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A Comparison Analysis of Spatial Structure of Traditional Chinese and Korean Residences Based on Spatial Syntax

Yaolong Zhang^{1*}, Yang Chen² and Jingjing Wang¹

¹LongDong University, Qingyang, GanSu Province 745000, China

²Southwest Jiaotong University, Chengdu, Sichuan Province, 610000, China

*Corresponding author's e-mail: 610312404@qq.com

Abstract. The traditional dwellings of China and South Korea reflect the basic living space of the two peoples at that time. They reproduce the social reality through the organization of space. It is a cultural product that reflects social reality. This study selects the representative examples of traditional residential buildings in China and South Korea. Based on the space syntax theory, analysis software such as depthmap and axwomen are used to analyze the similarities and differences between the spatial specific variable values, including integration, connectivity and control value. And through the above analysis, combined with the correlation between space and cultural connotation: (1) The quadrangle dwellings in China has a relatively shallow spatial structure compared to the Jeong-On's Traditional House in Korean, but the identifiable spatial structure in the two cases is similar. (2) The quadrangle dwellings is different from the courtyard in the Jeong-On's Traditional House in the entire space structure, and its connection center is the corridor space. The corridor plays the role of transition space in the interior space of the courtyard, and divides the spatial hierarchy according to the depth. (3) South Korea is a space of dual power structure, which is influenced by class and gender in the formation of spatial structure, while China has a very vertical order, but in a highly controlled space, The influence of class and gender can be ignored. This study will help us to further strengthen our understanding of the traditional living space of the two countries. we can point the way for us to explore non-standardized and new types of living in the future.

1. Introduction

Living space is the basic living space of people. It reproduces social reality through the organization of space. Therefore, it is a cultural product that reflects social reality. In recent years, with the rapid development of the economy, people's living standards have been continuously improved, and the demand for comfortable living spaces is increasing. People are eager to find a new non-standardized residential space. The traditional living space is influenced by natural, religious, cultural, social and political factors. Therefore, the internal space composition of traditional houses in different countries will also be different. Space Syntax Theory was proposed by Bill Hillier, Julianne Hansen, and others at the University of London's Bartlett College [1]. They believe that spatial factors should be considered in the abstract social structure, and social factors should also be considered in the material spatial structure. The spatial syntactic theory shows the relationship between space and society through a series of quantitative indicators of measurability, and constructs a unique and complete theoretical method system for expressing the complex relationship between spatial structure and human social behavior [2]. Based on the calculation of space syntax theory, regardless of the size, shape and distance of space, quantitative indicators such as integration, connectivity and control value are developed to



explore how space is organized[3]. Through analysis software such as depth map and axwomen comparing and analyzing the similarities and differences between Chinese and Korean traditional residential space under the influence of different natural environmental factors and social and cultural factors, it helps us to further strengthen our understanding of the traditional living space of the two countries. On this basis, we can Explore non-standardized,new types of residence to indicate direction.

2. Research object and method

In this study, a comparative analysis was conducted between the quadrangle dwellings, a typical residence in the Ming and Qing dynasties in China, and the traditional upper-class residence in the Chosun Period in South Korea.The Chinese quadrangle dwellings and the high-rise houses in South Korea reflect the housing style adopted by the two countries' housing culture during the period of cultural stability in the economic, political and cultural privileges.This study uses spatial syntax to quantitatively compare two traditional living space structures of different scales and forms, and analyzes the spatial structure through spatial syntactic analysis and justified graph, trying to clarify the social structure reflected in its spatial structure and cultural attributes.

2.1. Research object

2.1.1. Quadrangle dwellings

Quadrangle dwellings is a typical residential type of the Han Chinese, and its form originated from the palace building in the early Zhou Dynasty .The quadrangle dwellings from the palace building has since expanded to all levels, but still maintains its normative characteristics. It is characterized by an inward-looking space formed by a plurality of buildings centered around the atrium. At the same time, the order is set from front to back according to the axis, and there are also hierarchical orders on both sides.In terms of function, It is set up to accommodate guests and the space for the ceremony in the forebody, and is used as a space for daily life in the latter part.

