

Quantification of Feng-Shui Principles in the Design of Korean Houses

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Abstract Although Feng-Shui has been widely used in architecture and urban design and planning for thousands of years, it has not been properly studied as a scientific and thus rational approach. Feng-Shui has been recognized as an environment-friendly design and planning method in recent years due to its thoughtful consideration on the harmonious relationship between architecture and the natural environment. This study investigates its major principles and techniques that have been widely used in the design of houses through previous relevant researches. Then, the principles and techniques that are relevant to the residential uses are indexed for the quantification of Feng-Shui. Ten Feng-Shui indices are formulated and each index is quantified to make five points for a perfect match. These indices are then tested on three different types of house in Korea, namely traditional Korean houses, contemporary Korean style houses and contemporary architects' houses. The result shows that the first type of house records the highest Feng-Shui points and then the second and third types in that order. This result convinces us that the Feng-Shui indices can very effectively represent the degree of environmentally friendly design.

Keywords: Space Feng-Shui, Space Syntax, Koreanity, Korean Houses

1. INTRODUCTION

Feng-Shui has been used in various aspects of the traditional Korean architectural planning process. Yang-Teak Feng-Shui has been used for planning residential houses, palaces, government offices, temples and cities and Yin-Teak Feng-Shui has been utilized for positioning gravesites. Feng-Shui's nature-friendly philosophy and practical ideas of architecture planning have a close association with eco-friendly and sustainable architecture, which has become one of the major concerns in the built environment of the 21st century.

The fundamental concept of Feng-Shui is to form a sustainable society by creating a built environment that is in harmony with the natural surroundings. One of the reasons why Feng-Shui is not being actively used in the modern architectural planning process is that it lacks both scientific methodological aspects in architectural planning and systematic quantifications. In particular, the origin of

Yin-Teak Feng-Shui's longing for fortune has hindered its development as an architectural planning methodology.

This study, therefore, is to systemize and to select the core theories of Feng-Shui in order to develop Feng-Shui Indices based on the existing relevant researches. By applying these indices to each building, it will be possible to determine the degree of Feng-Shui implementation.

This research not only suggests a scientific quantifying methodology for Feng-Shui but also establishes the following significant outcomes. Firstly, it is able to determine the degree of implementation of Feng-Shui by applying the indices to various types of buildings. Thus, it makes it possible to compare the results with those from other research. Secondly, because of the fundamental eco-friendly concept of Feng-Shui, the quantitative comparison also indicates the degree of the environmental friendliness of the building. Lastly, this research identifies the degree of implementation of 'Koreanity' as it reflects the traditional values of Korean architectural planning methodology.

In this study, Feng-Shui is limited to Yang-Teak Feng-Shui which has been utilized and developed for thousands of years on the basis of Yin-Yang and the Five Elements theories. However, its lack of objectivity and rationality for modern architectural purposes has been an obstacle in applying it to modern architecture and urban design. Therefore, developing scientific evaluation methods is a precondition for the 'scientification' of Feng-Shui. These tasks, however, are long-term processes that require intensive studies by researchers from various backgrounds.

The goals of this study are to develop the Feng-Shui Indices and the quantification methods and to explore the possibilities of Feng-

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Shui's application in the built environment by applying the indices to four sample houses from three different housing types, namely traditional Korean houses, contemporary Korean style houses and contemporary architects' houses.

2. LITERATURE REVIEW

2.1 Feng-Shui as an architectural planning methodology

Feng-Shui Theory originated from the book of Geumnamgyeong written by Gwakkak in the 4th century (Son 2003). It has been taken into consideration and utilized as an architectural planning methodology in Korea, China, Japan and East Asian countries for thousands of years. Its nature-friendly ideology and practical ideals have been reappraised as a scientific methodology tool for the built environment of the 21st century (Choi 2002, Kim 2000, Too 2008).

Researches on Feng-Shui in architectural planning (Choi 2002, Ha 2008, Joo 2007, Ryu 2008) rationalized and categorized its theories by investigating building layouts or residential space types in order to approach Feng-Shui as a scientific methodology. Similarly, international researches have been focusing on analyzing the core theories of Feng-Shui and applying them in the modern architectural environment (Hwangbo 2002, Marafa 2003, Su-Ju and Jones 2000, Xu 2003, Xu 1998).

