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Tracing the Confucian Merchant Culture in the Spatial Layout of Traditional Commercial and Residential Buildings using Space Syntax

Meili Wu[1], Syarmila Hany Haron[1,*]

[1] School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Gelugor, Pulau Pinang, Malaysia

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ABSTRACT

Confucian merchant culture is the mainstream of traditional business culture. Regarding the research on Confucian merchant culture, researchers mostly conduct research from the perspectives of business management methods, business philosophy, and training people in business, emphasizing honest and trustworthy business management behaviour and the moral cultivation of business operators, and lack of research on commercial business sites. As the main type of traditional commercial buildings, Traditional commercial and residential buildings' spatial layout and spatial functions are closely related to the Confucian merchant culture. In particular, Confucianism contained in the Confucian merchant culture considerably impacted the traditional Chinese architectural form due to Confucianism's absolute dominance in traditional Chinese society. Thus, analysing the spatial layout and usage effectively traces the traditional commercial and residential building culture. The main research issues of this paper are the reflection of the spatial configuration on the cultural connotation of Confucian merchants and the characteristics of the deeper social environment and social-cultural system. This study examined a traditional exchange shop in central Shandong as an example. Through the visual analysis and Axial analysis of space syntax, the spatial layout characteristics under the influence of Confucian merchant culture in traditional commercial and residential buildings and the use relationship of different spaces corresponding to different users are investigated. The results showed that under the influence of Confucian merchant culture, the spatial layout and functions of traditional commercial and residential buildings reflect the ritual system and the people-oriented Confucian business philosophy. The concept of hierarchy in Confucian businessman culture has led to the dual-use buildings of commercial and residential buildings, still emphasizing the hierarchical distinction of architectural space. It further reflects the characteristics of unequal distribution of social resources in traditional commercial buildings leading to unequal use of architectural space.

* *Corresponding author.*
E-mail address: syarmilahany@usm.my

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1. Introduction

Confucian merchant culture is the commercial cultural thought of ancient Chinese Confucian merchants who integrated Confucianism with the laws of commodity economy, such as business philosophy, management thought, industry norms, and code of conduct [1]. In particular, the benevolence, righteousness, propriety, wisdom, and trust in Confucian culture are integrated into commercial activities. Confucian merchant culture sprouted in the Spring and Autumn Period and the Warring States Period, developed in the Song Dynasty, and flourished in the Ming and Qing Dynasties. It has gone through three stages. With the development of commercial activities, shop buildings more conducive to commercial transactions began to appear, that is, commercial and residential buildings [2]. Chinese traditional commercial and residential dual-use buildings refer to a type of building with both commercial and residential functions, originating from the needs of handicraft production and commodity economy development in feudal society. It is the primary type of commercial building in traditional cities [3]. This type of building is usually located on both sides of the street, and the layout is mainly a shop in the front and a residence in the back or a shop on the top and a residence on the bottom [2]. The spatial form of traditional Chinese architecture is deeply influenced and restricted by Confucian culture [4].

Scholars' existing research on Confucian merchant culture is divided into three categories: business philosophy, moral cultivation of managers, and architectural decoration. Emphasizes the spiritual connotations of honesty, perseverance, and aggressiveness in Confucian businessman culture [5]. Confucian businessman culture emphasizes caring for human nature, especially people's living arrangements [6]. In addition, one of the characteristics of Confucian businessman culture is the spirit of etiquette, which advocates the moral restraint of people in business activities [7]. Emphasize the moral cultivation of the operators themselves. However, etiquette is a social norm and the core content of Confucian culture [8]. It was not just staying at the superficial level of moral constraints. The existence of etiquette makes people form a hierarchy and a sense of superiority and inferiority, which is manifested in strict architectural regulations and spatial layouts in architecture [9]. The higher the level of buildings, the more obvious the concept of etiquette. Therefore, studying the Confucian merchant culture from the perspective of the space configuration of traditional commercial and residential dual-use buildings can increase the depth of the Confucian merchant culture. In particular, the architectural spatial structure reflects a social order [10]. For example, the traditional residential buildings - courtyards emphasize the internal and external order of seniority and inferiority [11]. It embodies the ethical order in which the patriarchal clan system of traditional society distinguishes between superiors and inferiors and where seniors and young are ordered. Therefore, this is also valid for further research on the characteristics of the deeper social environment and social and cultural systems.

Socio-cultural factors have a significant influence on the formation of architectural spaces [12]. The Confucian patriarchal and ethical culture emphasizes the order of dignity and social hierarchy, which affects the class distinction of architectural space layout and use [13]. Scholars have also analysed the internal relationship between culture and space through various methods. One of the studies established a convex space model to compare and find that the residential buildings contain cultural content such as patriarchal ethics, worshiping ancestors, and ethnic integration [14]. This shows that buildings conforming to the rules of culture and space reflect the social relations of the occupants. At the same time, accounting for the occupant factor is critical to understanding the impact of physical space division [15]. Since architecture is a cultural thing, its form and organization are also influenced by a culture whose architecture is its product [16]. The decisive influence of social

culture on living space makes the architectural form need to adapt to social norms [17]. Likewise, the degree of division within a building depends on the sociopolitical complexity of the culture [18].