Class nature is also reflected in the setting of the atrium. Take the four-in-one Quadrangle dwellings as an example. The front yard is usually the space for servant activities.The second courtyard is mainly used as a low-ranking member or tourist in the family, while the courtyard in front of the main house is used as an elder in the family, and the unmarried daughter in the family generally operates in the innermost courtyard.From this point of view, the spatial structure of the Quadrangle dwellings is the same as that of the upper-class houses in Korea. There is also a strict distinction between this class and gender.

2.1.2. Upper Class House

The upper house in the Chosun Period consists of Sarang-room,inner room,aengnang-room,main entrance hall, middle door, Maru,pavilion etc,Which are separated by wall or room.There are yards between the room, so the upper houses are also composed of many yards.All spaces that make up a traditional dwelling are continuous, while space is classified according to the upper and lower identity systems.The layout of the upper house is determined according to the theory of geomancy. A house usually consists of a space of 3 to 4 generations.The space in which the owner lives is the inner room and the Sarang-room, and the space is clearly defined according to the function.Sarang-room is the male space where the male owner lives and receives the guests, and assumes the social function of the family.Inner room is a place where the hostess conducts various activities related to family food and clothing, and is mainly composed of the inner room,inner hall,opposite room,kitchen and the storage room.As the space where women live and act, they are placed in the innermost part of the house and serve as the central space for family life. This is also the norm of Confucianism as a Chosun Period house of ruling philosophy.The Haengnang-room is located outside, mainly the space of the servant, and is also used as a space for men.Confucianism in the Chosun Period was based on the “the three cardinal guides and the five constant virtues”. This social norm formed two social classes, namely, the distinguished and the despicable, that is, the two-class society and the unification society. For this

reason, the upper class was further divided. The existence of housing space and the living space of the people[4]. Jeong-On's Traditional House is located in Gamcheon-ri, Gyeongcheon-myeon, Gyeongcheon-do, Gyeongsangnam-do. It consists of the inner space structure in the order of the inner room, Sarang-room, cortile and Sarang-yard. It is a typical representative of the upper-class residence in the late Chosun Period [5].

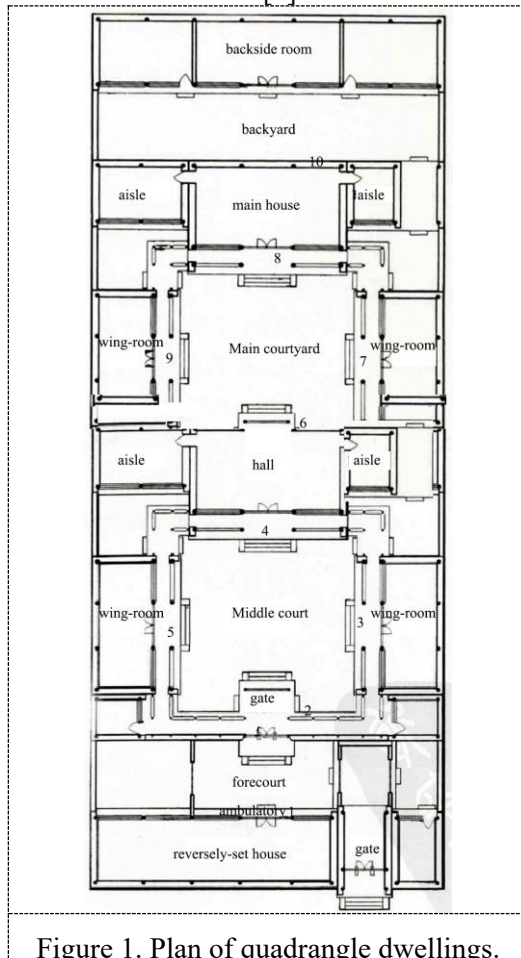


Figure 1. Plan of quadrangle dwellings.