Western researchers remain sceptical of these studies from the East Asian countries, claiming that they lack a scientific basis (Dukes 1971, Montenegro 2003, Mulcock 2001). Their ongoing researches are based on scientific facts and measurements, such as wind energy, geomagnetic field, geological energy, waterways, etc. (Campbell 2003, Eun 2001, March 1968, Merrill 2010, Park 1998).

In order to understand the possibilities of Feng-Shui in its potential application to architectural practice and to understand it from the scientific point of view, Feng-Shui needs to be reinterpreted from various perspectives. It is very difficult to understand the terminologies used in Feng-Shui and the wordings are too abstract, which makes it difficult to apply in practice (Choi 2002). Consequently, Feng-Shui has come to be regarded as superstition or a religious custom.

Even though there is some recent research such as that of Choi (2002), who has made constant efforts to systematize the core theories of Feng-Shui, there are no objective quantification methodologies which are applicable to the planning and design of various building types. Because of the limits in the ideological aspects of Feng-Shui, it is not possible to verify a quantitative methodology which can be applied in the field of architectural practice.

2.2 Research on the quantification of architectural design and planning

There are various methodologies to quantify architectural planning theories like Feng-Shui. The use of space syntax is attracting attention as it quantifies the spatial composition relationships. Space syntax was first developed by Hillier (1996). It investigates and analyses the spatial connectivity of the architecture and urban space, which is converted into lines, planes and isovists. Hillier's team has developed computer software to quantify the morphological characteristics of spaces.

There has been an increasing amount of research using space syntax theory in spatial studies of traditional Korean houses or modern Korean houses. In particular, there are major empirical studies about periodical spatial structure changes in various

housing types (Heo and Jeong 2001, Kim 2003, Lee 1998, Na 2004, Noh 2000, Ryu 1998;). These studies use the quantification values of space syntax, such as connectivity, integrations and intelligibility, and examine the changing patterns of spatial structure in traditional houses and apartments. They find that the spatial depth in them has been deepened and privacy of space has been intensified.

Furthermore, there is one study (Chang 2002) that uses various factors to evaluate the value of regional differences in traditional Korean upper class houses. This study applied space syntax analysis on traditional Korean houses, modern houses with traditional characteristics and contemporary houses, emphasizing spatial structure. It analyzed their differences with quantitative clarity (Chang and Shim 2011).

As described above, research efforts have been made to quantify the contents of architectural spaces using methodologies such as space syntax. There are Feng-Shui studies that are applied in the field of architectural practice and describe its core theories systematically. However, it is hard to find studies that apply quantified core theories of Feng-Shui to general architectural practice. Therefore, the main goal of this study is to derive indexing techniques to quantify Feng-Shui's practical core elements and apply them to the case study houses to verify their reliability as an architecture planning and design methodology.

3. DEVELOPMENT OF KEY INDICES AND QUANTIFICATION METHOD OF FENG-SHUI

3.1 Key index development of Feng-Shui

With reference to the existing studies (Choi, 2002; Ha, 2008; Ryu, 2008), which interpreted Yang-Teak Feng-Shui taking a scientific approach, this study systematized its core theories so that they could be used in architectural practice. In particular, Ha (2008) has categorized the core theories from an environmental point of view, which has been extracted from Feng-Shui literature, such as Yangtaeksamyo, Hwangjaetaekkyong and Gasanghak.

On the basis of these studies, Table 1 below classifies the theories which can be applied to the field of architectural practice. Table 1 consists of two main aspects of Feng-Shui, which are exterior site planning (C1~C4) and interior spatial planning (C5~C10). The indices associated with exterior site planning are the crosssection of the site (C1), the relationship between the site and adjacent roads (C2), the external spatial structure of the site (C3) and the house or azimuth orientations of the site. The interior related indices are as follows: the shape of the plan (C5); entrance or gate (C6); reception area in the living room or main hall (C7); bedrooms (C8); kitchen and dining room (C9); ancillary rooms such as toilets, bathrooms, utility rooms, outbuildings (C10). Each index, except C2, is explained with three planning factors of a sub-category that can be defined objectively.