Space syntax theory is a theory of space and society based on spatial organization. An attempt to identify how spatial configurations express a social or cultural meaning and how spatial configurations generate the social interactions in built environments [17]. According to the fundamental theoretical concept of space syntax, space is shaped in ways that reflect the direct interaction between space and people, and through this, the space we create, or the built environment, becomes humanized [18].

Positive analyses of space syntax theory emphasize two aspects: One is the representation of space and social elements, that is, using diagrams to display various data to present their patterns intuitively; the other is the analysis of the organization of space and social elements, that is, using objective variables to measure the organization pattern, to explore the connection between space and society, thereby revealing the universal and special inner mechanisms. Based on empirical analysis, explanatory models are formed to analyse, describe, explain, and predict different spatial and socioeconomic phenomena. In this way, space syntax analyses the social system and culture of architectural space.

Visual access (visibility) is a fundamental aspect that characterizes transition spaces' visual performance and helps the environment become more readable. Visibility is all about making the first impression and observing the surroundings [19]; it is supported by ‘‘permeability,” which enables ongoing movement through the space [20]. Scholars' have found that visibility as a visual aspect has a greater impact on user activity than permeability [20].

Traditional architectural space research based on space syntax is divided into three categories, the evolution of architectural space, the social system and culture of architectural space, and the comparison and analysis of regional architecture [14]. Most existing studies have obtained the connotation of benevolence, righteousness, morality, honesty, and trustworthiness of Confucian businessman culture through commercial operators and commercial activities. These conclusions are relatively shallow and vague, lacking the support of solid evidence. There is a lack of in-depth discussion on the social system, social environment, and social culture reflected in Confucian businessman culture. However, Confucian business culture is a complex cultural content formed by combining Confucian and traditional business cultures [5]. In particular, the ritual system in Confucian merchant culture has profound social significance. Confucian merchant culture is one of the essential components in the spatial connection of traditional Chinese commercial and residential buildings. This study examines Confucian merchant culture from the perspective of architectural space layout. Therefore, the study adopted a method based on a unique analysis, using space syntax to conduct comparative research on the building's interior spatial layout and functions. Based on the data evidence of space syntax, this paper explores the relationship between Chinese traditional commercial and residential buildings and Confucian merchant culture and the etiquette system in Confucian merchant culture. Further, it discusses the characteristics of traditional social environments, social systems, and culture to make up for Similar studies. At the same time, the scope of this study does not include the outdoor space of the building, such as the analysis of transitional spaces such as courtyards.

2. Methodology

This study performed two types of analysis: axial and visibility map analysis (VGA). Hillier & Hanson (1984) mentioned that people tend to the path according to their visibility. Hence, high-visibility spaces can be interpreted as spaces with the most accessibility and permeability [21]. Axial

analysis explores the degree of traversal in the space, and visibility analysis explores the visual performance in the space. These types of analysis will be performed using DepthmapX-0.80 software, a vector-based program developed at University College London by Turner, which addresses 2D plans and is used for calculating different measures and correlations [22]. Figure 1 shows the relationship of the space syntax used, while the following paragraphs explore the meaning of those measurements in depth.

Integration is regarded as a global measure that calculates the mean shortest path length for all nodes in the graph [23]. Accordingly, it reflects the integration or segregation status of any space within the spatial structure [24].

The control value indicates the degree of control of a space on the intersecting space, reflecting the degree of influence of a space on its surrounding spaces [25]. The control value is an evaluation method of space selectivity in an ideal state. If social, economic, and technical factors are discarded, the degree of freedom for the subject to choose a space unit is determined by the number of spaces adjacent to the space. The control value is obtained after mathematical weighting based on the number of spatial connections. The calculation formula is Eq. (1):

$$Ctrl_i = \sum_{j=1}^{k} \frac{1}{c_j} \tag{1}$$

Connectivity: Indicates the number of spaces intersected by a certain space in the system. Thus, it is a simple process that highlights the characteristics of a path/cell based on its immediate neighbouring spaces/cells disregarding the entire network [25-27].

The depth value refers to the shortest distance from a node to all other nodes. The depth value is not an independent morphological variable but an intermediate variable for calculating the degree of integration. Assuming d_{ij} is the shortest distance between any two points i and j on the connection graph, then the total depth is Eq. (2):

$$\sum_{j=1}^{n} d_{ij} \tag{2}$$

And the average depth value is Eq. (3):

$$MD_i = \frac{\sum_{j=1}^{n} d_{ij}}{n-1} \tag{3}$$

Here n is the number of summary points of a connected graph.