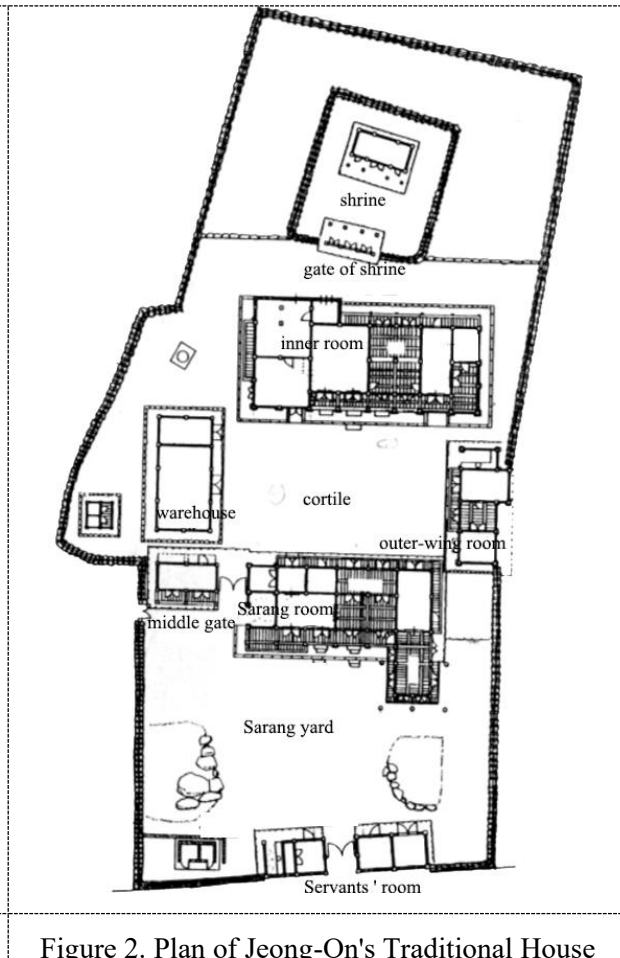


Figure 2. Plan of Jeong-On's Traditional House

2.2. Research method

Using the analysis method of convex space in the space syntactic theory, analyzed the similarities and differences of the spatial specific variable values in the two cases in the form of quantitative analysis, including the integration, connectivity, control value and other variable values. The spatial structure and hierarchy of the circle, so as to grasp the inherent social structure of its space.

Using the analytical method of convex map to analyze the plan of the traditional houses in the two countries, and the integration, connectivity and control values of each house are compared, and the average space structure is compared by using the average variable. If the integration is larger, it means that the space is more convenient in the whole system, the stronger the publicity, the better the accessibility, the easier the crowd gathers here, the integration is a potential variable value to measure a space to attract traffic[6]. The connection is the number of nodes directly connected to a node in the system. If the connection value of a space is higher, it indicates that the space is closely related to the surrounding space, and the permeability of this space is better. The control value can reflect the mutual control relationship between space and space. In order to ensure the objectivity of the analysis results, in the process of creating a convex space convex map, the residential units selected by China and South Korea will be applied the same standard. When creating a convex space, the courtyard space selected by China and South Korea needs to be identified as part of the spatial structure. At the same

time, the cloister of the courtyard is also one of the spatial elements. In order to adopt the same standard, the malu space used as the connection space in the Jeong-On's Traditional House should also be recognized as one of the elements of the entire spatial structure.

