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SONG, Jingying
Graduate School of Human-Environment Studies, Kyushu University : Doctoral Program

ZHAO, Shichen
Faculty of Human-Environment Studies, Kyushu University

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黄河流域内モンゴル地区における土居更新のケーススタディ

The Case Study of Earth Dwellings Renewal in the Inner Mongolia Section of the Yellow River Basin

宋晶瑩*，趙世晨**
Jingying SONG, Shichen ZHAO

Traditional vernacular dwellings need to undergo inevitable renovations to adapt to modern lifestyles. In the Inner Mongolia section of China's Yellow River basin, earth dwellings are a kind of vernacular dwellings. Over different periods, these vernacular dwellings have been updated. The research selected seven samples based on different construction years, construction methods, and infrastructure provisions. Firstly, the research organizes the samples' courtyards and living space forms for qualitative analysis. Subsequently, using spatial syntax, the integration values of the plans and functional spaces of each sample are calculated to analyze the organizational characteristics of the plans quantitatively. The results indicate that the involvement of builders with different identities affects the spatial form of residential spaces. The infrastructure configuration influences the content and usage of functional spaces. The renovated residences retain the traditional Kang-Stove space but adjust the spatial connections, making the updated plan organization more compact.

Keywords: Earth dwelling, Residential renewal, Space type, Space Organization
土居，住宅更新，空間形態，空間組織

1. Introduction

1.1 Background

Traditional vernacular dwellings are constructed by residents or artisans using local materials and traditional techniques. Native society and cultural factors influence and evolve the construction of dwelling spaces in vernacular architecture [1)]. However, traditional vernacular dwellings often pose safety hazards and are ill-suited for contemporary living, leading to a series of renovation and transformation practices. The Chinese government has organized and guided the renovation of vernacular dwellings since 2009[2)]. The study focuses on the Inner Mongolia section of the Yellow River basin, located in the upper reaches of the Yellow River. The geological conditions of loess deposition characterize it[3)]. Traditional vernacular dwellings in this region are made of earth (According to the 2011 China Rural Population and Labor Survey, 35.9% of dwellings in Inner Mongolia are constructed using earth[4)]). Due to economic constraints and the remote locations of these traditional dwellings, the renovation work in this region started relatively late. Before 2014, renovations were mostly carried out by residents themselves. From 2014 to 2017, the government hired construction units to carry out unified construction. In 2019, the government organized design personnel to provide design drawings and technical guidance, allowing self-construction and unified construction. In 2021, the government proposed separate sleeping, living, and dining spaces to improve the environment. In 2022, there was an improvement in the provision of water supply facilities and solar energy equipment for dwellings. The renovation of earth dwellings in the Inner Mongolia section of the Yellow River basin shows that contemporary construction methods involve the participation of professional technicians, leading to both self-construction and construction by others (government or developers). Space design now considers the independent use of different functional spaces, and the widespread provision of

*　都市共生デザイン専攻博士後期課程
**　都市・建築学部門

infrastructure offers new ways for indoor water supply and heating. These changes raise the question of whether contemporary dwelling renovations can balance local living culture or if they will result in entirely different living space styles.

1.2 Literature Review

In China, the attention to renovating vernacular dwellings began in the late 20th century. In 1995, Yongda Yin pointed out that vernacular dwellings should accommodate the continuously changing lifestyles of residents. They should not remain static like heritage preservation but need to adapt to traditional living culture[5)]. In the 21st century, as residential renewal projects unfold, research is driven by the dual objectives of improving living conditions while accommodating regional cultural considerations, leading to the development of renewal design schemes[6)]. Along with the completion of residential renewal projects in some regions, research has already commenced to analyze the differences between newly constructed and traditional spaces and to reflect on the behaviors associated with the renewal process[7)8)]. The renewal program on the earth dwellings in the Inner Mongolia section of the Yellow River Basin started relatively late, with studies often focusing on analyzing lifestyle changes[9)10)] or proposing renewal plans to preserve local residential culture[11)]. The organized renewal efforts targeting these earth dwellings as a focal point for transformation have been ongoing for nearly a decade. Some residences, having been in use after their construction, provide samples to observe and reconsider the impact of renewal initiatives on traditional residential culture.

