1. Introduction

Korea’s modern housing has undergone a drastic change in its housing style due to the modern influence; economic development, social systems, lifestyle changes, etc., since the Gabo Reform of 1894. In response to the rapid transformation of housing from the separation theory of Eating and Sleeping Rooms to the Public and private room theory, many studies have been conducted on the characteristics of modern housing over the past few decades. Although it discussed various perspectives’ conceptual features, there seems to be no established theory to explain the scientific approach.

Thus, this research started from the two questions as follows: (a) How is an old spatial organization mapped onto a new setting that is formally and functionally different? (b) The question of whether Korean modern housing’s typical spaces have inherited topological characteristics from traditional houses (Hanok). Moreover, to explain these questions in a scientific approach.

This research is the first step to consider the spatial composition of modern urban housing in Korea throughout the twentieth century (Figure 1). To grasps the change of modern urban housing in Korea, a comparative analysis of urban Hanok built in the Joseon Dynasty’s early modern period and traditional houses is conducted. These houses have characteristics of traditional dwellings but also comply with standards of social modernization. Hence, they are critical targets for bridging traditional and modern houses in Korea (Koo and Park 2009). This research is based on the premise that the Urban Hanok displays certain structural features of space. The purpose of this research follows: (a) To examine how the old spatial composition is mapped to new settings through a comparative analysis of Urban Hanok and traditional Hanok. (b) Extracting the spatial configuration pattern of traditional Hanok and urban Hanok proves that Urban Hanok inherits traditional houses’ spatial composition.

2. Literature review

2.1. Spatial configuration of domestic space

Space syntax, the analytical tool used in this study, is a set of techniques for representing and quantifying spatial patterns of buildings. It has been used to treat spatial configuration as a variable in a variety of studies of the social functions, cultural significance, and behavioral implications of layouts in contemporary and historical contexts. (Hillier, 1996). The advantage of representing topological relations of spatial features is that it allows a clear understanding of spatial structure by simplifying the connections between spaces. There can be differences in the degree of integration or segregation among domestic spaces with seemingly
2.2. Traditional housing plan in Korea

A Korean vernacular dwelling and its layout developed under the historical and social conditions of Korea. During the Joseon dynasty (1392–1910) of Korea, the basic design and layout of a traditional Korean residence were influenced by the social hierarchy and the cultural environment. When Yangjindang was being built in the seventeenth century, social status played a more critical role in determining the typical living quarter’s composition. The Confucian principles underlying the hierarchical social system had a tremendous influence on a traditional Korean residence’s basic design and layout. Accordingly, the separation of men from women, separation of superior from inferior classes, and the need for an ancestral shrine became fundamental elements in the composition and layout of residences (Inaji and Virgilio 1998). Yangjindang comprises four distinctive areas: those reserved for the men of the house, areas for women, servants’ areas, and service areas.

The spatial composition of Yangjindang was prioritized according to social mores, as follows: (a) male’s areas: Sarangbang (owner’s room), Sarangchae (male’s quarter), Sarangmadang (courtyard of the male’s quarter), Middle Room, Sarangdaecheong (Owner’s reception space), Sadang (Ritual ceremony space); (b) female’s areas: Anbang (matron’s room), Anchae (female’s quarter), Anmadang (courtyard of Anchae), Gonneobang (female’s room); (c) servants’ areas: Haenglangbang (servants’ room), Haenglang-chae (servants’ quarter); (d) service areas: Buok (kitchen), Gwang (Storage), Goggan (Storage), Bangas-gan, etc.

To intuitively observe the spatial composition of Yangjindang and simplify the functional area, Amorim’s (1997) sector analysis method is applied in the conversion to a Justified graph (j-graph). Korean traditional housing space is divided according to