3. Spatial analysis

3.1. Comparative analysis of specific variables in convex space

3.1.1. integration comparison

The red part of the higher value of the quadrangle dwellings space is distributed in the cloister in front of the inner courtyard. The red part of the higher value of Jeong-On's Traditional House in South Korea is distributed in the Sarang-yard. This part of the space has the highest accessibility, and the space in which people can easily identify is also in these places. At the same time, in the actual function, this part is the most functional and the most important. From the overall spatial structure of the quadrangle dwellings, the integration of the corridor is the highest, and the space around the inner atrium is highly integrated as a whole, and the overall integration gradually decreases from the middle to the sides. If the integration of a space is higher, people will easily reach this space. From another aspect, it is easy to reach the rest of the space from this space, and the user's control over the whole house is better. In terms of overall integration, the internal central courtyard space' integration used by the owner in both cases is highest.

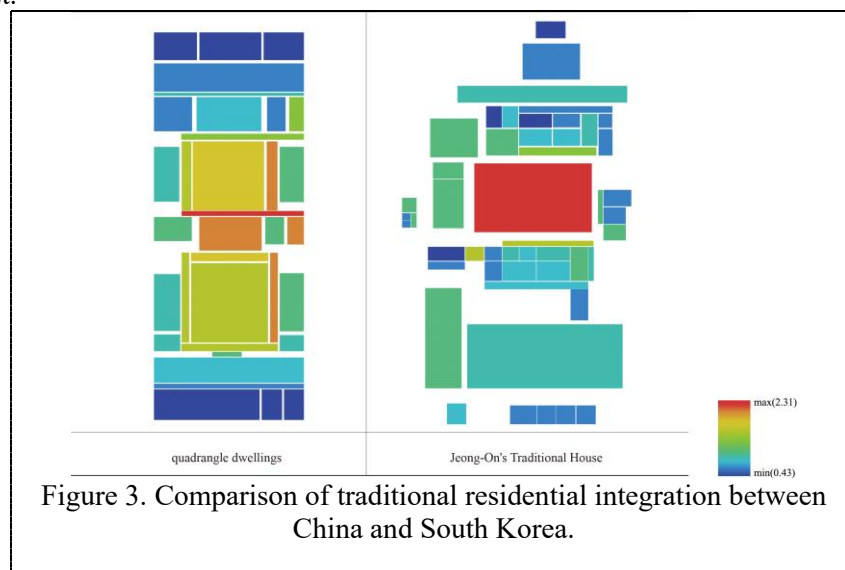


Figure 3. Comparison of traditional residential integration between China and South Korea.

3.1.2. connectivity comparison

The connectivity is the number of times a space in the topological space intersects other spaces. If the number of connections is higher, the connectivity of the space is higher, and it can be said that the space penetration capability of the space is stronger. People meet, gather and talk in this space, this space is highly public and active, and is the main public space in entire space. According to the data obtained from the Depth map, the space with the highest connectivity of the quadrangle dwellings is the corridor. But the space with the highest connectivity is the Sarang-yard at the entrance in the Jeong-On's Traditional House. In this two cases, the blue part with the lowest connection value is basically in the wing room. From the results of the analysis, the penetrating power of the courtyards of the two cases in the entire space structure is deviated, because the corridors of the quadrangle dwellings act as traffic spaces throughout the living space.

