-Tai Historical House in the past through Ecotect Analysis, and analyzes the results of the calculation in terms of its spatial allocation, openings, and outer walls, etc. This study also evaluates the effects of lighting and user’s sense of comfortable temperature under its environmental conditions according to the standards of residential quality nowadays. It further studies the ancestor of traditional architecture by reviewing its spatial order and compares to the current situation in order to feedback the modern architecture design. Part of the results of the simulation show that the variation of temperature indoors in each space is less dynamic than that of outdoors. The temperature in the space at the right of the main hall (northwestern side) is generally higher than that in the left (southeastern side). The highest temperature in the space farther away from the interior patio is usually higher than that in the space closer to the interior patio. The temperature near the outer side of the space above Hulong is higher than that in the middle. Accordingly, the location is closely related to the interior temperature. As to human’s sense of comfortable temperature, the results show that in summer, the Predicted Mean Vote (PMV) in the space at the left of the main hall (southeastern side) is generally higher than that in the right (northwestern side). In winter, the sense of comfortable temperature in the rooms in the corner is lower than that in other rooms at the inner side, the comparison between the space ethical order and the evaluation result did not show any obvious relationship. For the evaluation of lighting, the main hall and the restaurant at the outer left Hulong have better lighting while other space does not have sufficient and even lighting. Artificial lighting is needed to make the space more functional, the results shows that lighting conditions of space did not metaphor to the space ethical order.

Keywords
courtyard house, He-Yuan Architecture, quadrangle domestics architecture, computational simulation, thermal environment, light environment

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1 Introduction
Since the 1950s, the solid and economic modern architecture becomes the mainstream in Taiwan after dramatic population growth after World War II. Due to the increasing challenge of Global Climate Change and Heat Island Effect, those modern architectures have to rely heavily on mechanic equipment to achieve a comfortable thermal environment. Scientists and architects have paid increased attention to issues concerning energy conservation, carbon reduction,
energy sustainability, and ecological buildings. Many researches attempt to work out the ways and methods to adapt the environment from local traditional residential houses (Dili et al. 2011), because most of them are built according to local climate locally and geographical environment geographically. Taiwanese He-Yuan Architecture is one of the cases. It is heavily influenced by social ethic and Feng Shui, and has always been seen as an empirical science.

Taiwan area is characterized by hot and humid climates. Geographically, Taiwan contains beaches, plains, and mountains; therefore, the microclimate in various regions of Taiwan differs, and the natural approaches to maintaining the thermal environment of buildings according to microclimate conditions warrant further investigation (Chen and Li 2003). This study adopted computer simulation to construct the Lin-An-Tai historical house in Taipei City and perform a quantitative analysis on the simulated house by using the following factors: the climate conditions in 1785, geographical location, orientation of the house, and the physical environments (thermal and lighting environment). Subsequently, the actual construction materials used, openings, and spatial locations were incorporated for comparison to investigate the passive design strategies used for constructing traditional buildings in Taiwan and the effectiveness of these strategies. Overall, the objectives of this study were to (a) investigate how the indoor physical environment of traditional residences in Taiwan is related to the building envelope, opening, and spatial location, and (b) examine the quality of the indoor physical environment of traditional residences in Taiwan. (c) explore the relationship between He-Yuan Architecture’s spatial ethics order and it’s comfortableness.

2 Literature review

He-Yuan Architecture is a common type of traditional housing type in Taiwan, the arrangement is heavily influenced by social ethic and Feng Shui. There were two main school of thoughts in Feng Shui, the School of Compass thought and the School of Form thought. The Compass thought applies Astrology and Five Elements to arrange spatial order. Traditional He-Yuan Architecture always sits north and faces south which matches “sits Kan faces Li” in Compass thought. Kan represents North and also belongs to Water element in Five element theory. House reflects Water element, so it has to face Fire element which represents Li in Compass thought (Ma 1999).

On the other hand, the School of Form thought cares about the surrounding geography of the house location. Yi et al. (1996) compiled the perspectives of Feng Shui from the School of Form thought into a picture (see Fig. 1). The best location with the hill of parent on the back is also sitting north and facing south. It also has “Azure Dragon” on the east side and “White Tiger” on the right side. The east side is better than the west side. Therefore, He-Yuan Architecture in the school of form thought is similar to the compass thought. The space order is from inside to outside, eastern(left) to western(right) to reflect the ethic sequence of space.

Normally, the form of He-Yuan architecture can be modified in accordance with the increase of family members or the economic changes. Lee (2003) and Kang (2011) stated that, He-Yuan Architecture can be classified into 6 types (see Fig. 2). The first type has only one row of rooms and named “Yitaolong” which has no “Hulong”. “Hulong” is the row of rooms which perpendicular to the main rows of rooms. It is protecting the main rooms and acting as one of the Feng Shui form elements. The second type has an additional row of rooms, “Azure Dragon”, perpendicular to Yitaolong on left side and it calls “Danshenshou”. This type only has one “Hulong”. The third type has two additional rows of rooms on the both sides perpendicular to Yitaolong and named “Sanheyuan”. If it has front hall to enclose the courtyard, it is the fourth type, “Siheyuan”. The fifth type, multi-side house, has more rows on sides. The last type has more courtyard together as a multi-courtyard house. This research focuses on Lin- An-Tai Historical House and it is the type of multi-courtyard house.

In this study, we reviewed past studies investigating the physical environment of traditional architectures to determine how simulation tools and measures were applied. Previous studies (Dili et al. 2011; Chen and Li 2003; Hong 1985; Chen 1987; Baran et al. 2011) have conducted on-site surveys and adopted instruments to measure the physical