SPATIAL CONFIGURATION OF TRADITIONAL HOUSES AND APARTMENT UNIT PLANS IN HO CHI MINH CITY, VIETNAM: A COMPARATIVE STUDY

Phi Phuong Pham[1] , School of architecture, Chonnam National University, Gwangju, South Korea
Ngoc Quynh Giao Pham , Faculty of Multimedia Communication, Tomas Bata University, Zlin, Czech Republic
Se Gyu Oh, School of architecture, Chonnam National University, Gwangju, South Korea

The study aims to investigate the effects of the spatial configuration of traditional Vietnamese houses on the design of apartment buildings in Ho Chi Minh (HCM) City, Vietnam. To achieve the objective, the following approaches were implemented. Firstly, the transformation of the socio-economic structure in HCM City, which is a primary factor affecting the development of apartment buildings was examined. Secondly, the well-known space syntax method for analyzing the spatial structure plan was outlined. Thirdly, a survey of traditional houses and apartment buildings from 1960 to 2010 was conducted. Among the various traditional house styles, the Hue traditional garden house, which has primary effects on the modern housing design in HCM City, was selected as a representative sample to compare with apartment units. Lastly, the space syntax method was employed to analyze the spatial structure of the sample of traditional houses and apartment units. The effects of the Hue traditional house's spatial configuration on apartment buildings were analyzed. The result shows that the spatial configuration of modern apartment buildings and traditional houses have similar characteristics, including having an adaptable natural environment, and they both reflect Vietnamese culture and society. The findings can be applied when predicting development trends for the unit plans of modern apartments in HCM City, Vietnam.

Key words: Spatial Configuration, apartment unit plan, traditional house's spatial configuration, space syntax.

INTRODUCTION

Vietnam, located on the eastern margin of Southeast Asia, has an *S* shape, with 3/4 of its coastal length (3,260 km) on the East Sea. Ho Chi Minh (HCM) and Ha Noi, the capital, are two megacities, which are the economic and financial centers of the country, and Ha Noi has a history of more than 1000 years. Vietnam is divided into three main regions based on geography, the Northern, the Central, and the Southern regions. It is known that Ha Noi, Hue, and HCM are the financial centers of the Northern, Central, and Southern regions, respectively. Due to differences in their geography and the formation of each region, the socio-

economic characteristics are slightly different. This has led to differences in housing styles over time, especially with regard to traditional Vietnamese houses.

According to Ha (2002), the characteristics of traditional Vietnamese housing can also be divided into three groups based on geography. Traditional houses in the North built in the 16th and 17th centuries were spacious with two roofs, a symmetrical layout, and an odd number of compartments (e.g., 3, 5, or 7 compartments). Meanwhile, traditional houses in the Central and Southern regions built in the 19th and 20th centuries had similar features to each other. These houses were constructed using a form of four gable roofs, and they were about 1.5 times larger than those in the North. Moreover, the spatial configuration of houses was divided into the main house and the sub-house. The main house was designed with a symmetrical layout using

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[1] Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, South Korea
phiphuongarc@gmail.com

5-7 compartments, and the sub-house was built with 3-5 compartments. All traditional houses (for all three regions) were built using a brick basement, a wooden structure, and tiled roofs.

Nowadays, traditional houses exist on the urban fringes, but hardly any of them are newly constructed. Meanwhile, condominiums have become popular accommodation in megacities (e.g., HCM City) since they can save construction land and provide a large amount of housing. In HCM City, the population has significantly increased from 4.6-8.5 million people between 1995 and 2016 (Truong *et al.,* 2017). This has resulted in a high demand for newly constructed housing, especially high-rise apartments. Moreover, multi-functional buildings (for entertainment, enjoyment, and even work) are also required in order to satisfy the needs of residents. Thus, condominiums have grown up at various locations in city centers. The new apartment designs emphasize a spatial configuration to be in harmony with the natural environment.

Traditional houses built 200 years ago are still being used and maintained, since they are associated with the cultural traditions and national identity of Vietnam. The advanced features of traditional houses can be utilized for the design of modern apartments. Le and Park (2011) studied the ecological features of traditional Vietnamese houses that can be applied to contemporary high-rise buildings. However, the study focused only on houses in the North of Vietnam. Truong (2014) analyzed the physical characteristics of architectural forms and the spatial organization of apartments recently built in HCM City. Nguyen and Dewancker (2017) investigated the relationship between the planning of traditional Vietnamese tube houses and contemporary houses. However, a survey on the influence of the spatial configuration of traditional houses on the design of apartment units in the economic-financial center of HCM City has not been conducted so far.

This study presents an investigation into the changes in the spatial configuration of apartment building design in HCM City from 1960 to 2010. By utilizing previous survey research on traditional house design (Nguyen and Kobayashi, 2014; Nguyen, 2013; Ha, 2002; Pham *et al.*, 2019), the influence of the spatial configuration of traditional houses on apartment building design is presented, based on the space syntax theory.

TRANSFORMATION OF THE SOCIO-ECONOMIC STRUCTURE OF HO CHI MINH CITY

HCM City, located in the South of Vietnam along the Saigon River, is known as the largest and most prosperous city in Vietnam due to its historical richness and variety of religions and cultures. Since HCM city is positioned at an important location, it is favorable for city development from various aspects, including economics, transportation, and culture. According to the World Bank (2016), HCM's population is about 10 million of whom 2.95 million (29.5% of the population) live in rented houses. In particular, 2.33 million people (23.3% of the population) live in rooms of less than 10m^2. Meanwhile, the average area of housing should be 30m^2 per capita. Thus, housing construction is estimated to grow rapidly in the near future, especially for apartment units, due to limited construction land being available. This section briefly introduces changes in the apartment typology in different periods of HCM City's development, emphasizing the transformation of the socio-economic effects on the apartment typology. The economic periods of HCM City can be classified into before Vietnam's reunification, from reunification to "Doi moi" policy, and after "Doi Moi" policy.