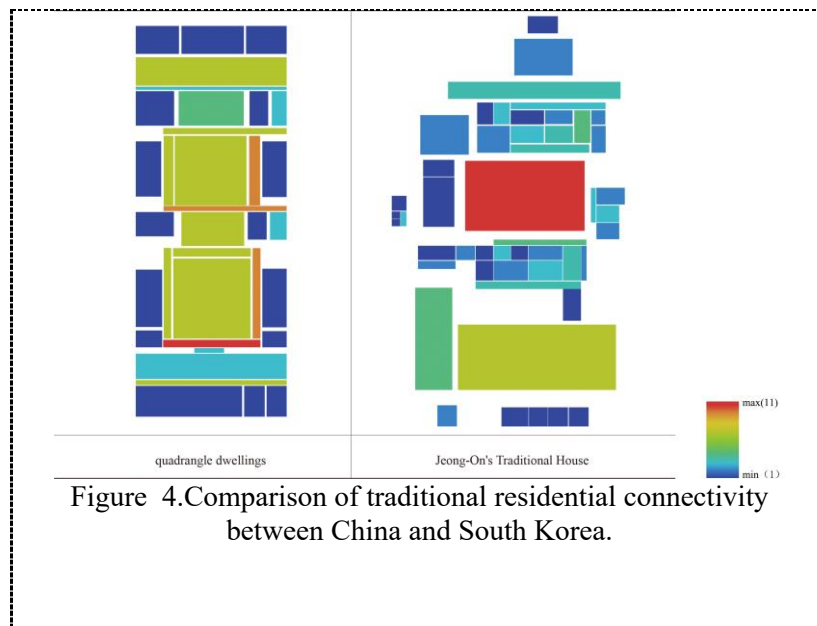


Figure 4. Comparison of traditional residential connectivity between China and South Korea.

3.1.3. control value comparison

Residential space is a relationship system composed of different spaces[7]. The highest control value in quadrangle dwellings is the corridor of the front and backyard space, followed by the other corridor space. If we consider that the corridor in quadrangle dwellings is used as a traffic space, the control values of all corridor spaces are similar, so the control value of the courtyard space can be relatively high. The space with the highest control value in Jeong-On's Traditional House is the Sarang-yard, which is a space for men to live in. This space can easily control other spaces, but it is also easy to be controlled. But unlike Jeong-On's Traditional House, the backyard's control value in the quadrangle dwellings is very high. This is because according to the ceremonial rules, women have the so-called principle of the family, in the layout of the house is reflected in the strong plane closure and strict internal and external separation, although there are channels between the inner and outer houses, but women must be active in the house. The spatial structure of quadrangle dwellings has a strict distinction between class and gender, reflecting the ideology of man is superior to woman[8]. The backyard is used as an unmarried daughter and female servant in the family, and most of their activities are limited to here.

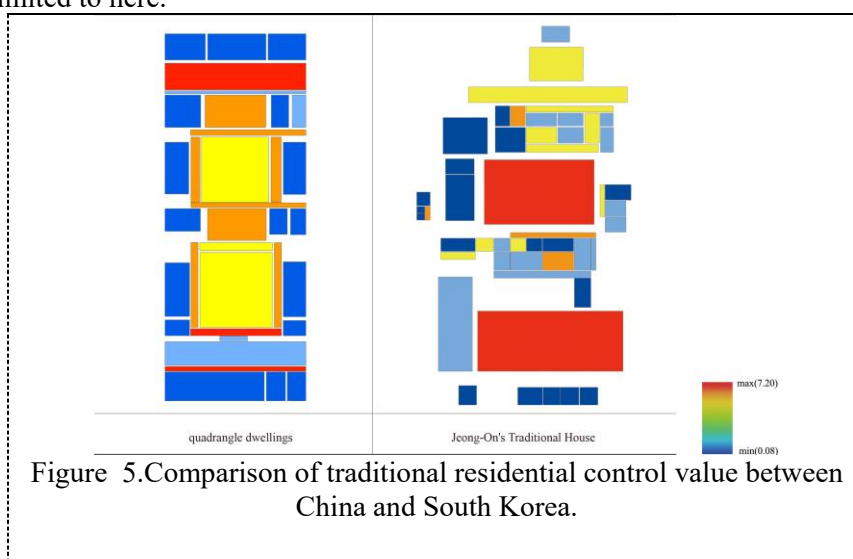


Figure 5. Comparison of traditional residential control value between China and South Korea.

3.1.4. Summary

From the results of the above-mentioned variable value analysis, the space with high integration, connectivity, control value has similarity, but they are not completely consistent, and the red value with high integration also appears in the central part of the space. The mean connectivity is almost the same. On the contrary, Jeong-On's Traditional House has the highest mean integration rate of 1.14, and quadrangle dwellings has the lowest average integration value of 0.71. It means that Jeong-On's Traditional House has a shallower spatial structure than the quadrangle dwellings.