Visual entropy (VE) (or point depth entropy) was suggested by Turner 2001 to address the global complexity of a configuration regardless of its geometric characteristics the impact [24]. Visual entropy is used in investigating the depth values of a grid cell and other attached ones, so entropy is high if the depth value of neighbouring cells is almost equal to that of an investigated cell and vice versa [27].

Visual control (VC) pertains to whether the space viewed from a node to other immediately visible nodes is greater or less than that perceived [28]. Therefore, a controlling point can present many areas, each seeing relatively less [25,29].

The clustering coefficient (CC) is the first local measurement subjected to certain nodes and is defined as the number of vertices connected within the neighbourhood of the current vertex to the number of possible connected vertices [27].

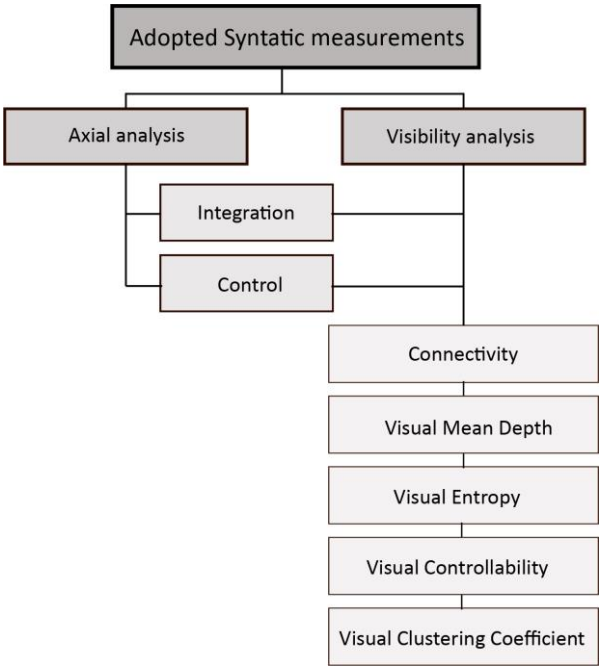


Fig. 1. The adopted syntactic measurements subjected

Table 1 demonstrates the implications of such measurements in terms of high and low values based on the abovementioned studies.

Table 1
Implications of high and low values of selected measurements

	High Values implications	Low Values implications
Integration	The space is at a higher core, more accessible and more visible	The space is at the edge, more difficult to reach, low visibility
Control	This space has a higher degree of influence and control over other spaces and has a larger view	The space is highly influenced by other spaces and has low visibility
Connectivity	There are more intersecting spaces with other spaces, with a wide view	Few intersections with other spaces, high visual restrictions, narrow field of view
Visual Mean Depth	The space is less likely to be passed through, and it is more difficult to reach, narrow vision	Space is extremely easy to pass through, easy to reach, Clear vision
Visual Entropy	The visual scene is more stable and overall	Irregularity of visual scenes
Visual Controllability	Large field of view controllability, with a higher level of field of vision	Low field of view, Positions with a high value of visual privacy
Visual Clustering Coefficient	The vision shielding of this space is strong, low levels of visual prediction	The space has a higher probability of being discovered and has a wide field of view

3. Results

A traditional exchange shop building named Da Detong for the case study. It is in Zhou Cun, Shandong Province. In August 2009, Zhou Cun, known as the "Century-year Commercial Port", was identified as the birthplace of Confucian merchants. It is the only Da Detong exchange shop building in Shandong Province. It is mainly engaged in money savings and exchange.

The different spaces of the analysed ticket number buildings are shown in Figure 2. The whole building consists of five parts: reversely-set house, side house, main house, treasury, and courtyard.

The yellow area belongs to the interior space, and the grey area belongs to the courtyard space. The blue area is located in the front of the building and is used for business operations; the red area is located in the rear of the building and is used for residence. The whole building belongs to the layout of the front store and the back residence. Among them, the inverted house and wing room belong to the commercial area. The inverted house is responsible for cash savings and exchange business, and the wing room is used for employees to live and work. The main house and treasury belong to the residential area. The functions of the main house include the residence of the general manager, meeting guests, reception, etc., and the reception objects are generally high-level business partners.