3.2 Development of quantification method of Feng-Shui

Table 2 suggests the quantifying methodology with three sub-categories, except C2, explaining their significance in order to quantify ten categories. Each index has five points so that ten indices (C1~C10) have a total score of fifty.

A five-point Likert scale is used for the sub-categories, ranging from very unfavourable (-2) to very favourable (2). This methodology is easily recognized not only by professionals but also by the general public.

Thirty-one sub-categories, except O5 (Unfavourable: if the site

Table 1. Key Feng-Shui indices for the quantification

Classifications		Categories	Sub-categories	Principles	Sources	
Exterior	Site layout: cross section	C1	O1	Very favorable: If the front of the site is low and the back of the site is high.	It prevents wind from the rear and increase sunlight from the front.	Taekjisamyong (宅地三樂)
			O2	Favorable: If the front yard is flat.	Even wind distribution reduces the risk of blast.	Taekliji(宅理地)
			O3	Very favorable: If the building is located in a high plane and the yard is located in a low plane.	It increases the amount of sunlight, provides a good ventilation and rainwater way.	Taekliji(宅理地)
	Road structure	C2	O4	Very unfavorable: If the site faces to a straight street.	It influxes of strong winds by vehicles.	Yangtaekillam(陽宅一覽)
			O5	Very unfavorable: If the site is located on a cul-de-sac.	It causes wind blast as no wind paths.	Yangtaekbijeonjib (陽宅秘傳集)
			O6	Normal: If the site faces to a curved road.	The influx and strength of wind is low.	Yangtaekillam(陽宅一覽)
			O7	Unfavorable: If the site faces to a cross road.	It accelerates the influx of strong winds by vehicles.	Yangtaekillam(陽宅一覽)
	Outdoor space	C3	O8	Very unfavorable: If the building within the site is so close to the road.	The influx of wind and noise.	Yangtaekbijeonjib (陽宅秘傳集)
			O9	Normal: If the centre of the building and the main gate are aligned.	Smooth circulation of the wind between the building and the main gate.	Gasanghak(家相學)
			O10	Very unfavorable: Outdoor space with acute angle.	The wind flow is blocked and cause a blast.	Taekjisamyong (宅地三樂)
	Architecture azimuth	C4	O11	Very favorable: If the building has south facing orientation.	Good amount of sunlight.	Hanjoengwoogi(閒情偶寄)
			O12	Favorable: If a main road is located on the west side of the site.	Good influx of light.	Gasanghak(家相學)
			O13	Very favorable: If the plant in the outdoor is on the west side of the building.	It prevents northwesterly winds.	Gasanghak(家相學)
Interior	Plan layout	C5	I1	Very favorable: 5:3 ratio (from the main gate) of the building plan.	Even distribution of light and seamless indoor air circulation.	Gasanghak(家相學)
			I2	Favorable: Building with circular, oval, octagonal, hexagonal shape.	Reduces shady places and increase good air circulation.	
			I3	Very unfavorable: 2:1 ratio (from the main gate) of the building plan..	Uneven distribution of light and the air is lock on the corner of the building.	
	Gate	C6	I4	Very unfavorable: If a main gate is narrower than a front door.	Gust is caused by amplified wind flow.	Hwangjaetaekkyong (皇帝宅經)
			I5	Unfavorable: If there is no backdoor.	Indoor air circulation is not running smooth.	Nakjijoonchik(落地準則)
			I6	Very unfavorable: If a main gate faces a front door	Strong winds flowing into the indoor.	Gasanghak(家相學)
	Living room	C7	I7	Normal: If the windows in the west bound building (from the living room) are open to the south.	Installation of a south facing window is beneficial the influx of light because of the small one in the westbound building.	Gasanggeukbijeon (家相極秘傳)
			I8	Normal: If the windows are open to the east (from the living room).	Smooth air flow and high insolation.	Gasanghak(家相學)
			I9	Normal: If the living room is located in the centre of the house.	The centre of building concentrates vitality.	Gasanghak(家相學)
	Bedroom	C8	I10	Unfavorable: If the bedroom is adjacent to kitchen.	It is unfavorable due to hygiene.	Gasanghak(家相學)
			I11	Normal: If the main bedroom is located in the centre of the building.	The centre of building concentrates vitality.	Gasangoyo(家相五要)
			I12	Normal: If the bedroom for the elderly faces the south or southeast	South or southeast facing building get good amount of sunlight with mild climate conditions.	Gasanghak(家相學)
	Kitchen	C9	I13	Very unfavorable: If the kitchen is located in the centre of the house.	It is very unfavorable due to hygiene.	Yangtaeksamyong(陽宅三要)
			I14	Favorable: If the kitchen faces east.	The summer influx of wind and air circulation serves good for hygiene.	Yangtaekdaejeon(陽宅大傳)
			I15	Unfavorable: If the kitchen is close to a well.	Drinking water wells could be contaminated by wastewater from the kitchen.	Yeokjeomsool(易占術)
Ancillary room	C10	I16	Favorable: If ancillary buildings are located on the west side of the main building.	Effective in blocking winter winds by ancillary building.	Gasangdaejeon(家相大傳)	
		I17	Very unfavorable: If the bathroom is located on the northeast or southwest side of the building.	It exposes to the cold winds and moisture.	Gasangcheonbaekyeonan (家相千百年眼)	
		I18	Very unfavorable: If the toilet is located in the centre of the building.	Spread of unsanitary elements by toilet.	Gasangbijeonjib (家相秘傳集)	