By comparing the R^2 of the quadrangle dwellings and Jeong-On's Traditional House space, the values are 0.46 / 0.40, which means that the spatial structure recognizable by traditional houses in China and South Korea is similar.

Table 1. Mean integration, Mean connectivity, Mean control value and R^2 .

	Quadrangle Dwellings	Jeong-On's Traditional House
Mean integration	0.71	1.14
Mean connectivity	2.46	2.61
Mean control value	1	1
R^2	0.46	0.40

3.2. Analysis of detailed spatial structures by Justified Graph

In order to know the gender and class distribution of the depth of the two cases, according to the process of people entering the internal space from the external space to draw justified graph. The justified graph provides an effective description of the spatial configuration of the two cases and an important way to quantify the configuration.

3.2.1. quadrangle dwellings

If only the entrance space 1 is connected to the outdoor, the justified graph presents a "deep tree" with a topological depth of 12 and a total topological depth of 285. In the justified graph, it can be seen that the corridor space of the south side on the yard and courtyard are both close to the trunk position, and at the same time controlling the number of treetop spaces, the space's control value is much higher than the space on the treetops. It plays an important role in Spatial system. The outermost space is the space used by the male servant, the interior has the space used by the owner, the living space of the female servant and the unmarried daughter at home is set in the deepest part of the courtyard, the elder space inside the family is set in the third courtyard space. On the whole, the status of class is more important than the gender to the layout of the living space of quadrangle dwellings. In addition, the lobby space of the reception guest is the boundary, and guests are not allowed to enter, thus separating the public space from the private space.

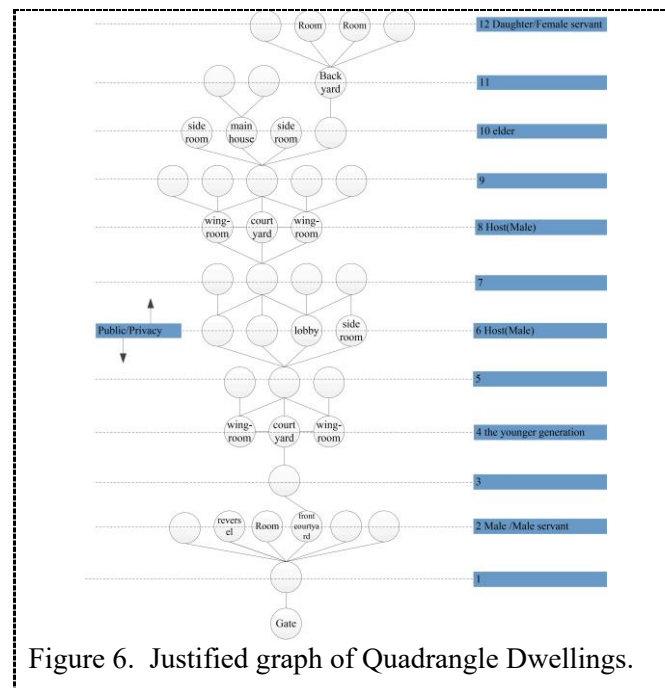


Figure 6. Justified graph of Quadrangle Dwellings.

The spatial structure of quadrangle dwellings shows a strong vertical level, this is also a true reflection of the vertical power structure in the spatial structure. The most distinctive space in quadrangle dwellings is the cloister. As mentioned above, if you do not pass through the corridor, you cannot move to another space in quadrangle dwellings. The owner's space is higher than the servant's space value in connectivity. As a traffic space, the cloister has the highest connectivity. From the control value, the hall and the main room used by the owner during the day have high control value, and the owner's space is more controllable than the servant's space. Unlike Jeong-On's Traditional House, the cloister space and backyard space have the highest control value.