![Figure 1. Overall research design.](image-url)
2.3. **Urban Hanok**

In the mid-1930s, under Japanese colonial rule, Seoul underwent a dramatic change. The Joseon Urban Planning Act, considered the beginning of modern urban planning laws in Korea, was enacted in 1934. As part of the land reorganization process, new residential areas were developed, including the Donam District outside the Old Town. A large number of Hanoks, traditional Korean houses with a wooden structure, were built in reallocated residential areas during this period. This newly emergent Hanok was referred to as the Urban Hanok to recognize its status as a new housing type (Jun and Yoon 2012). It was supplied by private housing developers comprising traditional artisans, and its form was based on traditional housing. The counterpart is the extroverted plan, which was called a “reformed house” at the time. The square shape of modern plots effectively embraced the introverted plan with a central courtyard and post and lintel structure, which unfolds a modular system of space grids (Song and Jung 2014). Therefore, the courtyard layout corresponds to the crowded modern urban structure, yet is simultaneously compliant with the cultural characteristics by reflecting the local Gyeonggi-Provence houses’ tradition (Cho, 1991).

It is considering (Figure 4), that Urban Hanok takes a simplified format of the traditional layout to fit into a small and tight urban plot that typically borders one street and three other neighbors. While the layout could vary from one site to another, it typically contains a unique structure that encloses the main function room. The main space, Anbang, Maru, a Buok, and Madang, can epitomize the spatial characteristic and the topology of spaces. Those two living spaces on top were named after their user (Anbang, a wife’s room) and construction material (Maru, a raised wooden-floor), unlike their modern counterparts, main bedroom, and living room, and this may be due to the fact that these rooms could not be associated with particular functions. This Spatial configuration
described above governed the housing culture for centuries with authority but, when the new housing type was introduced from the mid-twentieth century, changes began to be made. Those traditional space–activity relations started interactions to make different combinations in new domestic settings.

2.4. Differentiation of research

Research related to Hanok and Urban Hanok began to increase in 1990 and exploded in the 2000s (461 cases in 2020). It is because various legislation and promotion policies for Hanok are being established in Korea. Most of these papers are devoted to studying unit buildings such as the development of Hanok and the New-Style Hanok, which have no temporal or regional scope. In particular, the study on the target area designated in this study is Song (1988), Jung and Song (2014). Existing research tried to establish the value of Urban Hanok in the modern city by classifying the general types of urban Hanok and tracking the reconstruction process, and surveying residents’ behavior. Existing research lacks an objective basis for the correlation between spatial and behavioral factors, and the scope of research is limited to Urban Hanok. Besides, most of these studies are based on morphological and functional classification methods and rely on a narrative approach.

The spatial structure is based on the connection relationship between spaces. These connections are the basis for building a physical environment. It is because understanding the structural properties of space includes the essential features of the physical environment. Changes in the residential environment are closely related to social phenomena; understanding the spatial structure of housing interprets social aspects through consideration of the physical environment. The space syntax analysis

Figure 3. Justified graph and sectors’ graphs.

Figure 4. Hanok type in 11 Gahoe-dong (reproduction from: Song 1988).
used in this study can grasp spatial structures’ properties by reproducing space in a mathematical and quantitative form based on graph theory. Therefore, spatial characteristics can be defined and compared through objective indicators and quantitative data.

Thus, this study’s originality has three points as follows: (a) Interpreting the relationship between Hanok in the Joseon Dynasty and Urban Hanok through quantitative indicators. (b) Using the standard degree of integration, differences in spatial scale can be corrected and compared. (c) Through the correlation analysis between the difference factor and the integration value, factors affecting the entire house’s spatial structure are extracted.

In this study, we would like to explore spatial inheritance of the Urban Hanok and traditional Hanok in quantitative perspective by space syntax as an analytical tool. Space analysis aims to identify the relations between society and space. Space analysis results let us identify the characteristics of the targeted space and subsequent human activities based on social relationships.

3. Material and method

3.1. Data collection

The data for analysis were collected from 8 Joseon dynasty (16 – 19 c) Hanok plans, which are included in survey data published by the Korea Cultural Heritage Administration, and 33 Hanok plans, which are included in the Gahoe-dong Hanok Conservation District Survey Report (Seoul City et al. 1985). Of the 33 cases with the address 11 Gahoe-dong, 29 cases were extracted considering the building area and reconstruction degree. The excluded cases are 26–5, 2, 22, 94, 100. In the remainder of the text, for the sake of convenience, only the lot number will be indicated. For the analysis, a plan was drawn based on the layout of Gahoe-dong Hanok, which is described in the report. Additionally, in order to estimate the original shape that was constructed in the 1930s, the plan was drawn with the column structure of the original house taken into account.