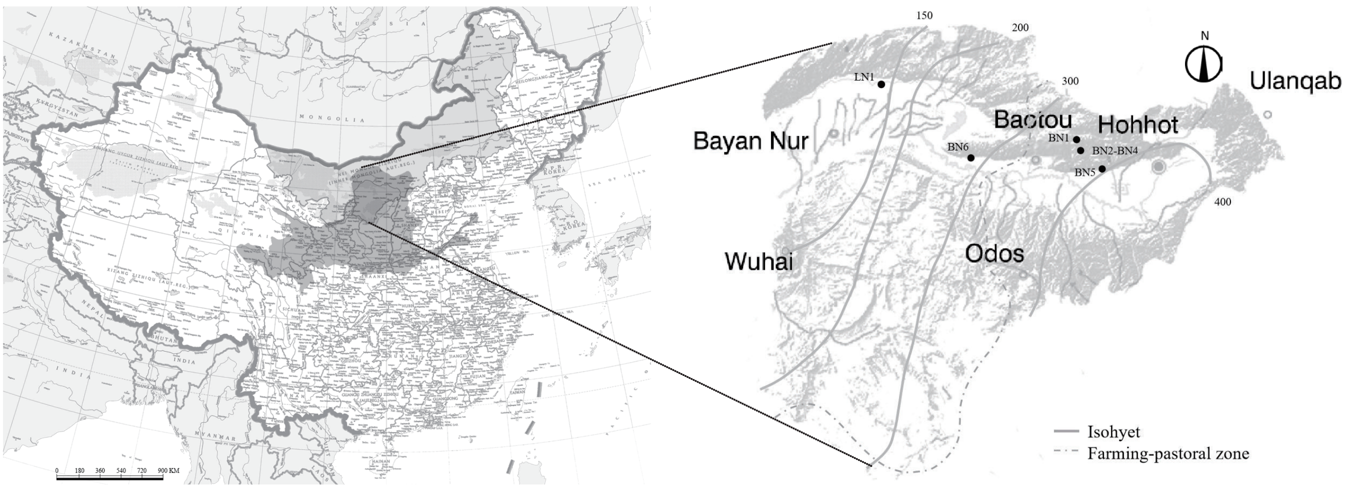


Fig. 1 Research scopes

1.3 Research Purpose

In the Inner Mongolia section of the Yellow River basin, after recent years of renovation practices, the number of traditional earth dwellings has decreased to approximately 8.99%[12)]. The research focuses on the changes dwelling renovations have brought to local traditional living spaces. The study selected seven cases of renovated dwellings and compared them to the area's traditional earth dwellings, analyzing the changes in the functionality and spatial organization of living spaces after renovation.

Based on the differences observed in the construction process of dwelling renovations compared to traditional construction methods, the study examines two factors: The identity of the builders and the addition of infrastructure. The research seeks to answer the following questions: Does the builders' identity impact living spaces? Does the increase in infrastructure affect living spaces? Do the renovated dwelling spaces continue the traditional living culture?