Table 2. Spatial Syntactic Analysis of Quadrangle Dwellings

	Space	Sex/Hierarchy	Integration	Connectivity	Control Value
	hall	M/host	0.97	4	2.45
	main house	M/host	0.69	3	2.2
Room	wing-room(Middle court)	M,F/host	0.64	1	0.25
	wing-room(Main court)	M,F/host	0.72	1	0.25
	reversely-set house	M/servant	0.43	1	0.25
	backside room	F/daughter,servant	0.43	1	0.25
	forecourt	M/servant	0.60	2	0.75
Courtyard	Middle court	M,F/host	0.84	4	0.87
	Main courtyard	M/host	0.98	4	0.9
	backyard	F/daughter,servant	0.51	4	3.5
	1(forecourt)	whole members	0.51	4	3.5
	2(Middle court)	whole members	0.88	6	3.2
	3(Middle court)	whole members	0.99	5	2.17
	4(Middle court)	whole members	0.93	4	0.95

ambulatory	5(Middle court)	whole members	0.83	4	1.67
	6(Main courtyard)	whole members	1.08	5	1.5
	7(Main courtyard)	whole members	0.97	4	1.65
	8(Main courtyard)	whole members	0.88	5	1.58
	9(Main courtyard)	whole members	0.97	4	1.65
	10(backyard)	F/daughter,servant	0.60	2	0.75

3.2.2. Jeong-On's Traditional House

If only the entrance space 1 is connected to the outdoor, the justified graph presents a "tree" with a topological depth of 8 and a total topological depth of 190. The justified graph can be seen that the Sarang-yard, the gate of cortile and An-yard are both close to the trunk position, and at the same time controlling the number of treetop spaces, the space's control value is much higher than the space on the treetops. It plays an important role in Spatial system. The male and female servants are arranged in the Haengnang-room, and the space used by the male and female hosts is set Sarang room. From the main entrance of the house to the Sarang-yard used by male, and then through the middle door into the female space -cortile, it can be seen that the upper house of the Chosun Period has a spatial structure that clearly distinguishes class and gender through Confucian norms.

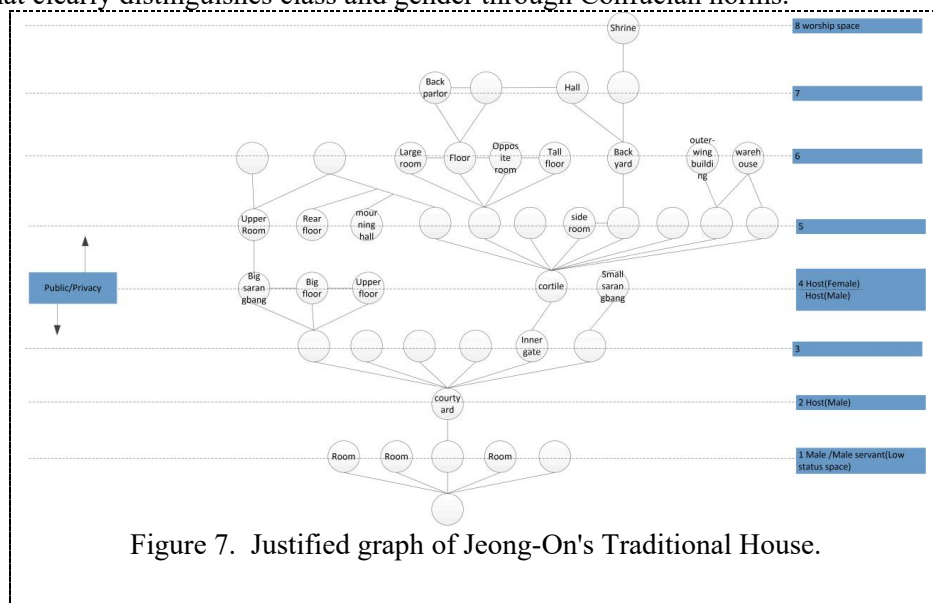


Figure 7. Justified graph of Jeong-On's Traditional House.

