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THE ADAPTABILITY OF TRADITIONAL COMMERCIAL AND RESIDENTIAL BUILDING SPACES TO CONFUCIAN BUSINESS CULTURE IN SHANDONG, CHINA

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Abstract

Traditional commercial and residential buildings emerged to accommodate commercial and residential demand. Continuously increasing and expanding, resulted to the formation of a certain scale of the ancient district complex. Previous studies have primarily concentrated on the architectural components and decorations of traditional commercial and residential buildings, neglecting the adaptive evolution of the building's internal spaces and functions. This study examines the adaptive evolution process of traditional commercial and residential buildings. The study explores the internal spatial configuration characteristics based on spatial syntax theory by observing traditional commercial and residential architectural spaces. The findings emphasize the positive influence of Confucian and commercial cultural concepts on architectural space and spirit. This study provides valuable insights into the adaptability of traditional commercial and residential buildings to culture and contributes to an improved understanding of traditional commercial and residential buildings. At the same time, it provides adaptive perspectives on the sustainability of culturally influenced traditional commercial and residential buildings and suggests sustainable strategies for the preservation of architectural culture.

Keywords: Confucian Business Culture, Adaptability, Spatial Configuration, Sustainable

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INTRODUCTION

In order to meet the needs of residential and commercial use, traditional commercial and residential buildings emerged and gradually formed an ancient commercial district complex of a certain scale. As the main architectural body composing the settlement pattern of ancient commercial district, traditional commercial and residential buildings were deeply influenced by Confucian and commercial cultures in the formation process and showed unique architectural cultures. Culture is the main factor in the evolution of human architecture, and it plays an important role in the environmental and social development of a place, as well as in sustainable development, and architecture symbolizes the cultural evolution of a society (Owoicho et al., 2024).

Currently, the accelerated urbanization process in China has led to the decline of traditional architectural development with the purpose of giving priority to economic orientation. In particular, the ancient commercial district, which is an important historical architectural area for the inheritance and presentation of traditional trade and commerce culture, includes numerous traditional buildings. In physical form and abstract expression, architectural works embody a society's culture and hidden environmental factors (Krauth et al., 2021). The results reveal that from this perspective, an architectural work embodies a society's cultural and hidden environmental factors in physical form and abstract expression. Through the spatial combination of architectural elements, it conveys the concepts and themes of the culture and architecture of that specific region. Referencing the ideas and themes of past architecture achieves a deeper concentration on architectural history, signifying a higher position than previous methods (Kamali, 2024). Therefore, architectural sustainability should be researched and protected accordingly.

Much research has been conducted in recent years on architectural heritage and sustainability, involving building reuse, upgrading, energy-efficient construction, and the development of sustainable building materials (Li et al., 2024). Researchers have focused mainly on the morphological and technological renewal of housing developments, and few studies have explored the cultural logic and connotations that have shaped this phenomenon (Eggan et al., 2018). In particular, the study of traditional commercial and residential buildings has been confined to a series of superficial aspects such as architectural decoration and function, ignoring the deeper mechanisms and cultural influences that shaped the spatial organization of the buildings. In addition, the continuity of traditional commercial and residential buildings has rarely been explored. Architectural continuity is the result of architectural adaptation. Adaptive architecture is a multidisciplinary field that includes buildings that are designed to adapt to their environment, inhabitants, and objects, as well as buildings that are driven entirely by internal data (Holger, 2010). Adaptive architecture is concerned with buildings

specifically designed to adapt (to their environment, to their inhabitants, to the objects in them), whether this is automatic or through human intervention (Maria et al., 2021). Regarding the adaptability of architecture, most studies have been conducted in terms of natural environments such as topography and hydrology, ignoring the spatial adaptability of culture. Therefore, there is an urgent need to explore the cultural and adaptive formation aspects of its space under modern conditions.

Through space syntax, the purpose of this study is to examine the adaptive changes in traditional commercial and residential buildings, as well as the cultural factors behind them. Spatial syntax is a quantitative language that explores the interrelationships between spatial configurations and human societies by analyzing the structural characteristics of human habitats, including cities, buildings, and landscapes (Mohamed et al., 2024). Space syntax can analyze the regularity of spatial functions and forms. The article concludes by exploring the deep mechanism between Confucian culture and architectural spatial configuration from an adaptive perspective.