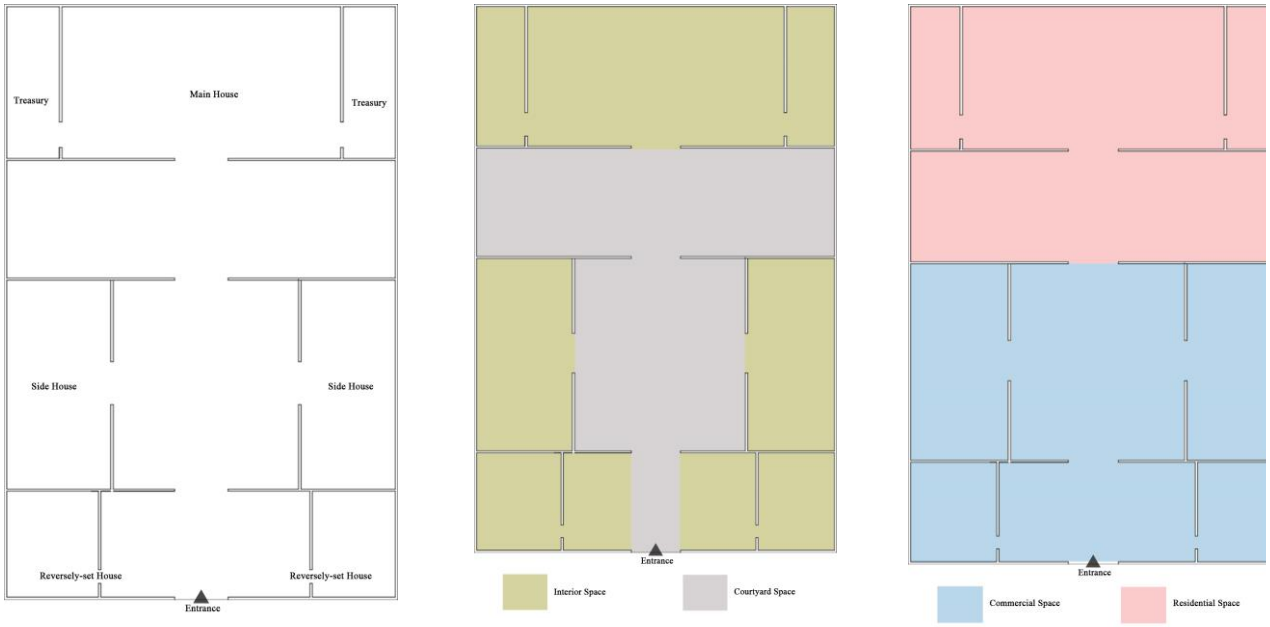
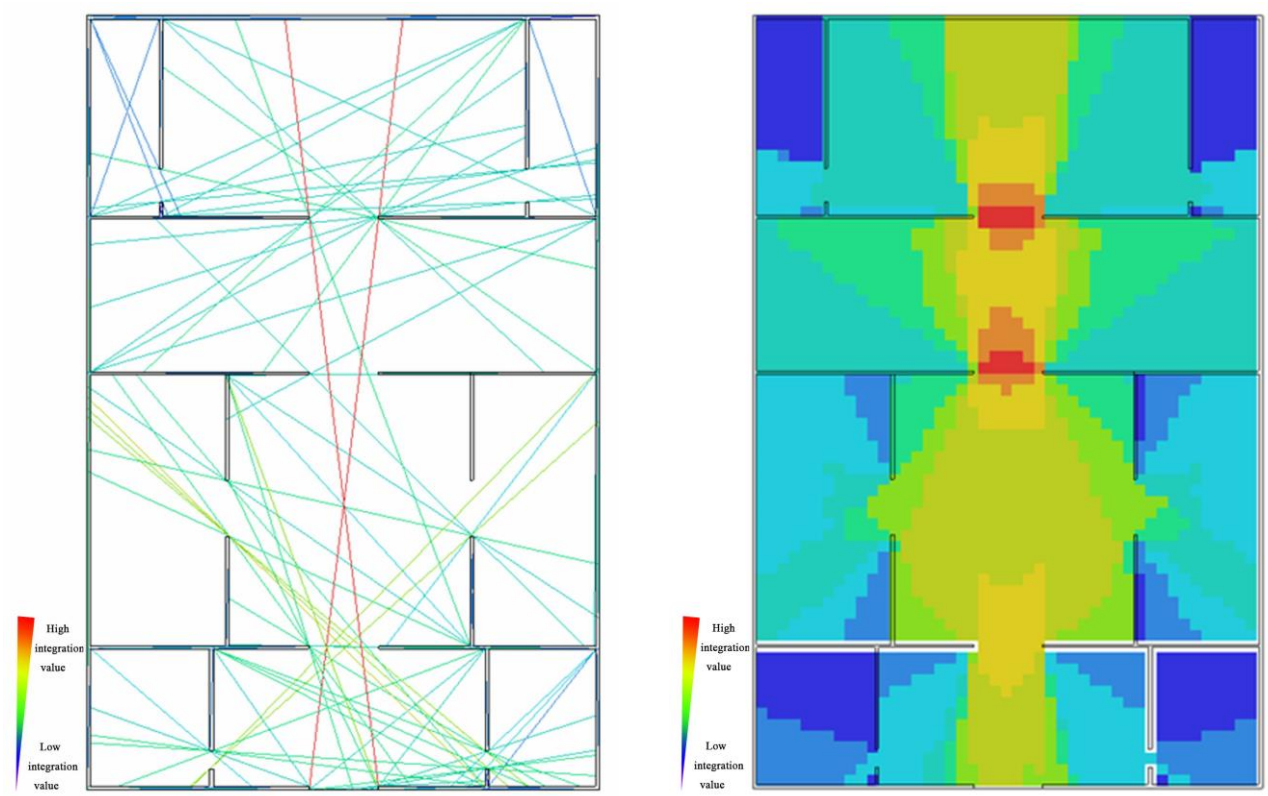


Fig. 2. Space Division of Da Detong exchange shop Building

Figure 3 represents the comparative analysis of the Visual and axial analyses for the exchange shop using integration measurements.