Table 2. Quantification method of Feng-Shui indices and their examples

Classifications		Categories	Sub-categories	Scores	Principles	Examples	
Exterior	Site layout: cross section	C1	O1	Very favorable: If the front of the site is low and the back of the site is high.	+2	Sum up the scores from each categories on the basic score (0): total 5 points	<p>①2+1+2=5 ②2+1+0=4 ③0+1+2=3 ④0+1+0=1</p>
			O2	Favorable: If the front yard is flat.	+1		
			O3	Very favorable: If the building is located in a high plane and the yard is located in a low plane.	+2 (slope yard: +1)		
	Road Structure	C2	O4	Very unfavorable: If the site faces to a straight street.	-2	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0=5 ②5-1=4 ③5-2=3 ④5-3=2 ⑤5-(3+1)=1 ⑥5-(3+2)=0</p>
			O5	Very unfavorable: If the site is located on a cul-de-sac.	-3		
			O6	Normal: If the site faces to a curved road.	0		
			O7	Unfavorable: If the site faces to a cross road	-1		
	Outdoor space	C3	O8	Very unfavorable: If the building within the site is so close to the road.	-2	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0=5 ②5-1-2=2 ③5-1-2-2=0 ④5-0-0-2=3</p>
			O9	Normal: If the centre of the building and the main gate are aligned	0 (other cases: -1)		
			O10	Unfavorable: Outdoor space with acute angle.	-2		
Architecture azimuth	C4	O11	Very favorable: If the building has south facing orientation.	+2	Sum up the scores from each categories on the basic score (0): total 5 points	<p>①2+1+2=5 ②2+1+0=4 ③0+1+2=3 ④0+1+0=1</p>	
		O12	Favorable: if the main road is located on the west side of the site.	+1			
		O13	Very favorable: If the plant in the outdoor is on the west side of the building.	+2			
Interior	Plan layout	C5	I1	Very favorable: 5:3 ratio (from the main gate) of the building plan	+2	Sum up the scores from each categories on the basic score (2): total 5 points	<p>①2+2+1+0=5 ②2+0+0-2=0 ③2+2+0+0=4 ④2+0+1-2=1</p>
			I2	Favorable: Building with Circular, oval, octagonal, hexagonal shape.	+1		
			I3	Very unfavorable: 2:1 ratio (from the main gate) of the building plan.	-2		
	Gate	C6	I4	Very unfavorable: If a main gate is narrower than a front door.	-2	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0-0=5 ②5-0-0-2=3 ③5-0-1-0=4 ④5-2-1-0=2</p>
			I5	Unfavorable: If there is no backdoor	-1		
			I6	Very unfavorable: If a main gate faces a front door	-2		
	Living room	C7	I7	Normal: If the windows in the west bound building (from the living room) are open to the south.	0 (other cases: -2)	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0-0=5 ②5-0-1-0=4 ③5-0-0-2=3 ④5-0-1-2=2</p>
			I8	Normal: If the windows are open to the east (from the living room).	0 (other cases: -1)		
			I9	Normal: If the living room is located in the centre of the house	0 (other cases: -2)		
	Bedroom	C8	I10	Unfavorable: If the bedroom is adjacent to kitchen.	-1	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0-0=5 ②5-1-0-0=4 ③5-1-2-0=2</p>
I11			Normal: If the main bedroom is located in the centre of the building.	0 (other cases: -2)			
I12			Normal: If the bedroom for the elderly faces the south or southeast	0 (other cases: -2)			
Kitchen	C9	I13	Very unfavorable: If the kitchen is located in the centre of the house.	-2	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0-0=5 ②5-0-0-1=4 ③5-0-2-0=3 ④5-2-2-0=1</p>	
		I14	Favorable: If the kitchen faces east	0 (other cases: -2)			
		I15	Unfavorable: If the kitchen is close to a well.	-1			
Ancillary room	C10	I16	Favorable: If ancillary buildings are located on the west side of the main building.	0 (other cases: -1)	Sum up the scores from each categories on the basic score (5): total 5 points	<p>①5-0-0-0=5 ②5-1-0-0=4 ③5-0-2-0=3 ④5-0-2-2=1</p>	
		I17	Very unfavorable: If the bathroom is located on the northeast or southwest side of the building.	-2			
		I18	Very unfavorable: If the toilet is located in the centre of the building.	-2			