LITERATURE REVIEW

Numerous studies have explored how architectural spaces adapt. As these studies reveal, architectural space epitomizes and is influenced by culture. It is powerful evidence of the embodiment of social relations. Architecture has been adapting to cultural development and social change (Anggoro et al., 2024). The process of integration of architecture, spatial structural characteristics, and functional relationships are key considerations (Subbotin et al., 2020).

Confucian merchants are practitioners who apply traditional Chinese culture, especially Confucianism, to commercial activities. The Confucian merchant culture has emerged through nearly a thousand years of practice by Chinese Confucian merchants. It has two basic characteristics: Ren and Li. Ren is benevolence and the Li is propriety (Rao et al., 2022). The inheritance of this traditional culture is passed down from generation to generation as a habit, and the operation of rituals is maintained by this habit.

In order to adapt to the development of social productivity and the needs of the commodity economy, China's traditional commercial and residential buildings have gradually developed from a single traditional residential model into a composite commercial and residential building model that integrates residential and commercial (Chen, 2018). The interpretation of the regional, contemporary, and cultural characteristics expressed by the building. Morphology is used to describe spatial forms and construction patterns through the three levels of city, street, and building and to illustrate the regional, contemporary, and cultural characteristics expressed by architecture (Wang et al., 2015). Meanwhile, the characteristics of the area under the traditional gathering

of commercial and residential buildings are expressed in three patterns of strip, dendritic type, and enclosure under the typological analysis (Cheng et al., 2022). This settlement pattern was formed to adapt to the external natural environment (Seuntjens et al., 2024). From a superficial analysis, the variability in the spatial configuration of traditional commercial and residential buildings mostly depends on the choice of the external natural environment. However, through space syntax, it is possible to show the inherent cultural mechanisms affecting spatial configuration from a quantitative point of view (Ayyıldız et al., 2024).

Traditional commercial and residential building patterns emerged from the craft production economy. Functional spaces are often adapted to the different business models in the building. However, the commercial demand for personnel has also increased dramatically, so in addition to the work areas, the living quarters for the employees have also been incorporated into the building.

RESEARCH METHODOLOGY

Space Syntax Theories

Since this study is a quantitative study of traditional commercial and residential architectural space from the perspective of Confucian and commercial culture, it is reasonable to choose space syntax as the basis for conducting the study. This is because the space syntax theory provides a quantitative approach to characterizing spatial connections and defining spatial properties. In particular, spatial configurations are studied in relation to socio culture. The distinctive characteristics of societies exist within spatial systems, and their knowledge is conveyed through space itself and through the organization of spaces (Takahashi et al., 2024). Space syntax refers to the relational characterization of space as a conformation, emphasizing that this characterization is the form of human behavior. Human behavior thus contains social knowledge (Hassan et al., 2024).

Space syntax theory was developed by Bill Hillier. He argued that science fosters creativity and started a conversation about connectivity, a fundamental concept used to study and understand spatial configurations and spatial relationships (Rauof et al., 2023). Space syntax involves connection values, control values, depth values and local integration as local variables for characterizing the structure of the local space (Yazdi-Bahri et al., 2024). Integration and depth are holistic variables that are used to characterize the structure of the overall space, and comprehensibility is a variable that describes the degree of correlation between a local variable and the overall variable (Garau et al., 2024).

To address the questions of this study, Visibility Graph Analysis (VGA) will be used. This analysis will be accomplished using Depth Map X, a space syntax Software. Figure 1 below shows the relationships of the space syntax used.

Integration is regarded as one of the most numerous and important covariates in space syntax analysis. It reflects how closely a node in the system is linked to more other nodes and is categorized into integration and local integration. Among them, the integration degree indicates how closely a node is connected to all nodes within the whole system (Lee, 2024).

Connectivity is the number of nodes in the system that are directly connected to a node as the connection value of that node. The higher the connectivity value of a space, the more closely this space is connected to the surrounding space, the stronger its influence on the surrounding space and the better its spatial permeability (Moqadam et al., 2024).

The visual clustering coefficient (CC) is a first local measure of some of the nodes, defined as the number of vertices connected within the current vertex neighborhood versus the number of vertices that could be connected (Turner, 2004).

Visual control (VC) pertains to whether the space viewed from a node to other immediately visible nodes is greater or less than that perceived (Sharmin et al., 2018). Therefore, a controlling point can present a large number of areas, each of which sees relatively less (Leite et al., 2018).