(a) and (b) show the spatial integration in axis and viewshed analysis, respectively. The warm and cold colours in the figure represent the degree of spatial integration. The redder the colour, the higher the degree of spatial integration; the bluer the colour, the lower the degree of spatial integration. The results show that the axial and viewshed maxima occur in the central axis area where the main house is located. Therefore, this region has the highest degree of integration, indicating its strong accessibility and openness. At the same time, the main house, as the most integrated interior space, shows its position as the core area of the building. The minimum value appears in the treasury located on both sides of the main house, indicating that this space is more closed in terms of sight and path discreteness.

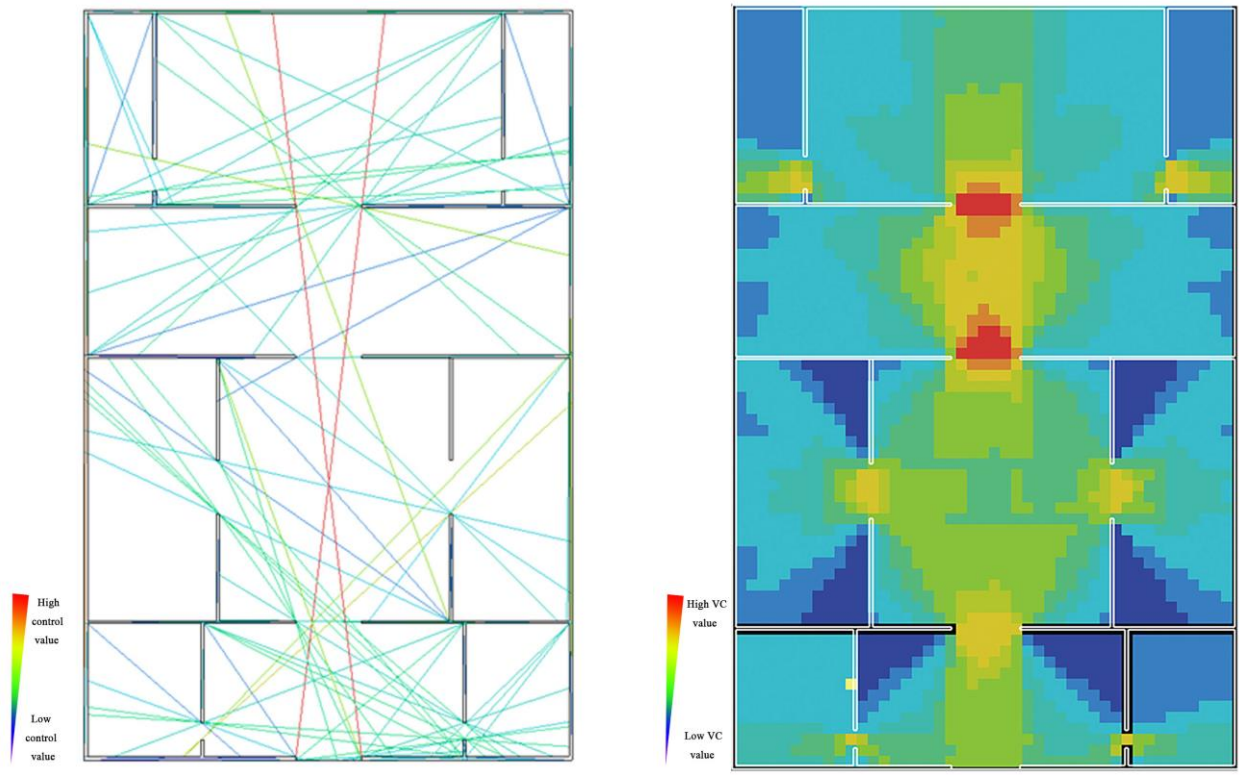


(a) Integration		(b) Integration	
Max	7.61	Max	16.30
Mix	1.75	Mix	4.08

Fig. 3. Visual analysis and axial analysis for exchange shop using integration measurements

Figure 4 represents the comparative analysis of the Visual and axial analyses for the exchange shop using control measurements.