Before Vietnam's reunification, 1975

Before 1975, Vietnam experienced political changes on its territory, and HCM City was known as Saigon. From 1945-1975, Saigon was under French and American rule. This was the first context for the formation of a colonial economy in Southern Vietnam. Saigon's economy rapidly developed under the colonial governments. Transportation systems connecting Saigon to the West and East parts of the territory were constructed to induce favorable conditions for economic development. During the Vietnam wars (against the French and the US), due to the war-torn countryside, people (so-called refugees) from rural areas sought housing in big cities (mostly in Saigon), thus creating demand for the development of apartments. Some of the large apartments, such as Khanh Hoi and Bac Hai apartments, were constructed not only for refugees, but also residents in the city. Managers and constructors introduced many options to satisfy customers' needs, with a cost of 15,500-35,000 VND (about 25-45$ in 1974). However, the price of apartments was relatively higher than the affordability of the poor in Saigon. After 1973, when the USA cut economic support for the South of Vietnam, Saigon's economy experienced a significant crisis. After Saigon fell in 1975, Americans, other foreigners, and a large number of Vietnamese evacuated the city (Zhou and Bankston III, 2000). This led to an insignificant increase in the housing market in this period.

From reunification to "Doi Moi" policy, 1975-1986

Northern and Southern Vietnam were reunified in 1975, and the country became The Socialist Republic of Vietnam. After the wars, Vietnam embarked on rebuilding the nation despite numerous difficulties and hardships. In order to build the new-born socialist country, the Vietnamese government launched many plans to push the growth of agriculture and industry. The period was divided into two phases 1976-1980 and 1981-1985 (5 years for each stage). The government managed most aspects of politics, the economy, and even socialist housing systems (MOC, 2020). For example, civil servants and workers, especially those who worked for the government, were provided with apartments or housing, and even food. However, because of inappropriate socio-economic development policies, Vietnam's economy faced unexpected stagnation and hyperinflation (Vuong, 2004). Housing in HCM city was operated under the subsidy policy. The state not only constructed housing, but also supplied housing to citizens, which was all part of the national five-year plan (1975-1986). As a result, the quantity and quality of housing were not considerably increased (Duong, 2003).

After "Doi Moi" policy, 1986

In 1986, the state of Vietnam imitated "Doi Moi" (renewal) policy to take the country out of the socio-economic

crisis. The economy shifted from being highly centralized to becoming a market economy. The state started to call for foreign investors and promote the many economic sectors, in which private sector investment in the housing market, transportation system and energy projects was especially encouraged. Moreover, the government stopped providing housing (Coit, 1998) and instead supported the marketization of the housing system from 1986. Foreign construction companies and domestic private entrepreneurs had a crucial role in planning and carrying out actual housing production under state supervision.

Up to 1990, a lot of high-quality housing was constructed, especially near the center of HCM City. Housing areas and the living infrastructure were progressively improved to satisfy residents' needs (Waibe *et al.*, 2007). Specifically, the average floor area per habitant was increased from 7.5m^2 (in 1991) to 10.27 m^2 (in 2000). According to Huynh (2015), housing construction projects after 2000 were known as being most successful when the Doi Moi policy was applied, which pushed socio-economic development. Most of the construction projects in the center of HCM City were apartment buildings due to limited construction land. Designers mostly focused on spatial configurations and technical requirements in order to satisfy economics and aesthetics.

SPACE SYNTAX METHOD

The space syntax method can be applied to analyze the properties of each space in a dwelling (Hillier and Hanson, 1989). It can also be used to evaluate the spatial configuration and to assess formative processes and social meaning. Thus, it is a helpful tool for assessing meaningful information about architectural spaces. For example, Figure 1 shows two possible relations between spaces A and B and outside space C. In Figure 1a, spaces A and B are directly connected to space C. Meanwhile, Figure 1b shows only space A connected to space C, so it is necessary to go through space A to space B if starting from space C. This indicates that the relationship between A and B is changed if space C is considered (Hillier *et al.*, 1987).
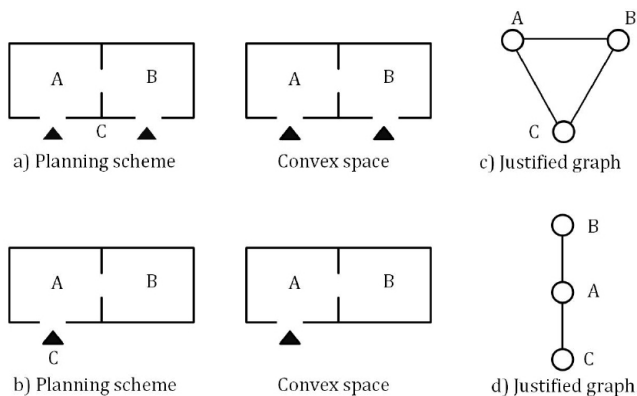

Figure 1. a) and b) two possible relations between spaces A and B and the outside, space C; c) and d) corresponding justified graphs; c)- Connecting space directly to the root space minimum depth: Symmetric system; d)- The linear sequence of the maximum depth of a space: Asymmetric system.
(Source: Hillier et al., 1987)