3.2. Analysis method

Spatial structure analyses of unit plans were carried out in three phases: first, the setting of the unit space and representation of spatial structure; second, selecting analysis indexes and tools; and third, statistical analysis for the space analysis results. The methodologies developed for each phase are as follows.

First, the spatial structure within a unit plan is represented as a series of convex spaces. This is done by creating a convex map. One convex space corresponds to one-unit space. The representation scope for a unit plan’s spatial structure includes all the inner and outer space defined by walls and columns within the space (Table 1).

Second, the integration value was selected as the analysis index for examining spatial structure properties. The most integrated and segregated spaces within a unit plan can be located using each unit space’s integration value. The overall spatial layout pattern will be mapped, and its characteristics will be examined. The degree of variance in integration values is considered an indication of how strong or weak social relations are related to spatial ordering, i.e. how much space is interchangeable with others. The difference factor is used to quantify this dissimilarity as a proportion of the sum of spaces’ integration values under consideration. In most spatial complexes, different functions and activities will be assigned to spaces, integrating the complexes to different degrees (numerical values). If these spaces’ integration values are in a consistent order across a sample, then it can be said that a cultural pattern is expressing itself spatially. This particular type of consistency in spatial patterning is called “inequality genotypes.” Whereas low values for the Difference Factor of Space ($H^*$) would indicate a “strong” genotype, values close to 1 would indicate a “weak” genotype, i.e. no functional differentiation and weakness in the functional efficiency of space (Figure 7). $H$ is the “non-relativized difference factor” for three spaces, $a$, $b$, and $c$, and $t$ is their sum. “Depthmap $X$” was used for space analysis. Using this tool, convex maps created in AutoCAD were imported, and after running the analysis, integration data for each unit space were exported into an Excel spreadsheet.

$$H = -\sum \left[ \frac{a}{t} \ln \left( \frac{a}{t} \right) + \frac{b}{t} \ln \left( \frac{b}{t} \right) + \frac{c}{t} \ln \left( \frac{c}{t} \right) \right]$$

$$H^* = \frac{H - \ln 2}{\ln 3 - \ln 2}$$

Table 1. Convex space division method.

| Principle of division |
|-----------------------|
| Inner space          |
| 1. fattest, fewest convex spaces. |
| 2. In the case of a continuous Toenmaru(veranda) in front of the Pang(room) and the Daechong(main hall), the Convex space is divided based on the column between the Daechong and the Toenmaru. |
| 3. In the case of a narrow and long floor, distinguish according to the wall. |
| 4. A Toenmaru with a width of less than 60 cm is considered to be not the purpose of the move and is excluded from the analysis. |
| Outer space          |
| 1. fattest, fewest convex spaces |
| 2. Exclude convex spaces with a minimum width of 1 m or less. However, it is included in the case of the passage connecting the inner space and the outer space. |
| 3. Like the corridor, the outer passage covered by the roof distinguishes it from other outer spaces around. |
The order of the integration values was observed in order to distinguish similar types and compare the results of the Difference Factor to identify genotypes. The biggest issue in analyzing traditional Hanok and Urban Hanok is the difficulty of comparing the integration value according to the difference in housing scale. The method of calculating the integration value includes a correction procedure to minimize the number of nodes’ influence. However, the improved calculation method cannot wholly escape the influence of the number of nodes (Kim 2011).

In this study, minimize the effect of the number of nodes with the difference in scale and use the

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**Figure 5.** Map of 11 Gahoe-dong district.

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**Figure 6.** Research structure.
standardized integration value that does not impair the comparative analysis's reliability by the scale difference.

This method is expected to compare and analyze residential spaces of different scales, using a standard normal distribution, which Z value calculation method (Figure 8).

$$Z = \frac{X - \mu}{\sigma}$$

(m: integration mean, o: standard deviation of integration).

Lastly, a j-graph was compiled to define the spatial structural genotype of the Urban Hanoks. The j-graph is used as the basis for further structural and syntactic analysis. The primary form of space syntax analysis proceeds from a technique of mapping buildings onto a spatial structure using the external entry points as a base.