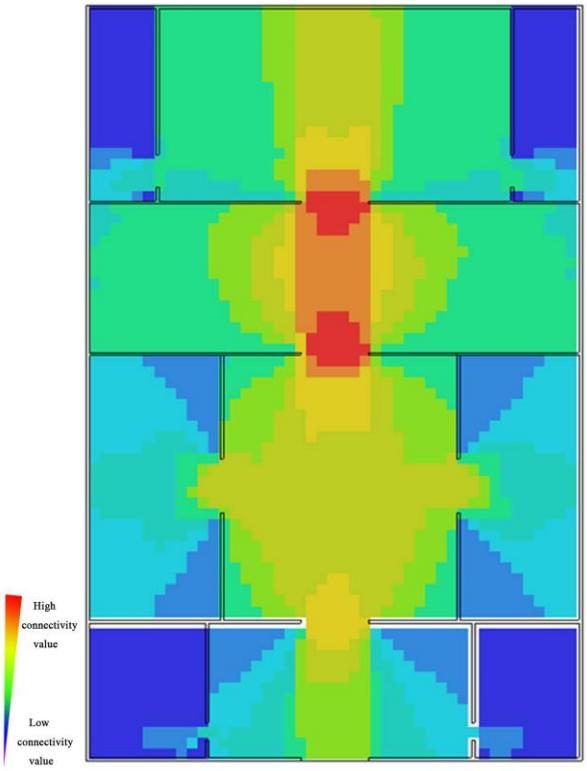
(a) and (b) show the spatial control in axis and viewshed analyses. The results show that the axial and viewshed maxima occur in the central axis area where the main house is located. Therefore, this area has the highest control value, indicating that the area of the main house and the central axis has a strong influence and control over other spaces and is in a dominant position. The minimum value appears in the side house, indicating that this space has a low influence on the building.



(a) Control		(b) Control	
Max	1.81	Max	1.65
Mix	0.56	Mix	0.24

Fig. 4. Visual analysis and axial analysis for exchange shop using integration measurements

Figure 5 represents the Visual analysis for the exchange shop using Connectivity measurements. The results show that the main house has the highest connectivity among the interior spaces, indicating that this space is closely connected with other spaces. At the same time, the courtyard of the living space area connected to the main house has higher overall connectivity. This is consistent with its key location connecting the front store and the back residence. In addition, reversely-set houses have lower connectivity. In addition, reversely-set houses have lower connectivity. Houses with inverted houses are less connected. The security, independence, and shelter that meet the needs of the trading space. This is consistent with its spatial properties.



	Main House	857.65
	Side House	505.74
	Side House	483.20
Average	Reversely-set House	174.61
	Reversely-set House	152.54
	Treasury	207.15

Fig. 5. Visual analysis for exchange shop using Connectivity measurements

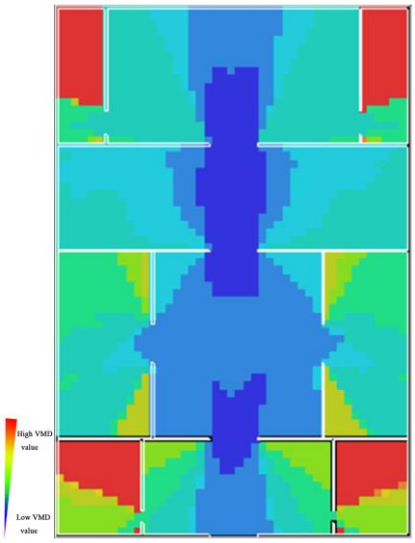
Figure 6 represents the Visual analysis for the exchange shop using Visual Mean Depth measurements.

The results show that in the interior space, the average visual depth value of the reversely-set house and the treasury is the highest, indicating that this space is more accessible to be hidden visually, has high privacy, and is generally located at the edge of the building. At the same time, the interior space with the lowest depth value is the main house, indicating that the main house space is in the visual centre and has a high degree of openness. This is consistent with the functional requirements of the respective spaces.

Figure 7 represents the Visual analysis for the exchange shop using Visual Entropy measurements. The results show that in the interior space, the visual entropy of the reversely-set house and the treasury is the highest, indicating that these two spaces have the highest spatial stability. At the same time, the space with the lowest visual entropy value is the main house, indicating that this space has stronger fluidity. This is consistent with the multifunctional properties of the space.

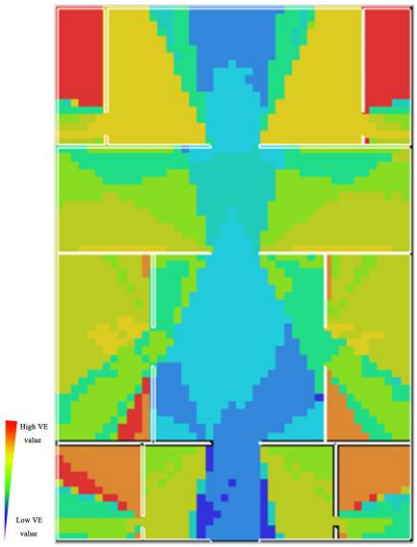
Figure 8 represents the Visual analysis for the exchange shop using Visual Controllability measurements.

The results show that in the interior space, the visual controllability of the main house space is the highest, indicating that the spatial vision of this area is good. The treasury has the lowest visual controllability, indicating that these two spaces have poor visibility, poor connection with other spaces, and are relatively closed. It meets the requirements of the treasury for high security.