is located on a cul-de-sac) which has three points, have five sub-categories as above. When each index does not fit in a case, zero score is applied into the case except C2 and other cases that are not mentioned in particular. However, in this study the normal (0) implies an advantageous meaning. In case of 'Road Structure (C2)', one or two sub-categories in four can be selected because they can meet any case. Application of the scale into the sub-categories is determined by the relative importance, which is derived from the existing literature. The indices' scoring method looks equivocal at first instance, but the existing literature including those on the Table1 with the references of Kim(2000), Park(1998) and Son(2003) explain each index according to the principles on the table. They also describe the relative importance among the sub-categories in each main category, based on their theoretical and practical, in particular, experiences. The scoring method in this study is solely based on their written expression in the literature.

The following is a case example of the C1 index. The C1 index has four quantification examples in its general cross-section, as shown in Figure 1. Type① building has a higher rear plane (+2) and a flat front plane (+1). The building plane is higher than the front yard (+2). This makes a score of five (2+1+2=5). In type②, the building has a higher rear plane (+2) and its front plane is flat (+1). The building plane is on the same level as the front yard (+0). This makes a score of three (2+1+0=3).

Similarly, type③ has a low rear plane (+0) and a flat front plane (+1). The front yard is lower than the building plane (+2). This makes a score of three (0+1+2=3). In type④, the building rear (+0) and the front (+1) are on the same level and its front yard is on the same level as the building plane (+0). This makes the total score of one (0+1+0=1). From these examples, therefore, the degree of Feng-Shui implementation is shown as ①(5)>②(4)>③(3)>④(1). The results are easily comparable.

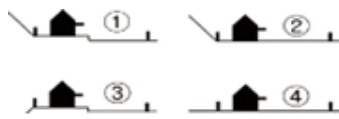


Figure 1. Example of C1 index



Figure 2. Example of C1 index

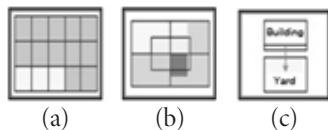


Figure 3. Criteria of ratio(a), centrality(b), orientation(c)

As another example, C6 (Door & Entrance) has four types of different layouts, as shown in Figure 2. The type① building layout has a front door which is smaller than the main gate (0) and back door (0). The front door and the main gate do not directly face each other (0). This means that no points are deducted from the total score of five (5-0-0-0=5). In type②, the entrance door is smaller than the main gate (0) and it has a back door (0). But the entrance door and the main gate are facing each other (-2). Therefore, the total score for the type② is three (5-0-0-2=3).