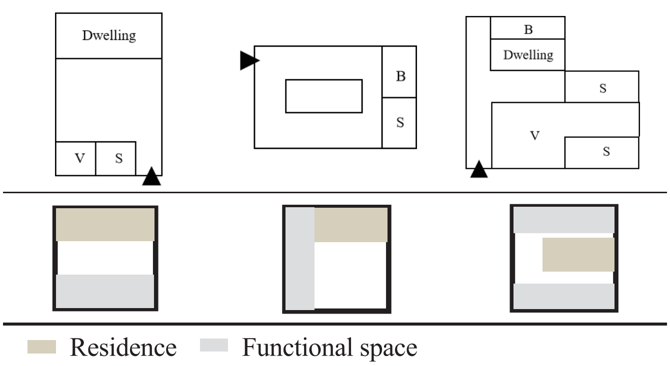
2. Research Object

2.1 Overview of Traditional Earth Dwellings in the Inner Mongolia Section of the Yellow River Basin

The Inner Mongolia section of the Yellow River Basin is in the central part of Inner Mongolia, situated in a transitional zone between China's northern semi-humid agricultural area and arid to semi-arid pastoral areas (Fig. 1). This geographical location has led to a coexistence of agriculture and animal husbandry as the primary means of livelihood. Consequently, many traditional earth dwellings in this region are accompanied by sheep pens. These dwellings, except some without clearly defined land boundaries, typically comprise housing units enclosed within a courtyard. Courtyards typically consist of storage spaces (S), Barn (B), vegetable gardens (Vegetable) for daily consumption, and garages (Garage) for storing vehicles or production equipment. The yard type can be categorized into three types of positional relationships of functional spaces and housing (Table 1): forward-facing (A-type), side-by-side (B-type), and front-back placement (C-type). In prior research, an analysis of 52 traditional earth dwellings' plans inferred a morphological classification influencing spatial organization[13]. The sleeping areas are the original spaces in earth dwellings; the other spaces are arranged based on them. The kind of sleeping areas become the basic indoor functional spaces in the plan and are used to divide indoor space into α (Sleeping area consists of directly connected Kang and stove), β (Sleeping area consisting of indirectly connected Kang and stove), γ (Sleeping area consist of bedroom and living room or dining room). The plans that cannot be classified into the three types before are determined to be the unique type * (Table 2).

Table 1 Courtyard Type

A-type	B-type	C-type



S: Storage B: Barn V: Vegetable G: Garage

Table 2 Basic Functional Type

α	β	γ	*

Space forms the basic functional space

Table 3 Cases Information

Code	Year	Construction method	Living facilities		
			Water supply	Sewerage	Solar
LN1	1990s	Self-build	○	○	○
BN1	2000s	Self-build	●	○	○
BN2	2000s	Others	●	●	●
BN3	2000s	Others	●	●	●
BN4	2000s	Others	●	●	●
BN5	2000s	Self-build	●	●	●
BN6	2010s	Self-build	●	●	●

●with ○without

2.2 Renewal Cases

Around the Inner Mongolia section of the Yellow River Basin, some residents engage in a mixed production mode based on seasonal activities and occasional migration for employment; some have purchased homes in suburban areas. The renewed dwellings are left vacant or used intermittently, which makes it hard to observe the actual utilization of living spaces. Ultimately, the research opted for seven cases where residents have lived in renewed dwellings for an extended period. The cases represent different periods of renovation practices, various construction methods due to different builders, and differences in infrastructure provisions. Among them, the dwellings constructed by "others" adhere to government-recommended blueprints, with samples BN2, BN3, and BN4 selected to represent three distinct recommended templates. One was constructed in the 1990s, one in the 2010s, and the rest were renovated and built during the 2000s. The proportion of self-built and other-constructed dwellings in the samples is roughly similar (Table 3).

Recently, local dwelling renovation work has focused on increasing the coverage of water supply facilities and the widespread adoption of solar energy. The study collected data on the basic living facilities in the samples, including water supply, sewerage, and solar energy utilization. Table 3 shows that the sample around the 1990s lacked living facility provisions and one built in the 2000s (BN1) is equipped only with water supply facilities. The rest of the samples have well-equipped living facilities.

3. Methods

3.1 Research Method

The study will identify spatial patterns and organizational characteristics of renewal dwellings and compare them with traditional earth dwellings in the Inner Mongolia section of the Yellow River Basin based on previous research[13]. The research employed a qualitative analysis to investigate the changes in the plan and the included functional spaces after the renewal. The impact of infrastructure provisions on spatial content is assessed through comparative analysis.

Space syntax is combined with Depthmap x for calculating and analyzing the renewal living space quantification. By comparing it with traditional earth dwellings, the study aims to analyze the changes in spatial organization and the influence of infrastructure provisions on the space after renovation.

3.2 Space Syntax

The Space Syntax, proposed by Bill Hillier and Julienne Hanson in the 1970s, can represent, quantify, and explain architectural space configurations[14]. Spatial organization can be seen as a member of 'morphic languages. Morphic languages are used to constitute social relationships through their syntax[15]. Therefore, the spatial organization can tell the relationships between individuals' space, and the relationship influences the access between individuals as the space syntax theory.