The convex space and justified graph (J- graph) are analyzed to examine spatial layouts. When a planning scheme is converted into a J-graph, the total depth (TD), mean depth (MD), relative asymmetry (RA), and real relative asymmetry (RRA) are calculated to show the spatial relationship between two rooms in a building. The convex space shows the adjacency relationships between spaces. It helps to reduce the spatial complexity of a layout to the fewest spaces. The planning scheme shows that the largest convex space is drawn by the boundary, followed by the next largest, and so on until all the space in the house is occupied. Based on the convex space, a J-graph might be drawn to show spatial relationships between adjacent spaces in the layout of a house. The J-graph is presented as a diagram from one space (root) to all of the others. Each unit space in the house is represented by a node (0), and each unit space is connected by a line. The J-graph might be deep or shallow, depending on the planning scheme. Moreover, the spatial relationships may be formed as branching trees or looping rings.

The total depth TD is calculated based on the J-graph by counting the number of nodes at each depth level and multiplying this number by their depth level. Summing these values provides the TD. Next, MD is the mean depth of a mode in the graph determined using Eq. [1]. The MD results allow for the calculation of relative asymmetry (RA) and real relative asymmetry (RRA), as shown in Eqs. [1]- [4]. The RA values range between 0-1(Hillier and Hanson, 1989). A low RA value for space indicates its strong integration with the system, while a high value suggests segregation from the system. The RRA values proposed in the study to make a comparison between different depth values are related to mutual depth (Hillier and Hanson, 1989). When the RRA is calculated for each space, the integration value (IV) is calculated, as shown in [4]. A high IV shows that space integrates very strikingly with the system, thus suggesting a public space. In contrast, the space is more private when the IV value is close to 0 (Ortega-Andeane *et al.*, 2005).

$$MD = TD/(k-1) \qquad [1]$$

$$RA = 2(MD-1)/(k-2) \qquad [2]$$

$$RRA = RA/Dk \text{ (diamond)} \qquad [3]$$

$$IV = 1/RRA \qquad [4]$$

This study used the J-graph to analyze the spatial configuration in apartment buildings and traditional housing in order to illustrate the relationships between the spaces through the integration value for each area. From that, a particular space was compared in terms of the depth of the node in the whole system. The planning scheme of a typical traditional house is shown in Table 1. The spatial configuration is separated into two principal parts, including the main house and the sub-house. The main house consists of a living room, a prayer area and bedrooms, and the subspace includes a kitchen, storage, and a toilet. Three primary spaces in the house, including the living room, bedroom, and kitchen, were selected for the calculation. The spatial structure of the house was re-drawn to develop a J-graph and calculate the properties of each space, as seen in Table 1. In Step 1, the selected spatial configurations were named with numerals, and the convex

analysis map was drawn. In Step 2, the J-graph was drawn. In Step 3, the values of the terminologies were calculated using Eqs [1]-[4] for the three spaces (living room, bedroom, and kitchen), which were selected as representative spaces for analyzing the properties of the space.

traditional houses contains a profound historical-cultural message. Previous research (Ly, 2012; Le and Park, 2011) evidenced that traditional houses are appropriate for local natural conditions because open spatial structures were commonly used to satisfy Vietnam's lifestyle and culture.

Table 1. Example of space syntax analysis for a traditional house unit using J-graph

Performing order	Illustration images		
Step 1: Drawing the floor plan layout and convex analysis map.			
	Floor plan layout	Convex analysis map	
Step 2: Justified graph and total depth (TD)			
	J-gragh and TD for living room	J-gragh and TD for bed room	J-gragh and TD for kitchen

Point number	Total depth (TD)	Mean depth (MD)	Relative asymmetry (RA)	Real relative asymmetry (RRA)	Integration value (IV)
Living room	16	2	0.286	0.840	1.19
Bedroom	23	2.875	0.536	1.576	0.63
Kitchen	21	2.625	0.464	1.366	0.73

Step 3: The value of terminologies is calculated by [1], [2],[3],[4]

Meaning of the Integration Value			

Legend	TS-Transition space BD- Bedroom	C- Corridor WC- Toilet	LR - Living room KT - Kitchen	W- Worship area P -Pantry

SURVEY ON TRADITIONAL HOUSE AND APARTMENT BUILDINGS

Traditional Vietnamese houses

The traditional Vietnamese house plays a vital role in the formation of the Vietnamese architectural identity. Under the development of high-rise housing typology in urban areas, many traditional garden houses in rural areas have also been preserved and developed. According to Ha (2002), the architectural forms of traditional houses have been built to adapt to the surrounding climate conditions for many years. Studying the characteristics of traditional houses yields precious solutions with regard to the natural environment. Moreover, the spatial configuration of

Hence, the characteristics should be researched, preserved, and utilized as a criterion for the design of modern housing.

In Vietnam, the oldest houses can be found in Hue City, which was built approximately 200 years ago. According to Nguyen, the traditional house has unique characteristics that can be utilized for modern house designs. Table 2 shows an architectural form of a traditional house adapted from Nguyen (2007). In the study, the spatial configuration of house plans was analyzed, as detailed in Table 2. The house layout consists of the main house, sub-house, surrounding garden, and other components. The main house was commonly designed with one floor, a wooden-structure for carrying loads, and clay tiles for the roof. The spatial structure of the main house contains

Table 2. Characteristics of Hue traditional garden houses
(Source: Nguyen, 2007).