It is the permeability structure where every convex space in the system is identified according to its relation to every other space or the relational logic of parts to the whole. The j-graph is more than a simple illustrative tool for clarifying space configuration in buildings. As space syntax was concerned, “the configurational variables” depth and rings turn out to be fundamental properties of architectural space configuration.

### 4. Result analysis

#### 4.1. Syntactic analysis of traditional Hanok

The study is limited to high-class housing in the Andong culture range during the Joseon Dynasty. This area was relatively well preserved in original form, and it is designated as a cultural property so that it can be analyzed based on related data. Case selection criteria are as follows: 1. Confirmable construction year, 2. Maintain original form, 3. Maintain the original construction site. The spatial composition of traditional Korean houses changed little by little with the times. In the late Joseon Dynasty, the range of overall standardized housing integration value gradually decreased and settled down between 2.3 and 1.5. In particular, changes in the average and standard deviation of housing integration in the late Joseon Dynasty (18 c-2 and 19 c-1) could not be confirmed. However, the BDF value was increased, which indicates heterogeneity of spatial configuration. In other words, it can be judged that the topological difference was reduced between spatial configurations. By observing the change in the value of DF*, the courtyard of each sector (Sarangmadang, Anmadang, Haenglangmadang) is judged to be the heterogeneity-inducing factor of traditional Korean houses (Table 3). Each sector's courtyard in traditional Korean houses is the most integrated space, with the properties being shallow and linking the different

### Table 2. Integration of main space and basic syntactic data – traditional Hanok.

| No | CS | Rank order | Mean | SDV | BDF | BDF* |
|----|----|------------|------|-----|-----|------|
| 16 c-1 | 41 | AMD > HMD > SMD > DMG > SDC > CB > BO > S > HB > SR > AD < BO > AB | 0.87 | 0.20 | 0.78 | 0.81 |
| 16 c-2 | 64 | HMD > SMD > AMD > DMG > GB | 0.94 | 0.22 | 0.74 | 0.86 |
| 17 c-1 | 68 | HMD > SMD > ADM > DMG > SDC > HB > BO | 0.96 | 0.21 | 0.73 | 0.86 |
| 17 c-2 | 67 | SMD > AMD > HMD > DMG > SDC > AD < BO > SB | 0.84 | 0.21 | 0.77 | 0.81 |
| 17 c-3 | 56 | AMD > DMG > SMD > BO > HMD > SB | 0.95 | 0.19 | 0.76 | 0.88 |
| 18 c-1 | 53 | AMD > SMD > DMG > HB > S > AD < CB > SDC > GB > O = BO > SB > AD | 0.89 | 0.21 | 0.75 | 0.81 |
| 18 c-2 | 56 | AMD > SMD > DMG > SDC > HB > S > AD < CB > SDC > GB > O = BO > SB > AD | 0.86 | 0.21 | 0.83 | 0.85 |
| 19 c-1 | 40 | AMD > HMD > DMG > SMD > BO > HB > S > SB | 0.98 | 0.21 | 0.88 | 0.91 |

CS = Number of convex space; BDF = Base difference factor; SDV: Standard Deviation Value; Area(m^2); BDF* = Difference factor without Madang. AMD: Anmadang, DMG: Deamungan, ADC: Andancheong, AB: Anbang, GB: Geonneobang, BO: Buwok, S: Storage, SMD: Sarangmadang, SDC: Sarangdaecherong, SB: Sarangbang, CB: Chanbang, O: exterior, HMD: Haenglangmadang, HB: Haenglangbang, SD: Sadang.
functional spaces. The main bedroom (Anbang, Sarangbang) and Ritual space (Sadang) are relatively segregated. The rank order pattern of the integration value to traditional Korean houses is as follows: the courtyard of each sector (Sarangmadang, Anmadang, Haenglangmadang) – interior living room (Andaecheong, Sarangdaecheong) – service space (kitchen, storage, servant’s space) – main bedroom (Anbang, Sarangbang) – ritual space (Sadang). Based on this pattern, the social-behavioral

Based on this pattern, the social-behavioral hierarchy of each unit space can be estimated. Based on this pattern, the social-behavioral hierarchy of each unit space can be estimated (Table 2).