Visual Entropy (VE) was suggested to address the global complexity of a configuration regardless of its geometric characteristics. Entropy values can be used as a possible indicator of the degree of orderliness of the system at a location (Netto et al., 2019). A higher level of visual entropy correlates with higher levels of randomness, interference, or unpredictability in physical space arrangements. At the same time, regularity and clear patterns in the system correspond to lower entropy from with leading to higher levels of prediction (Dursun et al., 2007).

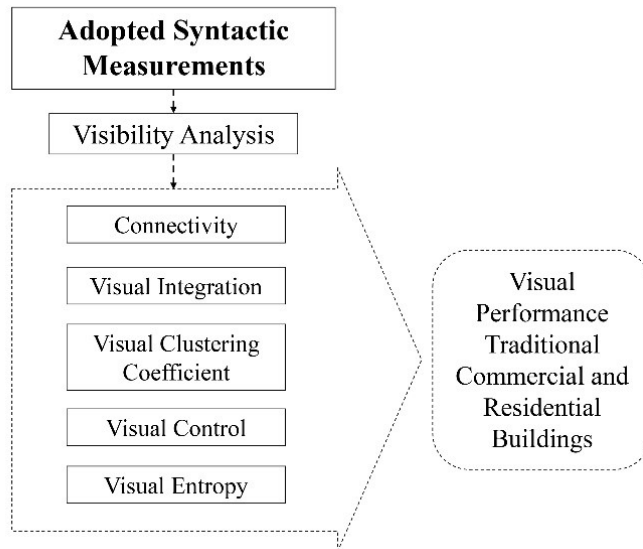


Figure 1: The adopted syntactic measurements subjected

Case Studies

A traditional commercial and residential building built in 1883 was selected as a case study for this research. As shown in Figure 2, the building is located in Qi County.



Figure 2: Location of building

The commercial nature of this building is financial. The building is named Da Dutong. The following Table 1 shows the basic distribution of the case.

Table 1: Information of Case

Content of Architecture	
Structure	Courtyard style
Height	Single
Function	Commercial and residential
Commercial Function Types	Financial
Location	Street Facing Buildings
Year of Architecture	Dynasty of Qing (1884s)

Figure 3 illustrates the various spaces within the analyzed building. The structure of the building is courtyard-style. According to the location and function of the rooms in the courtyard, they are divided into a reversely-set house, hall, side house, main house, and yard. Commercial functional areas in commercial and residential buildings generally have three types of spaces for customers: street-level spaces, courtyard spaces, and exclusive spaces. The reversely-set houses of non-street-facing buildings are generally used for functions such as rest and storage. In this case, the red area is interior space, and the grey area belongs to yard space. Since the building belongs to the two-entry courtyard style, the blue belongs to the front yard, and the green belongs to the backyard. The front yard is primarily used for commercial and staff living, while the backyard is the owner's living area. The entrance of the building is divided into a main entrance and a secondary entrance. The second courtyard serves as the primary space for the entire building.



Figure 3: Space Division of Building

ANALYSIS AND DISCUSSION

Having analyzed the collected data and focusing on identifying elements of Confucian business culture and the influence of Confucian business culture on the evolution of traditional commercial and residential buildings. The main features of traditional commercial and residential buildings, as well as the key values are derived from Confucian business.

Figure 4 below shows a visual analysis of a building using connectivity measurements. The diagram shows the connectivity of the areas in the space in warm and cold colors. The warmer the color, the higher the connectivity. Conversely, the cooler the color, the lower the connectivity of the space (Rao et al., 2022). The results show that the space at the transition between the front and back yards is the place with the highest connectivity, indicating that this location has the strongest accessibility. Because the courtyard serves as a link between the functional areas, especially this node runs through the front and back yards of the building. As a critical node, this is in line with its positional relationship. At the same time, all other spaces in the building are well connected to this area. In addition, the main house and the hall have the highest connectivity among the interior spaces. The main house is located in the deepest part of the building and takes on the role of the owner's daily residence and reception of business noble guests. The Hall serves as a semi-open transitional space that connects the front and back yards. This result is therefore consistent with the characterization of the function of the space.