Name type	House typology	
	Planning layout	Facade of main house
Type A 1 Gian - 2 Chais		
Type B 3 Gians - 2 Chais		
Type C 3 Gians		
Legend	W - Worship BD- Bedroom WC- Bathroom/toilet C - Corridor	LV- Living room KT- Kitchen P - Storage OF - Other function

a living room, a prayer room, and bedrooms. In traditional Vietnamese houses, the living room is a flexible space that can serve as a guest room, a sitting room, a dining room, or even a bedroom. Service spaces, such as the kitchen and storage, are located in the sub-houses, which are separated from the main house. The bathroom and the toilet are typically situated to the rear of the outhouse.

Apartment building typology in HCM City

To analyze the features of apartment buildings, 50 apartments built from 1960 to 2010 were surveyed at various locations in HCM City. The apartments can be classified into 12-types of apartment unit plans based on the construction period and socio-economic transformation in HCM city, corresponding to three periods (1960-1986, 1986-2000, and 2000-2010). The number of apartments surveyed for each period is as follows: 10 units for 1960-1986, 15 units for 1986-2000, and 25 units between 2000 and 2010.

From 1960 to 1986, apartment building typology appeared in HCM City (former name: Saigon City) in the early 1960s to meet the American and French armies' housing needs during the wars. After 1975, Saigon City became chaotic and most apartments were run down and degraded. The initial form of apartment buildings was a simple linear block with mostly horizontal access. The apartment buildings were designed with 3-5 floors, and a single-loaded corridor or double-loaded corridor type. The typical floor plan, with an area of 20-30m^2 per household, had three primary areas, including the kitchen, toilet, and common space for multi-function.

From 1986-2000, the Vietnamese government started to reform the economy by means of the "Doi Moi" policy (Forbes, 1995). The urban population increased along with economic growth, thus enabling development of the housing market in megacities like HCM City. Some researchers (Mizuno *et al.*, 2000) have pointed out that there will be approximately 46 million people in urban cities by 2025. It can be a great challenge to supply housing when there is a high population density. Moreover, it was estimated that the average number of housing units built from 1999 to 2009 was 273,500 units per year in Vietnam, most of which were high-rise apartment typologies (Un-Habitat, 2014). Because most new housing was built for migrants, civil servants, or people with a low-income, the service area in apartment units was small, about 30 m^2 (in 1999), which was adapted in order to meet fundamental living needs. In addition, in order to satisfy a number of high-income residents, some apartments were accessed from communal halls, which were connected to an elevator and stair core, and were relatively high (10-20 floors), with floor plan areas of about 40 m^2 for one-bedroom units or 60 m^2 for two-bedroom units.

Since 2000, high-rise apartment buildings (over 25 floors) have appeared more frequently in the form of tower blocks, as seen in Figure 2 and Table 3. These housing typologies are designed using international standards for a new living style that has gradually become the common form of dwelling in megacities (e.g., HCM City and Hanoi). Specifically, apartment floor plans commonly include two bedrooms or three bedrooms. The penthouse (a luxury apartment type) is positioned on the highest floor of the building, and it is designed to be a four-bedroom type, as seen in Figure 2 and

Table 3. As observed in Table 3, the spatial configuration in this period has been designed to satisfy not only basic living needs, but also relaxation and entertainment.

Twelve typical apartment layouts selected for the analysis include three units for 1960-1986, four units for 1986-2000, and five units for 2000–2010, as seen in Figure 2. The 12 layouts can be classified into one-bedroomed, two-bedroomed, three-bedroomed, and penthouses. It is noted that some apartment floor plan layouts built before 1975 did not have a bedroom, and the multi-functional area was utilized as a bedroom.

RESULTS

Results of the space syntax analysis of traditional houses

To identify the general characteristics of the Hue traditional garden house's spatial configuration, the spatial layout of four traditional houses in Table 2 was analyzed using space syntax. By applying the calculation steps in Section 3, the J-graphs of four houses were plotted in Figure 3, and the IV index for the three main spaces (living room, bedroom and kitchen) was calculated. The result showed three remarkable features of Hue traditional houses, as follows:

- Firstly, the general layout is separated exactly into two parts, made up of the main house and an auxiliary house, as seen in Figure 3. The main house consists of social and living functions, such as the living room, prayer area, and bedrooms. The main house's spatial structure has a long corridor located in the front area. The corridor plays a role as a buffer space that is a transition to the living room and worship area. The bedrooms are always located behind the living room, and there is just one entryway to ensure the homeowner's privacy. The auxiliary house, located next to the main house's right side, contains service spaces for living, such as a kitchen, storage, and a sanitary area. The auxiliary house entrance is separate from the main house;

- Secondly, based on the J-graphs in Figure 3, the diagram links four external spaces, including the courtyard, kitchen, pantry, and toilet, establishing a topology of these spaces, and they are completely separated from the main house. These spaces can be categorized as utility spaces that serve necessary living activities (e.g., cooking and farming). This linking is a genotype existing in traditional houses, thereby revealing the residents' lifestyles; and