The Madang of each sector is expected to have a high frequency of use by occupants, and the interaction among residents is expected to be the most active. Considering the interior space, Daecheong is expected to have a high frequency of use. On the other hand, the main bedroom has the property of being separated from the Centrality. The ritual space is considered to have a high degree of separation, making it difficult for residents to access. Each sector is divided into gender and status. Each area is strictly separated according to the separation code, and the Joseon Dynasty’s social rules based on Confucianism are represented by spatial configuration. All Sadang are most isolated from other spaces.

Due to Confucianism’s influence, ritual space (Sadang) is an essential space in Head House during the Joseon Dynasty. The Sadang is separated from other main spaces in the housing. The result is the formation of a consciously symbolic realm to separate the conscious space from everyday life. (Lee and Choi 2002)

What is interesting about the change graph. The relationship between the Sarangmadang and the Anmadang integration changes over time. Since the mid-Joseon Dynasty, the integration value of Anmadang has increased, and conversely, the integration value of Sarangmadang has decreased. These results suggest that the house’s centrality in the Sarangchae has deepened in the mid-Joseon Dynasty when Confucianism intensifies. However, in the late Joseon Dynasty, the space of Anchae can be interpreted as changing to the centrality. It reflects that much of the ritual life in the home was done in the Anchae. This change is also reflected in the main bedroom’s integration value (Anbang, Sarangbang) and Daecheong. The Anbang had a lower integration value than the Sarangbang, but the gap was diminished entering the late Joseon Dynasty. As a result, entering the late Joseon Dynasty, the centrality of the spatial configuration was changed to the Anmadang, and it can be interpreted that Daecheong and the main bedroom, which are the inner space centers, were settled in the same phase (Figure 9).

### 4.2. Syntactic analysis of Urban Hanok

For the syntactic interpretations of the sample, 26 cases of Madang-centered houses, 2 cases of mediated space-centered houses (between Deamunang and Madang), and just one case of a Sarangmadang-centered house was analyzed. As far as the mutually common genotype is concerned, the Madang is the most integrated space with the properties being shallow and linking the different functional spaces. The toilets and storage (in the Anbang), the exterior, and, to a lesser extent, the Munganbang, are relatively segregated.

| Table 3. Traditional Hanok.                                                                 |
|------------------------------------------------------------------------------------------------|
| Name and location                                                                                   |
| 16 c                                                                                                     |
| 1. 1522 Yeanyissi Head House, Andong                                                                 |
| 2. 1566 Ssangbyeokdang Head House, Bonghwa                                                             |
| 17 c                                                                                                      |
| 1. 1600 Chunjhyodang Head House, Andong                                                               |
| 2. 1600 Yangjindang Head House, Andong                                                                 |
| 3. 1613 Gyesoedang Head House, Bonghwa                                                                 |
| 18 c                                                                                                      |
| 1. 1700 Gwangsanigmsi Yuljaje Historic House, Andong                                                  |
| 2. 1792 Sugok Historic House, Andong                                                                  |
| 19 c                                                                                                      |
| 1. 1836 Hadong Historic House, Andong                                                                 |

Figure 8. Formula of standardized integration value ($Z$).
Table 4. Integration of main space and basic syntactic data – Urban Hanok.