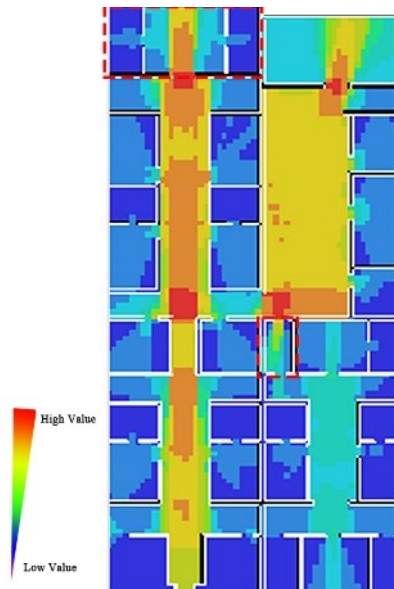


Figure 4: Visual analysis using Connectivity measurements

Figure 5 below shows a visual analysis of a building using integrated measurements. The results show that the highest integration occurs in the main axis area of the building, which indicates that this area has the highest accessibility and the best traffic flow. This also clearly indicates the location of the highest accessibility paths in the building. At the same time, the high level of integration of the interior space is mainly found on this side of the main entrance. The whole area linked by the main entrance is functionally in the main position and the main body of use is the owner of the building. Meanwhile, the area linked by the secondary entrance is mainly used by apprentices and employees. This result shows the core areas in the building.

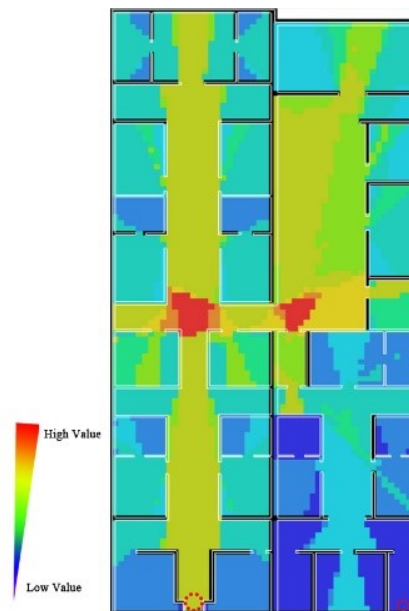


Figure 5: Visual analysis using Visual Integration measurements

Figure 6 shows the visual analysis of buildings using the visual clustering coefficient measure. The results show that the area with the highest visual clustering coefficient value is the reversely-set house located in the front yard, next to the main entrance. This area performs the function of currency exchange and money transaction. Customers who need to exchange money need to come here to do so. The daily flow of money requires a high level of privacy, while the higher flow of people also requires a higher level of attention to the space.

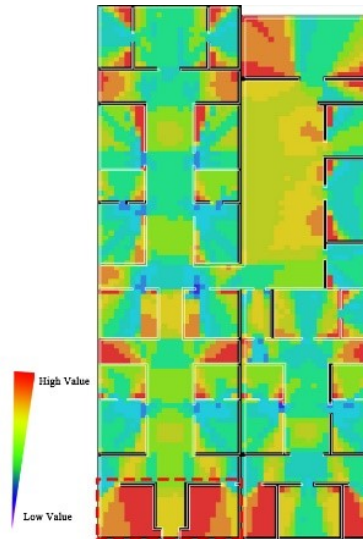


Figure 6: Visual analysis using Visual Clustering Coefficient measurements

Figure 7 below shows the visual analysis of the building using controlled measurements. The results show that the maximum value of the visual field control occurs in the area in and around the entrance of the main house. Therefore, this area has the highest value of control and has the greatest influence and control over other spaces, occupying the main position in the building. This result is consistent with the character of the main house. Also, the courtyard path that appears to have high control values matches the function of its main path.

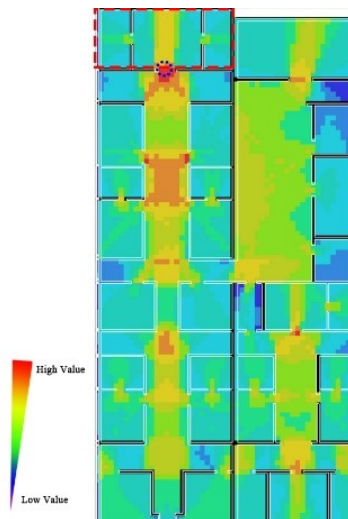


Figure 7: Visual analysis using Visual Control measurements

Figure 8 below shows a visual analysis of the building using the visual entropy measure. The results show that the area used by the employees is where the entropy value is low, especially in the area of the dining room and the kitchen in the backyard. This area is responsible for the daily life of the employees, in addition to the dining room space is responsible for the dining needs of all the people in the building. Therefore, the mobility of people in the area is high, the functions are diversified, and the activities are more frequent and complex. Areas with higher entropy values are on the side of the main entrance. The area of the main entrance requires more stability and low activity in the space.