- Thirdly, one primary genotype existing in four traditional houses was found through the integration value (IV), as shown in Figure 3. The IV of the living room differs within the floor plan of each house. Moreover, the IV of the living room is the highest of the spaces in the same system (also in Figure 3). From that, it can be concluded that the public and flexible features of the living room are the most important aspects for understanding the residents' lifestyles in a particular period. The IV of the living room has a high value by positively integrating into the system. In contrast, the kitchen and bedrooms have a lower integration value. They can be seen as private spaces.
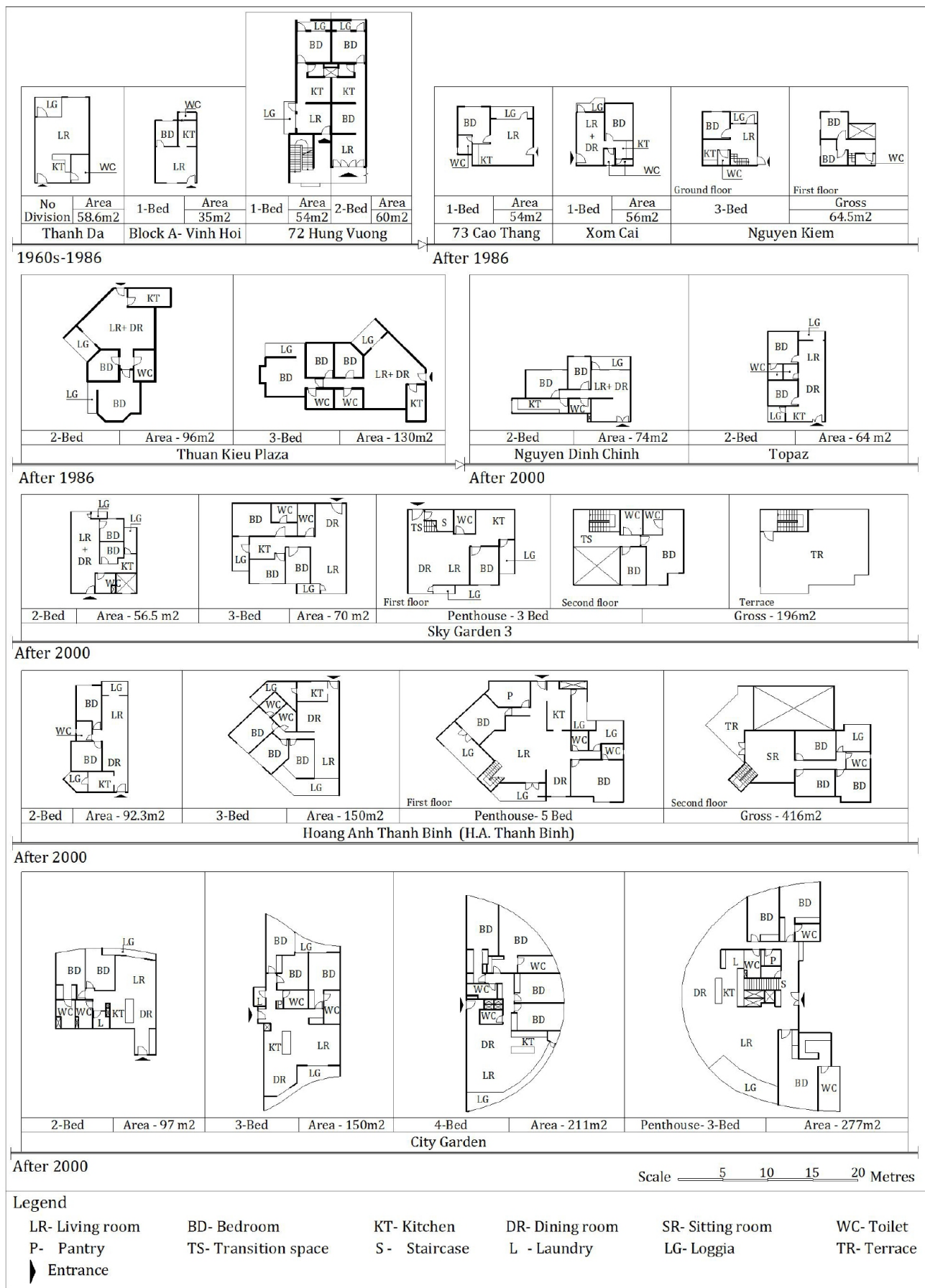
Figure 2. Floor plan of 12 apartment buildings

Table 3. Changes in apartment building typology in HCM city

Construction period	Before 1975	After 1986	After 2000		
			2005	2010	2015
Apartment block planning					
Apartment name	Vinh Hoi	Xom Cai	Sky Garden	Topaz	City Garden
Size of units(m²)	35	48-56	54-65	64-66	70-200
Location	Central area	City fringe	City fringe	City fringe	City fringe
Block typology	Linear block	Linear block with courtyard	U-shaped block	Grouped block	Wave towers
Access way to units	Double loaded corridor access	Cluster corridor access	Hall access	Combined type	Hall access
Number of storeys	4	4	26	26	28
Number of units per block	28	20	6	10	16