| No | CS | Rank order of (MD > DC > DM) | Mean Area | BDF | BDF* |
|----|----|-------------------------------|-----------|-----|-----|
| 16 | MD > DC > DM > B9 = BO > CB = MGB > GB = AB > B5 > O | 1.24 | 85.9 | 0.61 | 0.78 |
| 28 | MD > DMR > DC > MS1 > DM = GB > B9 = CB = BO = T | 1.49 | 92.5 | 0.58 | 0.69 |
| 44 | MD > DC > DM > GB = MRB = MB = BO > S2 > O = S1 = AB > B9 > S(AB) | 1.17 | 112.5 | 0.58 | 0.82 |
| 45 | MD > DC > DM > GB > T = BO > AB > O > MGB > S(AB) | 1.02 | 54.5 | 0.64 | 0.80 |
| 46 | MD > DC > DM > GB > T = BS = B = BO = CB = MS > AB > O > MGB > S (AB) | 1.40 | 72.3 | 0.47 | 0.78 |
| 47 | MD > DC > DM > MGB > CB > MS = AB > GB > O > S1 > S2 > S (AB) | 1.09 | 89.9 | 0.63 | 0.81 |
| 75 | MD > DC > MS1 > GB > DM > T = B7 = BO > CB > AB > MGB > O > S(AB) | 1.27 | 49.5 | 0.53 | 0.81 |
| 105 | MD > DC > DM > GB > BO > B4 > AB > O > MGB > S (AB) | 1.02 | 53.8 | 0.64 | 0.81 |
| 122 | MD > DC > DM > GB > MS = BS = BO > CB > O > MGB > S (AB) | 1.12 | 99.1 | 0.59 | 0.80 |
| 123 | MD > DC > DM > GB > BO = B4 > AB > O = MGB > S(AB) | 1.02 | 39.6 | 0.64 | 0.81 |
| 131 | MD > DC > DM > GB > MS = BS = BO = AB > O = MGB > S(AB) | 1.18 | 56.1 | 0.57 | 0.82 |
| 103 | MS1 > MD > DM > MS3 > DC = S3 > GB = M2 = BO > CB > O > T = MGB = AB > SMD > S(AB) > SB 1.63/1.39/1.17/1.01/0.94/0.89/0.89/0.81/0.81/0.73/0.67/0.67/0.67/0.60/0.50/0.46 | 0.86 | 79.3 | 0.72 | 0.77 |
| 104 | MS > MD > DM > DC > GB > T2 = B6 = S = BO > O > MGB > AB > T1 > S (AB) | 0.91 | 38.6 | 0.71 | 0.77 |
| 118 | MD > MS > DM > DC > GB > DM > CB = BO > AB > O > MGB > S (AB) | 0.98 | 56.1 | 0.69 | 0.78 |
| 197 | MD > DC > DM > GB > T = BO = B = BO = S1 > AB > O > S3 > S2 > S (AB) | 1.17 | 65.7 | 0.68 | 0.86 |

CS = Number of convex space; BDF = base difference factor; BDF* = Difference factor with out Madang Value; Area(m²). MD: Madang, DM: Deamungan, DC: Daceoeng Maru, DMR: Toesmaru, MGB: Munganbang, AB: AnBang, GNB: Gounmounbang, BO: BuOuk, S: Storage, T: toilet, SMD: Sarangmadeng, SDC: Sarangdaceoeng, SB: Sarangbang, MS: mediated space, CB: Chanbang, O: exterior, ST: stairs.
The first genotype has an integration rank order as follows: Madang – Daecheongmaru – Deamungan. Daecheongmaru is the center of the inner living space that connects the Kounnoubang with the Anbang. It is mainly a space for guest reception and housework and serves as a bedroom in the summer. The Deamungan separates the outer space from the inner space. It is connected to storage or a Munganbang and forms a separate area distinguishing it from the main living area. This genotype has significant configuration differences between the rest of the living spaces in the Madang. It relates these spaces as a whole to the exterior of the house (decision-relativized base difference factor). The remaining rooms are located apart within the configuration, but their relations are not structured to anything to the same degree. They are segregated and multifunctional, accommodating a variety of domestic activities.

The second genotype has an integration rank order as follows: Madang – Deamungan – Daecheong-maru. This type is similar to the first type. The order of the Deamungan and the Daecheongmarca was different, and the number of spaces connected to the Deamungan increased. It can be concluded that there are no topological differences between Order 1 and 2.

The third genotype has an integration rank order, Madang: mediated space – Deamungan – Daecheong-maru. No clear commonality was found in the rank order, but the mediated space’s high-integrated values were confirmed. The mediated space is between the Madang and the Deamungan, and it is connected to the sub bedroom, storage, and the Chanbang (sub-function of the kitchen). As a result, it increases the house’s spatial depth and triggers the phenomenon of isolation of the Madang and Deamungan.