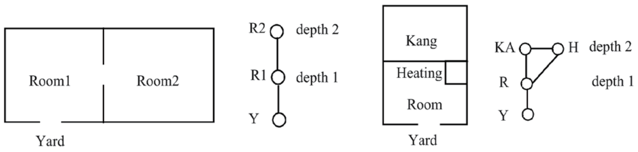


Fig. 2 J-graph drawing method

In the calculation process, the first step involves creating a J-graph (A justified graph takes one space as the root point, the spaces connected to it are placed at one level of depth, the spaces connected to those at the first level are drawn at the second level, and so on, until all levels of depth from that starting point are represented.) In traditional J-graphs, individual points represent distinct spaces, and they are connected based on their spatial relationships. However, given the simplicity of spatial structure in the traditional dwellings of the Inner Mongolia section of the Yellow River Basin. The characteristic of multiple functional spaces within a single room, a transformation is applied in the drawing process. In this modified approach, one point represents a category of functional spaces, and lines are used to connect these spaces based on their usage relationships. In the second step, calculations are performed based on the drawn connections to interpret the spatial organizational characteristics using various parameters (Fig. 2).

3.3 Parameters

The research uses the Integration (i) parameter in space syntax to analyze the organizational characteristics of the floor plan and various functional spaces. Integration is a normalized distance from any space of origin to all others in a formula. It calculates how close the origin space is to all other spaces[14]. For spaces, a higher i value indicates greater accessibility, reflecting a space's ability to attract traffic. For a plan, a higher i value indicates a higher level of compactness in the plan's arrangement.

$$Integration(i) = \frac{1}{RRA} = \frac{DK}{RA} = \frac{DK(K-2)}{2(MD-2)} \qquad Eq.(1)$$

K: Number of spaces in the system

Mean Depth (MD): The average depth reaching all other spaces from each space within the plan when taken as the root.

DK: The Relative Asymmetry of space from a Diamond–Shaped graph.

4. Residential Renovation Practice

4.1 Spatial Types and Function

4.1.1 Courtyard Space

The relationship between functional spaces and housing is mostly categorized as A-type and A+B type in the courtyards of renewal dwellings. B-type is rarely used independently. During the renovation process, functional areas within the courtyards tend to be placed opposite the housing, and in cases of space constraints, they are supplemented by side placement. Among the self-built cases, the courtyard forms are mainly A-type with a combination of A and B types, and the usage ratio is balanced. The only C-type courtyard in the sample is the BN3 case, which was constructed by others. Like traditional earth-dwelling courtyards, S (Storage), B (Barn), and V (Vegetable Garden) remain the most used functional spaces in the courtyards. In the cases others construct, traditional usage habits configure functional spaces. Among these, S is considered an essential space, with B only absent in the BN5 case. In four out of seven cases, V is set up, with only one self-built case (BN5) where residents should have emphasized including V space in the renovation. Only the BN6 case is equipped with G (Garage), which differs from traditional courtyard spaces where dedicated G spaces are rarely found in the surveyed samples. Three self-built cases have included TO (Toilet) in the courtyards, with one with K (Kitchen) and solar facilities (Table 4). In courtyard renovations, self-built samples, compared to those constructed by others, exhibit similarities in the choice of functional area locations. Still, they tend to be more arbitrary regarding spatial content provisions.

Table 4 Courtyard information

Code	Courtyard type	Functional space						
		S	B	V	G	TO	K	Solar
LN1	A	●	●	○	○	●	●	○
BN1	A+B	●	●	○	○	●	○	○
BN2*	A	●	●	●	○	○	○	○
BN3*	C	●	●	●	○	○	○	○
BN4*	A+B	●	●	●	○	○	○	○
BN5	A+B	●	○	●	○	○	○	●
BN6	A	●	●	○	●	●	○	○

* Construct by others ●with ○without

S: Storage B: Barn V: Vegetable G: Garage TO: Toilet K: Kitchen

4.1.2 Residential Space

In the renovation of dwellings, both self-built and those constructed by others tend to exhibit a consistent preference for the choice of living space form, with all sampled cases using the β or β+γ composite form. This tendency indicates a consensus between residents and professionals in isolating the stove from the kang space to reduce mutual interference. Previous research identified 14 categories of functional spaces in traditional earth dwellings. In the renovation cases, three types of spaces, LA (Laundry), SA (Sacrifice), and MU (Makeup), are not used, while two new types of spaces, SH (Shower) and Si (Sink), have emerged. S is considered an essential indoor function from utilizing functional spaces in the samples. KA, a traditional sleeping space, continues to be widely used after renovation. The stove tends to have cooking and heating functions, represented by the K(c,h) space, with the addition of H (Heating) as a supplementary heating system. The combination of BR (Bedroom)+LR (Living room) as part of the β+γ form is commonly used, and BR, DR (Dining room), and LR are present as independent spaces but do not constitute basic functional spaces when used in isolation (Table 5).