a) Type A: 1 Gian- 2 Chais	b) Type B: 3 Gians - 2 Chais	c) Type C: 3 Gians

Legend
LR - Living room   BD - Bed room   KT - Kitchen   W - Worship   DR - Dining room   SR - Sitting room
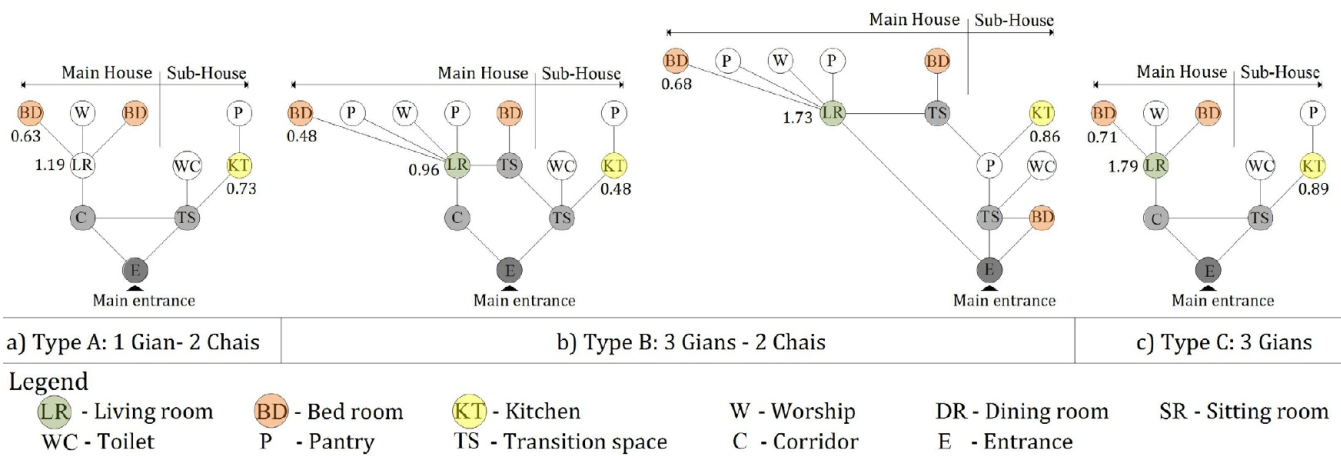WC - Toilet   P - Pantry   TS - Transition space   C - Corridor   E - Entrance

Figure 3. J-Graph with the entrance as the root note for traditional houses

Results of the space syntax analysis of apartment unit plans

The J-graph and IV were used to determine the features of the traditional house that were utilized for the design of architectural apartment buildings. First, the 12 layouts of apartment buildings representing the common properties of apartments were analyzed by converting them into a J-graph, as seen in Figure 4. Then, the IV was calculated for the three main spaces (living room, bedroom and kitchen) in the apartments to show their properties. The characteristics of the apartment buildings in three periods (from 1960 to 2010) are detailed, as follows:

Apartment units from 1960 to 1986

The apartments constructed before 1975 have the smallest area out of the three periods. The spatial configuration was arranged like a railroad without a hallway, and the rooms were positioned next to each other. Based on the convex map and J-graph, as illustrated in Figure 4, two main features of the spatial configuration of these apartments were identified. First, there is no bedroom. Instead, a large space is useable

for different purposes, for example as a living room, dining room, workspace or for sleeping. Second, the main entrance is directly connected to the living room or kitchen without any directional space or subspace, as illustrated in the J-graph in Figure 4. It is noted that there were just a few partitions between the spaces. A flexible common space can be used for family members. In general, the spatial configuration in the period only serves the same basic needs, such as eating and sleeping. The apartment model was strongly associated with the socio-economic situation during the wars, that is, the socio-economy faced many difficulties. Moreover, the IV values for the three main spaces, namely the living room, bedroom, and kitchen, are slightly different, thus indicating a reduction of privacy in the space.

Aparment units from 1986 to 2000

After 1986, the construction of apartment buildings developed with various types. Most apartment building styles referred to the patterns of developed countries (such as China, Korea). The private space in apartment unit layouts can be especially noticed. Figure 4 shows two different zones
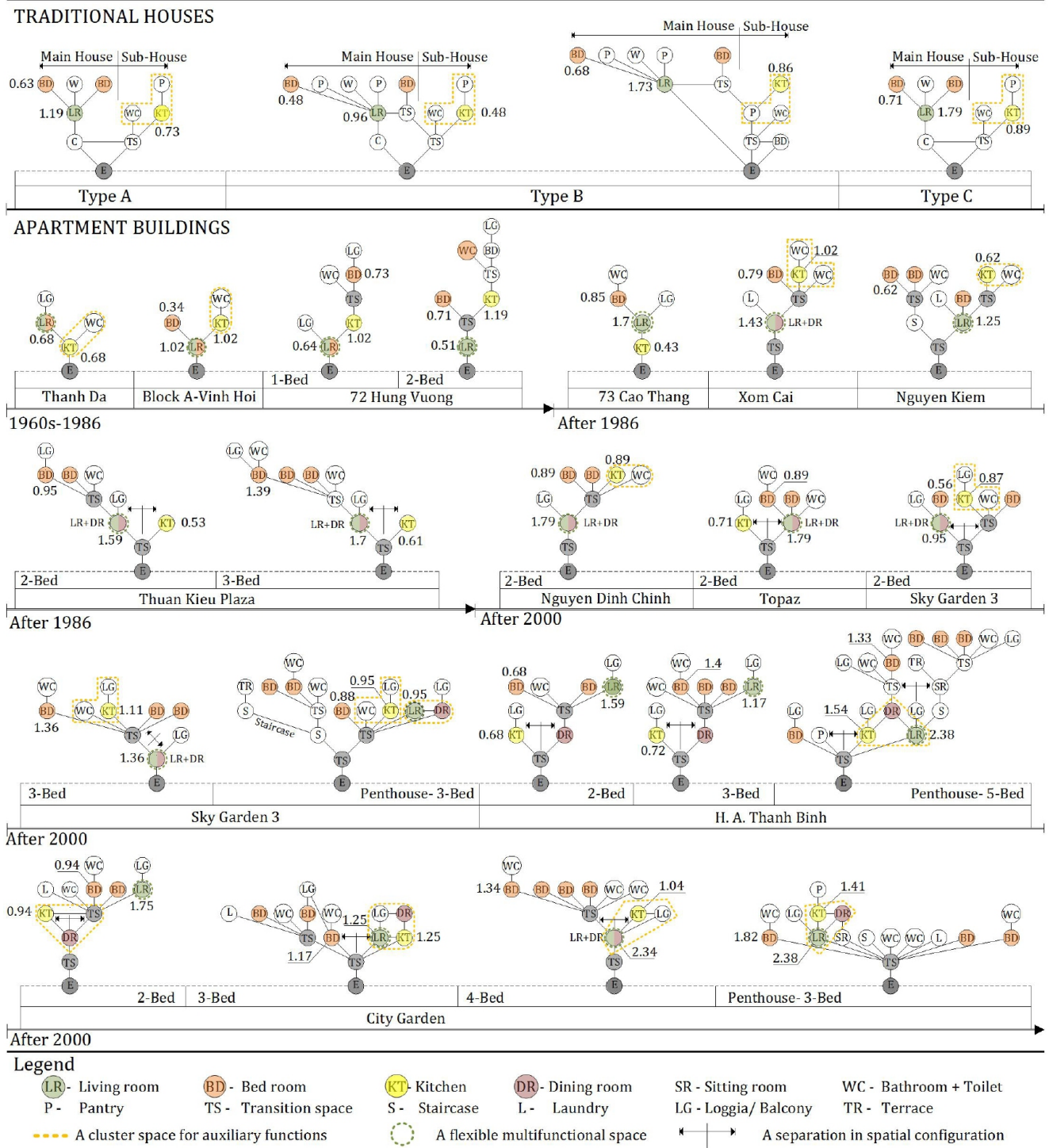
Figure 4. Comparison of traditional houses and apartment unit plans