The fourth genotype has an integration rank order as follows: Madang – Daecheong. This type is omitted from the Deamungan, and the main gate leads directly into the Madang. Compared with the other types, the Madang concentration is high and has a high integration value average. The fourth genotype has an integration rank order as follows: Madang – Sarang Madang. This type differs from other types in that there is an area of Sarangchae (male’s quarter). The composition of the functional area is most similar to

![Figure 9. Change of standardized integration value.](image)

Table 5. Comparison with existing research.

| Type            | T-S | E-T | U-S | R-S      |
|-----------------|-----|-----|-----|----------|
| Basic 1         | -   | -   | -   | (17/91/92) |
| Reduction 1     | -   | -   | -   | (3/38/39/21) |
| Basic 2         | -   | -   | -   | (2)      |
| Reduction 2     | -   | -   | -   | (40/41)  |
| Urban           | (16/42/44/4546/47/96/105122/123/131) | (18/104/103/118) | (28/75) | (99) |
| Unclassified    | -   | -   | (99) | (101)    |
traditional housing. The directions to enter the two Madangs are set differently, and each constitutes an independent sector. It is connected to the inner courtyard through the Sarangdaecheong and has a homogeneous integration value compared with other types. Houses 17 and 99 are examples of this type (Table 4).

The syntactic interpretations reveal that these deep-core and circulation structure houses configure life patterns by constructing a social interface between guests and hosts, men and women. The Difference Factor clearly shows the difference between the genotypes. Rank orders 1 and 2 are concentrated on average around 6, and rank orders 4 and 5 are distributed on average around 7. Rank order one is distributed by an average of approximately five lower than other genotypes. This phenomenon is correlated with the Madang concentration, and the integration value

| Type               | Traditional | Ring-shape | Tree-shape |
|--------------------|-------------|------------|------------|
| Spatial structure  | ![Diagram](image) | ![Diagram](image) | ![Diagram](image) |
| Integration core   | AMD, SMD    | AMD, SMD   | MD         |
|                    | HMD         |            |            |

Table 6. Comparison of spatial structure.

![Figure 10. Typical case of Urban Hanok j-graph.](image)
when removing the Madang clearly shows this difference.

4.3. Justified graph of Urban Hanok

In the Joseon dynasty, the land was provided unevenly by social status. The ordinary people were able to own 257.85 m² of land, and Gahoe-dong is a high-class residential area, but the average is 82.32 m². As the area was reduced, the house’s physical area was reduced, and the functionality was also reduced compared with traditional houses. The sample j-graphs reveal the tree-shape and ring-shape of the Urban Hanoks. Different functions occupy separate branches. There is a strong emphasis on keeping the dwellings away from the exterior to be easily accessible. The traditional Korean house planning strategy is associated with a spatial configuration. No direct casual encounters between the residents and the visitors are seen as valuable opportunities for social exchange. It is an attempt to secure minimum independence between mutual domains in a reduced spatial structure. These features appear as topological linear subgraphs, and at a depth of three levels, the integration core is represented as a radial sub-graph connecting all the other spaces (Hanson 1998).

The extended tree-shape refers to a graph of “tree branches” in which a node grows in the form of “tree-shape” in the middle of a linear array. It can be seen as a more profound variation of the integrated nucleus. The space between the Madang and the Deamungan is added to increase the space's depth; it deepens the region’s differentiation rather than tree shape. The cause of this change the formation of parcels as the area’s independence becomes stronger as the Anchae is not facing the Deamungan. A ring-shape is a graph type in which there is at least one ring sub-graph on the phase diagram. Ring-shapes have a small annular partial graph with four or five nodes forming a loop. In other words, an annular partial graph is added based on the “tree-shape” (Figure 10). It can be judged that the annular connection structure composed of Haenglangmadang – Mungen – Sarangmadang – Mungan – Anmadang of the Joseon dynasty’s traditional houses is reduced and maintained. It was possible to classify the Urban Hanok according to the morphological view more finely. As a result, the syntactic viewpoint analysis could suggest the possibility of complementing the existing analysis method (Table 5).