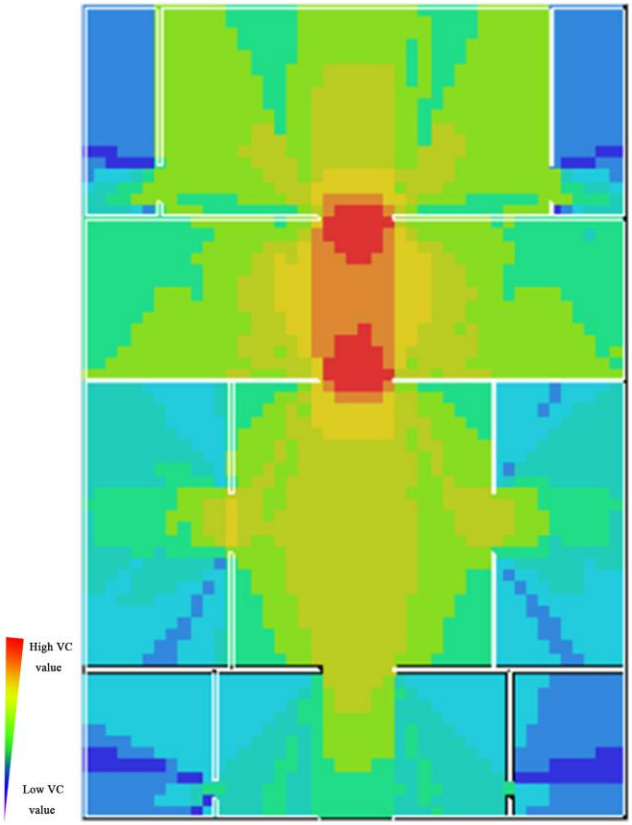
	Main House	1.979
	Side House	2.241
	Side House	2.268
Average	Reversely-set House	2.843
	Reversely-set House	2.876
	Treasury	2.842

Fig. 6. Visual analysis for exchange shop using Visual Mean Depth measurements



	Main House	1.575
	Side House	1.652
Average	Side House	1.650
	Reversely-set House	1.722
	Reversely-set House	1.714
	Treasury	1.837

Fig. 7. Visual analysis for exchange shop using Visual Entropy measurements

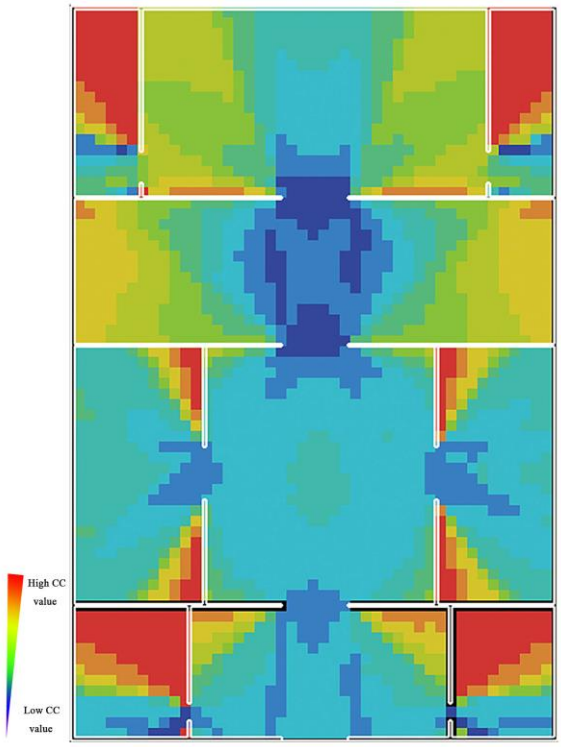


Average	Main House	0.358
	Side House	0.252
	Side House	0.243
	Reversely-set House	0.180
	Reversely-set House	0.183
	Treasury	0.164

Fig. 8. Visual analysis for exchange shop using Visual Controllability measurements

Figure 9 represents the Visual analysis for the exchange shop using Visual Clustering Coefficient measurements

The results show that in the interior space, the clustering coefficient value of the treasury is the highest, and the clustering coefficient of the reversely-set house is slightly lower than that of the vault because the currency exchange and transaction functions of the reversely-set house require less space privacy than the treasury. At the same time, the clustering coefficient value of the side house is the lowest.



Average	Main House	0.725
	Side House	0.679
	Side House	0.684
	Reversely-set House	0.828
	Reversely-set House	0.819
	Treasury	0.868

Fig. 9. Visual analysis for exchange shop using Visual Clustering Coefficient measurements

Figure 10 compares the six interior spaces in terms of space syntax values. It can be seen from the figure that the interior space with the highest spatial stability is the treasury. This space is used as a storage area for gold and silver, which is in line with the requirements of the space function. Followed by the inverted house and the main house, the spatial stability of the wing room is the lowest. This also illustrates the correspondence between spatial functions and spatial attributes.