in the apartment floor plan layout, including a residential area and a service area. Specifically, the kitchen is completely separated from the main branch of the system, and the living room is at the center of the apartment's spatial structure. The bedrooms are connected by transitive space accessible from the living room or staircase. Moreover, the area of apartments from this period is greater than that of those built before 1975. The other features can be listed as more than two bedrooms, toilets, and several balconies or loggias.

As illustrated in Figure 5, interestingly, the living rooms in "73 Cao Thang" apartment and "Thuan Kieu" Plaza have the first and second highest integration values of those built at that time. The increase of integration value points out that a space is located at the center of the spatial configuration of the apartments, like a permeable space. It plays a crucial role in connecting the functional space within the housing units. Furthermore, according to homeowners, the living room has multiple functions, for example, as a reception

room, a dining room, and a relaxation area. Thus, the design of apartment buildings focused more on quality of life, that is, more privacy and space for family members.

Apartment units built between 2000 and 2010

Apartments built between 2000 and 2010 were subject to enormous changes in the spatial structure. The number of functional spaces and the size of each unit increased to ensure spiritual life. Based on the J-graph in Figure 4, there are three essential features of the apartment floor plan. Firstly, the spatial configuration is separately divided into two zones, including a flexible residential zone (bedroom, living room) and an auxiliary zone (a kitchen, pantry, toilets, and balcony or loggia). In particular, the residential zone is divided into static and dynamic groups. Figure 4 shows that the static zone consists of a bedroom and a personal room directly connected to the service area through a transition space. These spaces are located on the corner or middle of the apartment, and they occupy the deepest place inside it to ensure privacy. Meanwhile, the dynamic zone, made up of the living room, dining room and service areas (e.g., kitchen, laundry, and storage), is usually located near the entrance. Secondly, these apartments have more than two space transitions, situated at the entrance or in the intermediate space connecting the static and dynamic zones, as seen in Figure 4. Thirdly, the most striking finding from the J-graph is a connection between the guest room and outside spaces through the balcony or loggia. The living room was also designed with a loggia or a balcony. The change is the most significant in an apartment building in this period.

For apartment buildings constructed since 2010, Figure 5 shows that the living room has the highest index of integration value, thus indicating that the living room is a public and flexible space. In some cases, the integration values of the living room are equal to that of the kitchen (Figure 5). It indicates that the role of the kitchen has been changed in modern society. In other words, the kitchen is no longer a domestic space, as in previous apartments (Figure 4). Moreover, in some apartments (H.A. Thanh Binh, City Garden), the kitchen has been placed next to the loggia for ventilation, and is directly connected to the dining room or living room. The kitchen can also be designed inside the living room or dining room without a partition, to form a circular layout type. It is noted that prior to this, apartments had a rail layout.

Moreover, Figure 5 reveals the lowest integration value of bedrooms in apartment buildings. The low IV values show that the privacy properties of the bedroom are still maintained, although socio-economic conditions have changed. Since 2010, luxury apartment units have been constructed rapidly due to economic development and an increasing standard of living. Economic growth has led to changes in society and in human behavior. However, these apartments still own the original features, that is, open space to connect the human and surrounding environment. The spatial configuration shows that the apartment has more than three bedrooms (an increase in space) and a connection between the inner space and natural environment via a large terrace and balcony (an increase in the quality of space). These spaces were designed as duplexes, with some apartment buildings even having additional swimming pools.