4.4. Traditional attributes of Urban Hanok

Interesting point of the change in integration value, the whole depth of the Spatial configuration of Urban Hanok has been reduced, and the integration value of the Madang has been greatly increased. When a traditional Hanok was incorporated into the urban space, servants, and males (Haenglangmadang and Sarangmadang) have been compressed or omitted, and most of the spaces are connected to the Madang to enhance the centrality of the spatial. That reflects the social impact of the Confucianism collapse and the reduction of family composition in the late 19 c. It can be judged that the phenomenon what concentration of movement and behavior was expressed in spatial composition. Besides, the rank order pattern is clearly maintained in the Madang-Daecheong-Anbang. In particular, Anbang has maintained a low level of integration value.
(−0.5) in the spatial configuration after the late Joseon Dynasty. It is isolated from the center and is advantageous for securing privacy. Daeecheong has the characteristic of connecting the Madang and the personal space and can be estimated as supporting the behavior of the internal space (Figure 11).

Analyzing the correlation between the integration value and BDF value representing the heterogeneity of space makes this result clearer. There was a weak correlation (−0.26) with the mean of integration and a strong correlation (−0.91) with the integration of the Madang (Anmadang, Haenglangmadang, and Sarangmadang) of each house (Figure 12–13). In other words, the stronger the centrality of the Madang, the clearer the identity of the spatial composition. Korean traditional houses go through Madang, an exterior space, semi-exterior spaces such as Jungmun. After taking off the shoes, traditional Korean houses enter a private space through a semi-inner space such as Toesmaru or Daeecheong. The mechanism of residential life is directly related to the status of the space. The characteristics of the spatial structure reflecting living could be the main characteristics of traditional Korean houses (Lee and Choi 2002). A previous study (Hillier, Hanson, and Graham et al. 1987) revealed the genetic characteristics shared by farmhouses in Normandy France and has a spatial characteristic of overlapping complex activities such as hospitality, transportation, and family gatherings. Korea’s Madang has a complex function space (salle commune) such as moving, washing, preparing food, and everyday family gathering. Its form and spatial composition continued to the Urban Hanok in the 1930s. Urban dwellings in Korea in the early stages of modernization inherited traditional spatial characteristics. 5 Discussion

In this research, an objective identification of the implication of Urban Hanoks was attempted from a syntactic viewpoint, by searching the structural properties of space. Through a literature review, the research scope was set to the period from the 1930s, and the spatial structures of the cases were analyzed. The analysis results revealed high case rates of the Madang-centered spatial layout type. This supports the fact that spatial configurations found in Korean traditional housing were still present as a modified form in 1930s urban housing, as well as accepting the modernization period of household life. According to previous studies based on habitual behavior, in the early days of modernization, improved hanok has been inherited a main function of spaces (Anbang, Daeecheong) and behavior of residents since the Joseon Dynasty. (Yoon et al. 1992) Many researches have observed changes such as: living room: Daeecheong, kitchen, change of Anbang location. However, through this study, it became clear that the spatial Configuration of Korean houses is centered in the Madang from a topological point of view.
Traditional Hanok and Urban Hanok in the 1930s are included in a different timeline and social background, which is an influential factor concerning spatial structures. Specifically, particular multipurpose areas that are defined as central spaces differ according to the surrounding environment. Anmadang, Sarangmadang, and Haenglangmadang in Joseon Dynasty, Anmadang, Sarangmadang areas in Seoul 1930s (Ring-shape), and Madang in Urban Hanok (Tree-shape) are central spaces in the spatial structures. This study revealed how contrasting housing cultures could be reflected in this housing type to create a spatial structure with regional characteristics (Table 6).

Meanwhile, the layout modifications found in the tree-shape show the resilience of a traditional living culture. The research results especially suggest that it can be reinterpreted as the Madang genotype of a spatial structure inherited from generation to generation. This research utilized a quantitative methodology, namely, space syntax, to draw principles for Urban Hanok plans’ spatial layouts. This research is significant in that it clearly identified the analysis results from an objective perspective. However, it only addressed cases of structures built after the 1930s (29 cases), and only 8 cases in Joseon Dynasty (Andong culture range) were treated out of all existing housing types. Follow-up studies will thus be necessary for this study. The periods after the introduction of modern housing to present-day scenarios will be examined, and changes in spatial structure properties will be identified in detail.

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