4.1.3 Infrastructure Impact on Living Space

The configuration of water supply, sewerage, and solar energy facilities in the updated dwellings has provided convenience for indoor water use. Functional spaces affected by infrastructure provisions include T, W (Washstand), SH (Shower), and Si (Sink). The usage data in Table 5 shows that cases with well-equipped infrastructure, particularly those constructed by others, all have indoor provisions for TO and SH. W and Si are divided into separate spaces depending on the usage context. Although infrastructure is provided in the self-built case BN6, the residents did not adjust living space content based on these provisions, and this still needs to be done.

4.2 Residential Space Organization

4.2.1 Plan Organization

Based on the usage relationships between spaces, a J-graph was constructed (Table A1), and the i values for each sample were calculated according to Equation (1). Previous research has confirmed that the plans' basic functional space type directly affects spatial organization[13)]. Therefore, the samples were divided based on the plan. In the updated samples, the overall clustering of β and β+γ plans is consistent with traditional plans, with β and β+γ plans showing similar clustering. When considering the spaces that constitute basic functional spaces, the clustering of β plans is higher than that of β+γ plans. Compared to traditional plans, both updated plans show increased i values, indicating a more compact layout in the updated samples. Using self-built and other-constructed samples in the updates did not exhibit significant differences in plan organization (Table 6).

4.2.2 Functional Space Organization

Comparing the i values of functional spaces in traditional earth dwellings with the seven sample cases allows us to observe changes in i values before and after renovation (Table 6). The functional space's mean i is the average integration value of spaces that have functional and eliminate the living space itself (counting without the yard and room point in the J-graph of Table A1). It describes the average relationship between individual spaces. The space with a mean i higher than the functional space's value represents a close connection to other spaces in the plan organization. The In traditional β plans, spaces like W, H, K (c,h), and KA are considered high-clustering spaces, with i values higher than the mean i value for functional spaces. Among them, H has the highest i value. After renovation, the β plans show high clustering for spaces like H, K (c,h), DR, and LR, with K (c,h) and LR having the highest i values. However, individual cases reveal

Table 5 Residential Plan Information

Code	Basic functional type	Functional space															
		H	K (c,h)	K	KA	BR	DR	LR	S	TO	W	ST	LA	SA	MU	SH	Si
LN1	β+γ	○	●	○	●	●	●	●	●	○	○	●	○	○	○	○	○
BN1	β	●	●	○	●	●	○	○	●	○	●	○	○	○	○	○	○
BN2*	β+γ	●	○	●	●	●	●	●	●	●	●	○	○	○	○	●	●
BN3*	β	●	●	○	●	○	○	○	●	●	●	○	○	○	○	●	●
BN4*	β	●	●	○	●	○	●	●	●	●	●	○	○	○	○	●	●
BN5	β+γ	○	●	○	●	●	○	●	●	●	●	○	○	○	○	●	●
BN6	β	●	●	○	●	○	●	●	●	○	●	○	○	○	○	○	○

* Construct by others ▒ New functional space ●with ○without H: Heating K(c,h): Kitchen(cooking, heating) K: Kitchen KA: Kang BR: Bedroom DR: Dining Room LR: Living Room S: Storage TO: Toilet W: Wash stand ST: Study Room LA: Laundry SA: Sacrifice MU: Makeup SH: Shower Si: Sink

that only BN6 exhibits a lower i value for H space. K (c,h) has consistently high i values across all plans, indicating that the stove remains a central space in plan organization during the renovation process. KA, W, and S appear as high-clustering spaces in only one case each, with significant differences between the samples. DR and LR have high i values in BN4 and BN6, consistent with the performance of updated β floor plans, suggesting a trend toward a dual-center spatial organization in the renovation cases. Like traditional floor plans, spaces like K, BR, and TO are far from the plan's organization center. In contrast to self-built samples, other-constructed cases include SH and Si spaces, with Si placed close to the center of the plan organization.