DISCUSSION

By applying the space-syntax method to analyze apartment buildings, five characteristics of housing can be summarized, as shown in Table 4. First, the areas of apartment buildings have increased (1960 to 2000), and the maximum size is found in apartment buildings built after 2010. Second, the height of apartment buildings has also increased, with a height of more than 20 stories for apartments constructed after 2000. Thirdly, the space typology has changed over time, from a railroad layout (before 1975), a wing layout (1986-2000), and a circular layout (2000-2010). The increase in the height of apartments and their shape indicate the development of the economy and advances in construction technology. Fourthly, since 2010, there have been service areas (e.g., green space and swimming pool) in high-rise apartment buildings. Lastly, the spatial configuration of modern apartments (since 2000) has been strongly affected by traditional house styles, as seen in Table 4.

By comparing the features of traditional houses and apartment unit plans, three main features regarding the spatial configurations of apartment units can be summarized. Firstly, the spatial configurations of most apartments in the first period (1960-1986) differed from those of traditional houses. Their lack of spatial division based on function is remarkably different from traditional houses. Compared to traditional houses, the living room area in apartments was
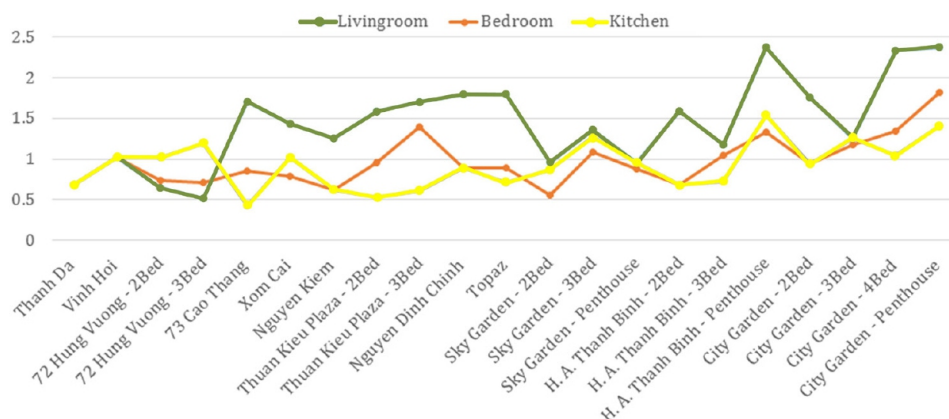

Figure 5. Integration values calculated for apartment buildings

large during that period, also serving as a dining, worship, or study room. This space could be changed to adapt to each household's daily life.

on the development of the socio-economy, from the railroad layout (before 1975), wing layout (1986-2000), and circular layout (2000-2010). In particular, the result

Table 4. Summarized characteristics of traditional houses and apartment buildings

Type	Hue traditional garden house	Apartment buildings		
		Before 1975	After 1986	After 2000
1. Size of units	>100	30-50	50-60	60-200
2. Number of stories	1	3-4	10-20	>20
3.Typology of space	L-shaped layout	Railroad layout	Wing layout	Circular layout
4. Functions	Dwelling+ Production	Dwelling	Dwelling	Dwelling+ many service spaces
5. Spatial arrangement	Strong division	Lack division	Strong division	Strong division
5.1. Living room	Flexible space	Flexible space	Flexible space	Flexible space
5.2. Bedroom	Privacy space	Common space	Privacy space	Privacy space
5.3. Kitchen	Close space	Common space	Open half-space	Open space

Secondly, the spatial structure of apartment units built after 1986 was slightly affected by the traditional house style. Specifically, the kitchen and toilet (cluster space) were located at the entrances, and the IV value of the living room (using a J-graph) was higher than the other spaces, as seen in Figure 5. The high IV value indicates that the living room is a community area for the family. Thirdly, the spatial configuration of apartment units built since 2000 has definitely been affected by traditional house styles. Three essential features can be listed: (1) a strong division of the spatial structure, (2) separation of the residential space into dynamic and static, and (3) connection with the natural environment. In contrast, the role of the kitchen has a significant difference, that is, the living room, dining area and the kitchen are connected directly.

CONCLUDING REMARKS

In this study, the effects of the spatial configuration of the traditional Vietnamese house on apartment buildings design in HCM city were investigated. Firstly, the development of the socio-economic structure in HCM City from 1960 to 2010 was briefly described. Secondly, the space syntax method for analyzing the spatial plan of the structure was outlined. Thirdly, traditional houses and apartment buildings between 1960 and 2010 were surveyed. Lastly, the space syntax method was applied in order to analyze the spatial structure of a number of traditional houses and apartment units. The effects of the spatial configuration of the Hue traditional house on apartment buildings were examined.

From the analysis, the remarkable features of the apartment buildings can be listed as follows:

• The spatial configuration of modern apartment buildings is similar to the features of the traditional house, including harmonization with nature and Vietnamese socio-cultural adaptation, which merits further investigation in terms of the application of the modern apartment design;

• The spatial layout of apartments has changed based

shows that the circular layout is strongly separated into two zones (static and dynamic);

• The appearance of flexible functional spaces (living room, dining room, and sitting room) is a focus of the design in modern apartments; and

• The kitchen in modern apartments is located close to the entrance or the living room, thus reducing the privacy of the space. Meanwhile, the kitchen in traditional houses is separated from the main house.

The results indicate that the spatial layout of the modern apartment has still retained the Vietnamese traditional house's spatial configuration. The findings provide useful information for the designs of modern apartment buildings in megacities. However, the present study has limitations because the analysis of the spatial configuration of apartment buildings was qualitative. Future study can focus on the design of a sample apartment planning unit, which takes into consideration the characteristics of traditional Vietnamese houses.

ORCID

Phi Phuong Pham https://orcid.org/0000-0002-4220-9182

Giao Quynh Ngoc Pham https://orcid.org/0000-0002-5713-6895

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