From the floor plan, there is a clear distinction between the inner room and the area of Sarang-room, but the spatial depth of the inner room and Sarang-room overlap. We can understand that class factors have a greater impact on space than gender in the process of in the formation process of spatial structure. In addition, if the female space "inner room" is regarded as "private space" and "Sarang-room" is regarded as "public space", the boundary between private space and public space can be divided into the fourth stage. From the connectivity, the space used by the owner is much higher than the servant, even in terms of control value, the owner's space is significantly higher than the space used by the servant. Judging from the situation of the hall space, the Sarang-hall has the highest control value, followed by the Inner hall., the lowest space of control value is the small Sarang-hall and the outer-wing hall. It can be seen that the control value of the space used by the owner is also slightly different. From the control value of the room, the control value of space used by the owner is significantly higher than that of the servant, which indicates that the owner's space is more controllable than the servant's space.

Table 3. Spatial Syntactic Analysis of Jeong-On's Traditional House.

	Space	Sex/Hierarchy	Integration	Connectivity	Control Value
Courtyard	Sarang yard	M/host	1.19	10	7.20
	cortile	F/host	2.31	11	6.75
Hall	Sarang hall	M/host	1.06	3	1.83
	Samll-Sarang hall	M/host	0.83	1	0.33
	Inner hall	F/host	1.15	4	0.75
	outer-wing hall	-	0.99	2	0.33
Room	Sarang room	M/host	1.06	2	0.58
	inner room	F/host	1.09	3	1.25
	Servants ' room	M,F/servant	0.87	1	0.09

3.3. Summary

As can be seen from table 4, the corridor space of quadrangle dwellings and the courtyard space in the Jeong-On's Traditional House in Korea have the maximum connectivity and maximum control value, and are the integration center in the entire space structure. Judging from the results of specific spatial structure analysis, the spatial structure of Jeong-On's Traditional House in Korea is consistent with the characteristics of residential architecture in the Chosun Period. It is based on Confucianism and has strong lock-up. It uses its large doors and gorgeous walls to express their wealth and authority. Strictly observe the distinction between men and women, identity and age in the formation of spatial structure. But quadrangle dwellings has a very vertical order, on the vertical axis, a courtyard is a spatial level, one level has a spatial nature and a spatial nature has a spatial form.

Table 4. Comparison of Syntactic Analysis Results of Traditional Houses in China and Korea.

	Quadrangle Dwellings	Jeong-On's Traditional House
Integration center	ambulatory6(Main courtyard)	cortile
Connectivity(max)	ambulatory	cortile
control value(max)	Ambulatory1(forecourt)	Sarang yard

It can be seen from the justified graph that the space of the two cases is a tree structure. Although the overall structure of the Jeong-On's Traditional House is shallower than that of the quadrangle dwellings, its spatial circulation is better.

4. Conclusion and outlook

The spatial structure of quadrangle dwellings shows a strong vertical space level, which is also a true reflection of the vertical power structure in the spatial structure. The most important element of the quadrangle dwellings' spatial structure is the corridor. The corridor controls the movement of people in the spatial structure, plays a role of transition space in the interior space of the courtyard, and divides the spatial hierarchy according to the depth. From the analysis of Jeong-On's Traditional House, it can be seen that the traditional way of living in Korea is a space tool for the host to express their own life and behavioral norms and make the differences between social classes more obvious.

Traditional spatial formation is influenced by the climate, culture, social organization and social relationships in the family. Although it has been a long time since the 15th century, the physical appearance and form of living have not changed much, the structure of living space has evolved from social organizations and social relationships within the family. Through the analysis and correct

understanding of the spatial organization of traditional dwellings, it is hoped that the new coping styles can be pointed out when it is necessary to explore new types of dwellings in the future.

Acknowledgement

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