In type③, the front door is smaller than the main gate (0) and it does not have a back door (-1). The front door does not face the main gate (0). This adds up to four points (5-0-1-0=4). Finally, in type④, the main gate is smaller than the front door (-2) and it does not have a back door (-1). The main gate does not face the front door (0). This adds up to two points (5-2-1-0=2).

The indices of C5 and those for C7 to C10 deal with the measurements of ratio, centrality and orientation. As shown in Figure 3 (a), for the ratio, square compartments, which include buildings within the site, are set based on the size of the main rooms of the building. For centrality measurement methods, as shown in Figure 3 (b), a square is set which includes all the buildings within the site and another square is placed in the centre of it, and it is then divided into four compartments. If a certain space is within more than half of the internal square, it means that the space is located in the centre.

The orientation is set by the relationship between the living room (main hall) and the yard. The orientation is defined by the direction of the building towards the yard.

4. APPLICATION OF THE FENG-SHUI INDICES TO KOREAN HOUSES

4.1 Traditional Korean houses

Yangjindang, Hyangdan, Unjoroo and Nokwoodang are representative houses of the Yeongnam and Honam, Southwest and Southeast region of South Korea respectively. These four traditional houses were built with the philosophical ideas of Confucian tradition as well as Feng-Shui. Table 3 shows the degree of implementation of Feng-Shui of these four traditional houses after applying the quantification method.



Figure 4. Yangjindang house

Using the 10 indices, Yangjindang shows its degree of implementation of Feng-Shui as follows. For the C1 index, Yangjindang is located on flat land (0) and it has a flat front yard (+1). Its main buildings are sited higher than the front yard (+2) as they are on a stylobate. This makes a score of 3 (0+1+2=3). For the C2 index, the house is adjacent to a curved road (0) which scores 5 (5+0=5). For the C3 index, its main gate is not located on the axial line of the house (-1) and the house is not right next to the adjacent road (0). The shape of the house's outdoor space does not make an acute angle (0). This gives a score of 4 (5-1-0-0=4). For the C4 index, Yangjindang has a south-facing orientation (2). It has plants on its northwest side (1) and does not have a wide road on its west side (0). This gives a score of 3 (2+1+0=3).

In terms of the interior indices, for the C5 index, the proportion of the housing site does not make a ratio of 5:3 (0). Its shape is not curved or oval (0) and its proportion does not make a ratio of 2:1 (0). This gives a rather low score of 2 (2+0+0+0=2). For the C6 index, the front door to the main house building is smaller than the main gate (0) and the house has a back door (0). The front door does not directly face the main gate (0), which gives score of 5 (5+0+0+0=5). For the C7 index, the house faces south (0) and has a south-facing window (-1). The main hall is located in the centre of the house (0) which gives a score of 4 (5-0-1-0=4).

For the C8 index, Yangjindang’s bedrooms and kitchens are relatively close to each other (-1), the master bedroom is located in the centre of the house (0) and the bedroom for the elderly is situated to the northeast side of the house (-2). This gives a total score of 2 (5-1-0-2=2). For the C9 index, the kitchen is not located in the centre of the house (0) and it does not face east (-2). The kitchen is well separated from the well (0). This gives a total score of 3 (5-0-2-0=3). The C10 index has a score of 4 (5-1-0-0=4) as there are no ancillary buildings attached to the west side of the main house (-1). There is no bathroom on its northeast side or southwest side (0) and the toilet is located on the edge of the site (0).

Yangjindang scores 33 out of 50 from the ten key Feng-Shui indices. Applying this methodology to the three other houses to quantify the degree of implementation of Feng-Shui indices produces the results in the table below. Hyangdan has the highest score of 38 among the four houses compared. The second highest score is 36 for Nokwoodang. Yangjindang and Unjoroo scored lowest with 33 points. However, this is still a relatively high score, considering that 50 is the maximum.