In the β+γ floor plans, traditional plans have high i values for spaces such as H, K (c,h), DR, TO, and W. After renovation, the overall performance in the sample cases shows high i values for spaces like KA, BR, DR, LR, S, and ST, which significantly differs from traditional plans. Among the three cases, the individual performance of functional spaces aligns with the overall pattern, except for LN1, where KA and DR are located far from the plan organization center. Spaces like H and K are only used in the other-constructed case BN2 and are far from the center of the plan organization. W space has a high i value only in BN2, while the performance of other spaces is consistent with the self-built sample BN5. Spaces like TO, SH, and Si are far from the center of plan organization in the updated samples. The organization of β+γ plans exhibits a multi-center characteristic. Still, the significant differences between traditional and updated floor plans suggest that the renovation did not consider traditional plan organizational features.

4.2.3 Infrastructure Impact on Space Organization

TO and W are movable in traditional earth dwellings due to the lack of drainage facilities. W is typically closely connected to other functions to facilitate use, resulting in a high i value. TO is often set up for people with mobility issues or disabilities, and its placement varies based on changing usage requirements. In updated dwellings with complete infrastructure provisions, except for BN6, they all feature independent bathroom spaces consisting of TO-W-SH, and the traditional W is divided into two spaces: W for washing and Si for kitchen use. After the update, we observed changes in the i values of TO, W, SH, and Si spaces. In the β plans, compared to traditional floor plans, the i value for TO is similar, indicating that its position in floor organization remains unchanged before and after the update. The i value for W

Table 6 Residential space integration value

	Mean i														
	Functional Space	Basic functional space	H	K (c,h)	K	KA	BR	DR	LR	S	TO	W	ST	SH	Si
Type β															
Traditional plan[10)]	0.89	0.98	1.04	0.98	0.85	0.94	0.76	0.87	0.85	0.83	0.78	1.01	-	-	-
BN1	1.03	1.11	1.21	1.21	-	1.02	0.95	-	-	0.95	-	0.95	-	-	-
BN3*	0.92	1.10	0.98	1.07	-	1.12	-	-	-	0.85	0.78	0.78	-	0.78	0.98
BN4*	0.96	1.04	0.96	1.07	-	1.01	-	1.22	1.22	0.77	0.88	0.88	-	0.88	0.96
BN6	0.96	0.91	0.88	1.16	-	0.86	-	0.99	1.04	0.99	-	0.99	-	-	-
Total	0.97	1.04	1.01	1.13	-	1.00	0.95	1.11	1.13	0.89	0.83	0.92	-	0.83	0.97
Type β+γ															
Traditional plan[10)]	0.86	0.86	0.98	0.95	0.73	0.8	0.8	0.89	0.78	0.85	0.91	0.95	-	-	-
BN2*	0.93	1.05	0.89	-	0.84	1.13	1.01	1.05	1.01	0.95	0.73	1.01	-	0.73	0.84
BN5	0.83	0.91	-	0.74	-	0.94	0.98	-	0.98	0.84	0.76	0.76	-	0.76	0.69
LN1	1.04	1.02	-	0.87	-	0.87	1.10	1.02	1.10	1.10	-	-	1.02	-	-
Total	0.93	0.99	0.89	0.81	0.84	0.98	1.03	1.04	1.03	0.96	0.75	0.89	1.02	0.75	0.77

* Construct by others ▒ The space mean i higher than functional space H: Heating K(c,h): Kitchen(cooking, heating) K: Kitchen KA: Kang BR: Bedroom DR: Dining Room LR: Living Room S: Storage TO: Toilet W: Wash stand ST: Study Room SH: Shower Si: Sink

decreases after the update, while the Si space split from W has a high i-value and is closely connected to other spaces. After the update, the newly added SH spaces are all used with TO, and their positions in the plan organization are the same. In the β+γ plans, traditional plans place TO and W near the center of floor organization. After the update, only the W space in BN2 has increased connectivity and a high i value due to its independent setup. In contrast, TO, SH, and Si spaces are far from the plan organization center.