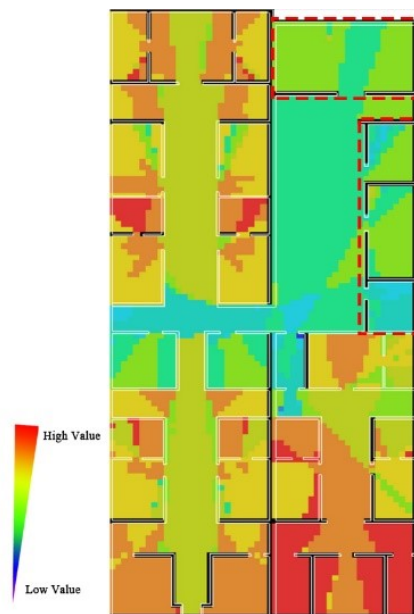


Figure 8: Visual analysis using Visual Entropy measurements

Table 2 shows the average visual field values for each house and functional area in the building. There is a large difference in visual accessibility and controllability between the interior spaces of the front and back yards. Backyards have higher accessibility and control values than front yards. Front yards have higher attention and mobility and therefore higher visual clustering coefficient and visual entropy values. In addition, the mean values for interior spaces were less correlated with space dimensions.

Table 2: Average visual field values for each space.

Type of Space	Visual Integration	Visual Clustering Coefficient	Visual Control	Visual Entropy
M-MH	3.75	0.69	0.93	2.58
M-SH-F	3.23	0.67	0.89	2.60
M-RSH-F	2.62	0.91	0.94	2.70
M-SH-B	3.42	0.67	0.85	2.60
M-RSH-B	4.13	0.73	0.77	2.26
S-MH	2.83	0.73	0.95	2.57
K	3.78	0.66	0.65	2.23
H	4.70	0.74	0.64	2.09
S-SH	2.51	0.67	0.91	2.68
S-RSH	2.56	0.74	0.90	2.73
DR	3.79	0.79	0.94	2.32
T	1.91	0.91	0.87	2.85

Abbreviation	Name
M-MH	Main Entrance-Main House
M-SH-F	Main Entrance-Side House-Front Yard
M-RSH-F	Main Entrance-Reversely-set House-Front Yard
M-SH-B	Main Entrance-Side House-Backyard
M-RSH-B	Main Entrance-Reversely-set House-Backyard
S-MH	Staff Entrance-Main House
K	Kitchen
H	Hall
S-SH	Staff Entrance-Side House
S-RSH	Staff Entrance-Reversely-set House
DR	Dining House
T	Toilet

Figure 9 below shows the detailed numerical variation of the relevant view situations in the building. The connection values of the various spaces in the building vary considerably, with the yard space being overall higher than the interior space. It indicates that the traffic flow in the courtyard space is smoother. Other visual field values vary less, especially the visual entropy value of the building, which ranges basically between 1.5 and 3, indicating that the areas are clearly divided and the overall architectural space is more stable.