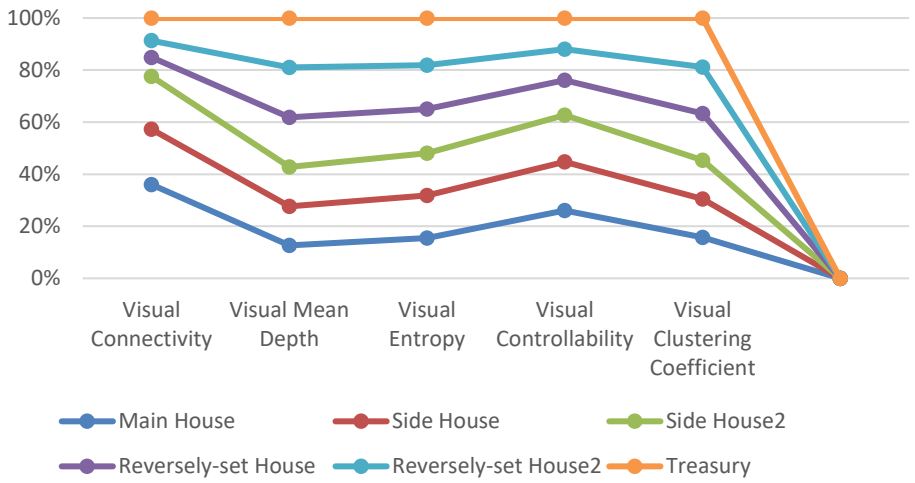


Fig. 10. Data comparative analysis of six interior Spaces

4. Conclusions

The above analysis shows that the ritual system and hierarchical concept in the Confucian merchant culture are reflected in the traditional commercial and residential dual-use buildings. This provides a new research method to delve into Confucian merchant culture's details and determine the influence of the ritual system on traditional commercial and residential buildings.

Aiming at the conclusion that the ritual system is used for self-restraint in previous studies, this study analyses the hierarchical differences reflected in the ritual system in the Confucian merchant culture from the perspective of differences in spatial configuration. On the one hand, as the main house and side house with the main living function, the main house is the most integrated interior space in the building, indicating its position as the core space. As the living area of the general manager, it is very different from the wing room used by employees with a low degree of integration, which reflects the etiquette system and the system of superiority and inferiority in Confucian businessman culture. It shows that in the commercial building space, the system of etiquette and superiority still exists and is valued. This also shows the unequal use of architectural space caused by the uneven distribution of social resources in traditional society. On the other hand, the main house space also provides a free, long-term living area for high-level customers. It also shows that customers are valued, cherished, and treated well. It embodies the people-oriented and customer-first Confucian businessman culture. At the same time, as the living area of the employees, the side house unconditionally provides protection for the employees' daily life. This also shows the concern for human nature emphasized in Confucian businessman culture, especially for human living space. In addition, as the most private space in the building, the treasury has the highest spatial stability. It is adjacent to the main house, which also shows that in the mixed-use commercial and residential buildings, the core position of the residential area is greater than that of the commercial area. At the same time, the courtyard area, as the key to connecting various interior spaces, bears the turning point of the front shop and the back residence. Its high degree of integration shows that it effectively integrates commercial and residential spaces and realizes their interpenetration. The staggered transformation of space is realized in a square inch.

This study traces the origin of Confucian merchant culture from the perspective of space configuration with the help of space syntax in order to analyse how the ritual system is reflected in traditional commercial and residential buildings. This enables us to analyse the relationship between Confucian merchant culture and space utilization, providing a new perspective for analysis. It can be concluded that the spatial layout and organizational sequence of traditional commercial and residential dual-use buildings have a high degree of matching with the hierarchical order required by the ritual system and are divided according to the space of interior and exterior, subordinate and superior. In addition, the space division and use of traditional commercial and residential buildings depend on the differences in users' social resources. Users of different classes, identities, statuses, and wealth control the space differently. This is consistent with the results of space syntax analysis. The previous research methods were mainly based on literature research, and space syntax is the research method of this paper. By establishing a structural model to study space, quantitatively analyse the organizational relationship between the part and the whole of the space network, reveal its internal laws, and provide more information for the research results. Great protection.

At the same time, the limitations of this study are reflected in two aspects. On the one hand, the case selected in this study is an exchange shop. However, there are many traditional commercial and residential buildings in China, such as tea houses, dyeing workshops, and drug stores. In addition, this study excludes the focus on transitional spaces such as courtyards in the building. These can be further explored in future research. Future research can focus on the relationship between the space

utilization of more traditional commercial and residential buildings and Confucian merchant culture, and gradually expand the scope of research, aiming to establish a research system that outlines the relationship between the two. This can provide a sufficient reference for extracting the cultural elements of different types of traditional commercial and residential buildings and protecting the reuse of traditional commercial and residential buildings in the future.

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