5. Conclusion

The need to update traditional vernacular dwellings to adapt to contemporary living is inevitable. The discussion about how to update them and the impact these updates will have on local residential culture has always been a topic of interest. This study analyzes the spatial form and organizational characteristics of seven updated dwelling cases collected from the Inner Mongolia section of the Yellow River Basin. It examines the impact of different participants and changes in infrastructure during the updating process on spatial construction. Furthermore, it compares these updates with the characteristics of traditional earth and straw dwellings to observe how the updated dwellings have evolved in terms of their spatial features.

The sample identifies two construction modes: "self-build" and "others-constructed," based on whether the government or developers coordinate professional design and construction. Regarding courtyard layout, other constructed samples cover three traditional spatial arrangement methods, while in choosing functional space content, they follow traditional courtyard usage practices closely. Conversely, "self-build" samples have more variation in space content, reflecting individual choices based on living habits and personal needs. Both construction modes show consistency in residential space form selection. There is no significant difference in floor organization between the two construction modes, and they don't exhibit notable differences compared to traditional floor plans.

Out of the seven samples, five are equipped with complete infrastructure. Apart from BN6, the living space in other plans is influenced by infrastructure, leading to changes in functional space usage. TO and W are combined in rooms to create a new functional space, SH. The traditional W is split into Si space, serving as separate environments for bathing and kitchen use. Regarding spatial organization, only Si in the β plans and the independently used W space in the β+γ plans exhibit high connectivity with other spaces. The other spaces are located far from the center of the plan organization.

Renewal dwellings have fewer V and G spaces within the courtyard than traditional earth dwellings. The reduction in V spaces may be related to changes in how contemporary life resources are acquired. The presence of G spaces in traditional dwelling courtyards is typically determined based on needs as residents live in the space. From the updated cases, it is evident that G spaces are not considered essential within the courtyard. In the living floor plans, the traditional Kang-Stove model is still used. The update plans are more compact than the traditional plans, indicating shorter depth in the usage relationships between functional spaces, making functional use more convenient. There are noticeable changes in the organization of functional spaces before and after the update. In β floor plans, the floor plans exhibit a dual-center organizational trend around H-K(c,h)-KA and DR-LR. The plans in β+γ plans, both before and after the update, present a multi-center organizational feature, but the functional spaces serving as centers are almost entirely different. The evidence suggests that during updates, dwellings consider adopting suitable functional spaces but seldom refer to traditional styles when establishing usage relationships between spaces.

The research uses seven cases to analyze the impact of differences in the identity of builders and infrastructure under contemporary construction conditions on dwellings' space. It demonstrates the spatial form and organization differences between updated dwellings and traditional residential characteristics. The study aims to analyze reality cases to reflect residence renewal programs. It seeks to offer guidance for achieving a balance between modern technology and the preservation of traditional living culture in future dwelling updates.

However, due to the transitional phase of rural areas in the Yellow River Basin of Inner Mongolia, occupational changes and population mobility pose challenges in observing the actual usage of vernacular dwellings after updates. The limited and uneven distribution of research samples introduces limitations of the results. With the completion of more residential renewal projects, additional samples can be collected to further elucidate regional residential renewal performance.