Table 3. Feng-Shui scores of four traditional Korean houses

Index	Yangjindang	Hyangdan	Unjoroo	Nokwoodang
C1	0+1+2=3	2+1+2=5	2+1+2=5	2+1+2=5
C2	5-0=5	5-0=5	5-1=4	5-0=5
C3	5-1+0+0=4	5+0+0+0=5	5+0+0+0=5	5+0+0-1=4
C4	2+1+0=3	2+0+0=2	2+1+2=5	2+1+0=3
C5	2+0+0+0=2	2+2+0+0=4	2+2+0+0=4	2+0+0+0=2
C6	5+0+0+0=5	5+0+0+0=5	5+0+0+0=5	5+0+0+0=5
C7	5+0-1+0=4	5+0+0+0=3	5+0-1-2=2	5+0+0+0=5
C8	5-1+0-2=2	5-1+0-2=2	5-1-2-2=0	5-1+0-2=2
C9	5+0-2+0=3	5+0-2+0=3	5+0-2-1=2	5-2-2+0=1
C10	5-1+0+0=4	5-1+0+0=4	5-1+0+0=4	5-1+0+0=4
Total	33	38	33	36

4.2 Contemporary Korean style houses

Contemporary Korean style houses express Koreanity through the characteristics of the spatial configuration of traditional Korean houses. Similar to the comparisons of the traditional Korean houses above, four contemporary Korean style houses were selected. They are Guinheon, Monghakjae, Soojoldang and Imgeodang. This study explains Soojoldang house in detail.

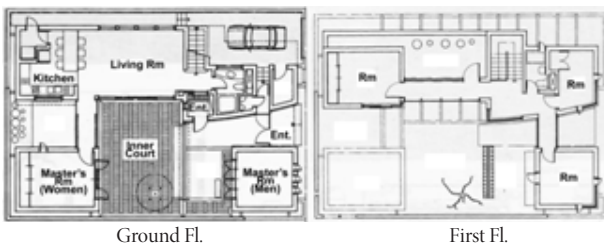


Figure 5. Soojoldang house

The C1 index has a total score of 2 (0+0+2=2) as the rear ground of the site is flat (0). It has a front yard (0) and it is placed lower than the building (+2). For the C2 index, it has a straight road adjacent to the building (-2) which gives a score of 3 (5-2=3). The C3 index has a score of 3 (5-0-2-0=3) because the main gate is located on the centre line of the main building (0). The building is right next to the adjacent road (-2) and the shape of the front yard does not make an acute angle (0). For the C4 index, the building faces south (2) and there are no plants on its northwest side (0). A wide adjacent road is not on its west side (0), which gives a total score of 2 (2+0+0=2).

The C5 index has a score of 4 (2+2+0+0=4) as the proportion of the main building’s floor plan is the ratio of 5:3 (2). The building is not curved or oval in shape (0), nor does it have a 2:1 ratio (0). For the C6 index, the main gate is bigger than the front door of the building (0) and they do not directly face each other (0). The building has a back door (0). This gives a score of 5 (5-0-0-0=5). The C7 index has a score of 2 (5-0-1-2=2) as the building faces south (0) and it has a south-facing window (-1). The living room is not located in the centre of the house (-2).

For the C8 index, there are separate bedrooms and kitchen (0); the main bedroom is not located in the centre of the house (-2); the bedrooms for the elderly face south (0). These give a score of 3 (5-0-2-0=3).

Even though Soojoldang is regarded as a representative contemporary architectural style of Koreanity, it only scores 31, which is the lowest score among the four houses compared. However, it is still not a low score, given the maximum of 50 points. Table 4 shows the results for the other three contemporary Korean style houses to which the ten key Feng-Shui indices are applied.

As shown in Table 4, Guinheon has the highest score of the four houses compared, with 39 points. The reason for this result is, firstly, that it is located in a suburb, and secondly it reflects the strong commitment of the architect and the client’s demand for an eco-friendly design with the nature.