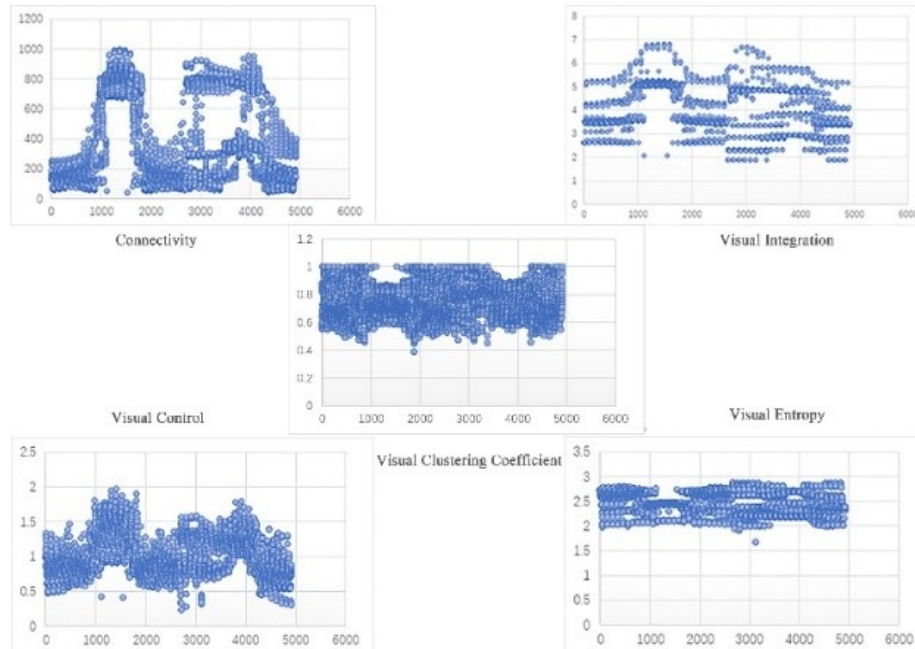


Figure 9: Point -like analysis of visual value measurement

Figure 10 below shows the comparison of 12 interior spaces in terms of visual values. As can be seen from the figure, when the visual integration of the localized space is at high values, the visual clustering coefficient, visual control, visual entropy values are relatively at low values. Visual accessibility indicates the degree of enclosure of the space. For example, hall belongs to the semi-enclosed indoor space, which connects the front and back yards in front and behind, and is the way to the two courtyards with the highest accessibility. At the same time, the frequent human activities and semi-open structure reduce the privacy and instability of the space, resulting in low visual clustering coefficient, visual control, and visual entropy values. This result is consistent with the structure and function of the space.

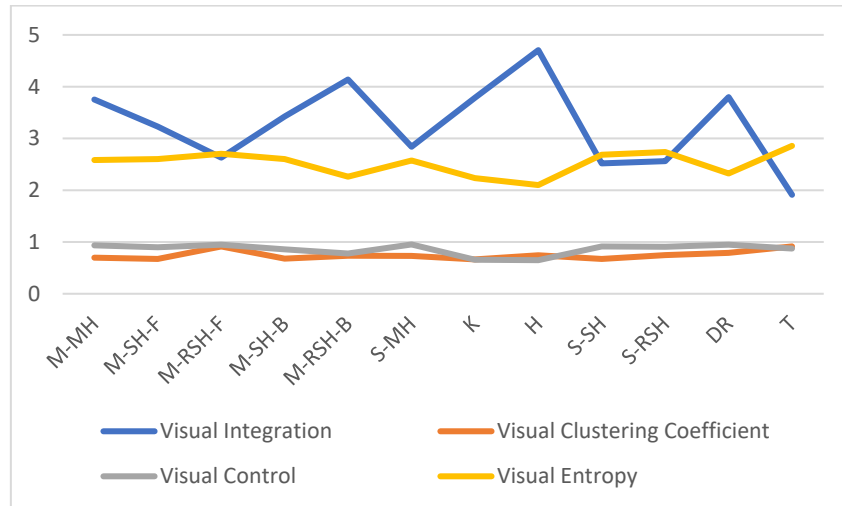


Figure 10: Data comparative analysis of twelve interior Spaces

CONCLUSION

Taking traditional commercial and residential buildings as the research object, this study explores the phenomenon of cultural migration and fusion in space through the quantitative study of spatial syntax, which measures the spatial relationship and emphasizes the influence of Confucian business culture on the adaptation of traditional commercial and residential buildings. The concept of customer first is the core content of Confucian business culture, which originates from the concept of reverence for benevolence and respect for propriety in Confucianism, and is carried over to business, i.e., customer first. It is reflected in the relationship between merchants and customers, mainly through the quality of service provided by merchants. The main house, as the highest-ranking space in the building, serves not only for the owner's living but also as a place of hospitality for receiving noble guests. As a result, the space expresses this important idea.

Traditional commercial and residential buildings have been influenced by the idea of rituals in Confucian and commercial culture in the spatial configuration, especially in the living space area. The hierarchy in the space is emphasized. The hierarchical concept of traditional Chinese architecture is deeply rooted, which is reflected in many aspects of architectural space. Although traditional commercial and residential buildings integrate the openness of commerce, they are still influenced by the cultural environment, and the architectural space continues and adapts to this idea, so that there is a hierarchy in the domination of space by the personnel. The degree of domination of space depends on the identity, status, and ability of the user, which is consistent with

the results of the analysis of spatial syntax. This hierarchy expresses the inequality in inhabited space and further illustrates the imbalance in the distribution of social resources.

Meanwhile, the limitation of this study is the exploration of the external environment of the building, especially the street spatial scale outside the building, which has an influence on the structure and changing characteristics of the forecourt space. Subsequent studies can incorporate the influence of the external environment, such as street scale and topography, on the spatial adaptation of traditional commercial and residential buildings. This can provide sufficient reference for the sustainability of traditional commercial and residential buildings.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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