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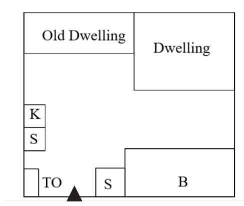
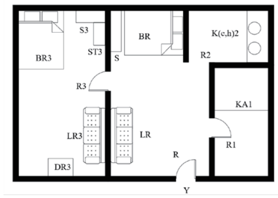
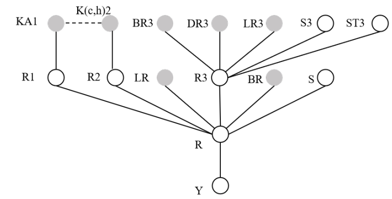
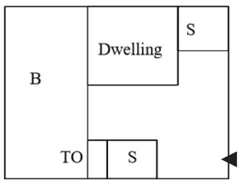
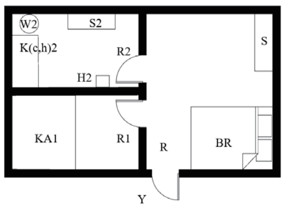
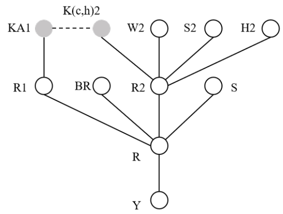
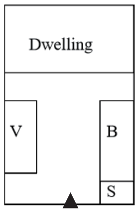
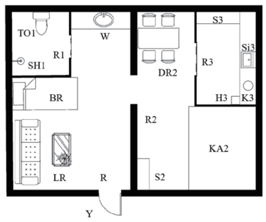
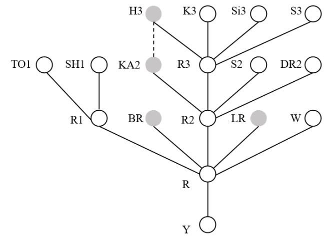
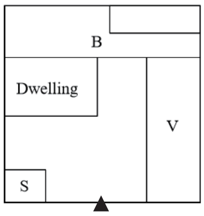
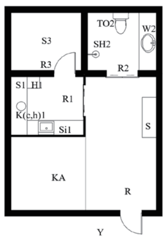
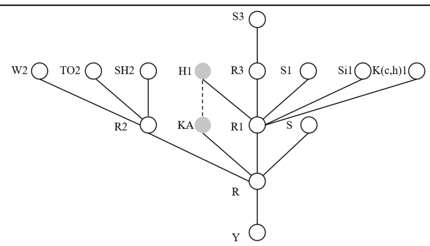
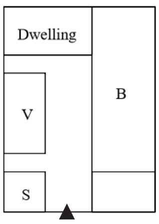
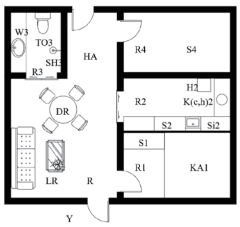
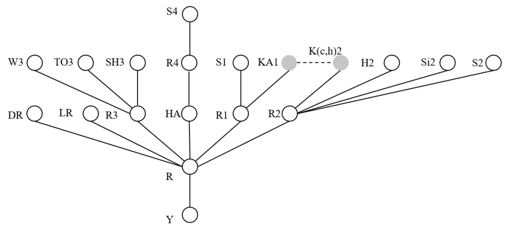
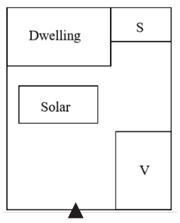
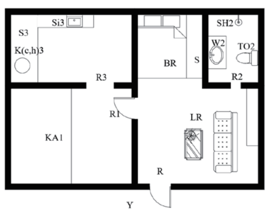
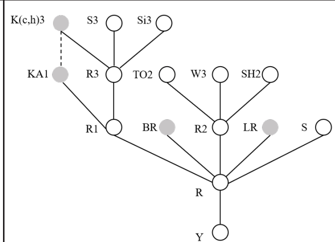
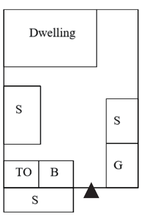
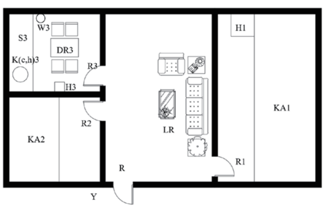
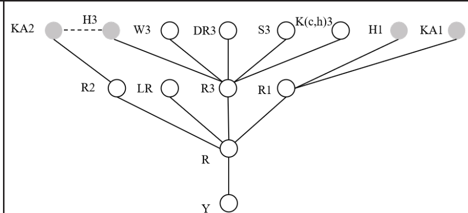
（受理：令和 5 年 10 月23 日）

Appendix A

Table A1 Cases' Plan

Code	Plan		J-graph
	Yard	Dwelling	
LN1			
BN1			
BN2			
BN3			
BN4			
BN5			
BN6			

● Basic functional space R: Room Y: Yard H: Heating K(c,h): Kitchen(cooking, heating) K: Kitchen KA: Kang BR: Bedroom DR: Dining Room LR: Living Room S: Storage TO: Toilet W: Wash stand ST: Study Room SH: Shower Si: Sink