Table 4. Feng-Shui scores of four contemporary Korean style houses

Index	Guinheon	Monghakjae	Soojoldang	Imgeodang
C1	2+1+1=4	0+1+2=3	0+0+2=2	0+1+2=3
C2	5-0=5	5-2=3	5-2=3	5-2=3
C3	5-1+0+0=4	5+0+0+0=5	5+0-2+0=3	5-1-2+0=2
C4	2+1+0=3	2+0+0=2	2+0+0=2	2+0+0=2
C5	2+2+0+0=4	2+0+0+0=2	2+2+0+0=4	2+0+0+0=2
C6	5+0+0+0=5	5+0-2+0=3	5+0+0+0=5	5+0+0+0=5
C7	5+0-1+0=4	5+0+0-2=3	5+0-1-2=2	5+0-1-2=2
C8	5+0-2+0=3	5+0-2+0=3	5+0-2+0=3	5+0-2+0=3
C9	5+0+0+0=5	5+0-2+0=3	5+0-2+0=3	5+0+0+0=5
C10	5-1+0-2=4	5-1+0+0=4	5-1-2+0=2	5+0-2+0=3
Total	39	31	31	32



Figure 6. Lian House

4.3 Contemporary architects' houses

The contemporary architects' houses emphasise their spatial formativeness rather than traditional Korean architectural concepts, defined as 'Koreanity'. Four contemporary architects' houses (L house in Kwigokdong, Lian House, Route House and Vector house) are selected for this study. The degree of implementation of the Feng-Shui for Lian house is as follows.

The C1 index for the Lian house has a score of 3 ($2+0+1=3$), as its rear ground is higher than the front (+2). It has a sloping front yard (0) which is lower than the building (+1). For the C2 index, the house faces the straight road (-2) which scores 3 ($5-2=3$). In the C3 index the main gate is aligned with the centre line of the building (0). The building is not right next to the adjacent road (0) and the outdoor space of the site has an acute angle (-2). This gives a score of 3 ($5-0-0-2=3$). For the C4 index, the house faces east (0) and there are no plants on its northwest side (0). A wide adjacent road is on its west side (2), which gives a total score of 2 ($0+0+2=2$).

For the C5 index, the ratio of the building plan does not make 5:3 (0) and its shape is not round or oval (0). It is not a 2:1 ratio (0), which gives a score of 2. The C6 index has a score of 3 ($5-0-0-2=3$) as its front door is smaller than the main gate (0). It has a back door (0) and the main gate does not directly face the front door (-2). For the C7 index, Lian house faces east (-2) and it has an east-facing window in the living room (0) which is not located in the centre of the building (-2). This gives a low score of 1 ($5-2-0-2=1$).

The C8 index has a score of 3 ($5-0-2-0=3$) as it has a separate living room and a kitchen (0), the main bedroom is not in the centre of the building (-2) and the bedroom for the elderly faces south (0). For the C9 index, the kitchen is not in the centre of the building (0) and does not face east (-2) and a well position is not applicable in this house (0). It has a score of 3 ($5-0-2-0=3$). The C10 index has a score of 4 ($5-1-0-0=4$) as it has no ancillary building on its west side (-1), the bathroom is not on the northeast or southwest side (0), and the toilet is not in the centre of the building (0).

Lian house has a total score of 27 for the ten key Feng-Shui indices. The total scores of the other three contemporary architects' houses are shown in Table 5. L house in Goigokdong has the highest score of 31 among the four houses, but this score is the same as those of Soojoldang and Monghakjae.

Table 5. Feng-Shui scores of four contemporary architects' houses

Index	L house in Goigokdong	Lian house	Route house	Vector house
C1	$2+1+2=5$	$2+0+1=3$	$0+1+2=3$	$2+0+1=3$
C2	$5-3=2$	$5-2=3$	$5-2=3$	$5-0=5$
C3	$5-1+0+0=4$	$5+0+0-2=3$	$5-1+0+0=4$	$5-1+0+0=4$
C4	$0+0+2=2$	$0+0+2=2$	$0+0+2=2$	$0+0+0=0$
C5	$2+2+0+0=4$	$2+0+0+0=2$	$2+2+0+0=4$	$2+0+0+0=2$
C6	$5-2-2+0=5$	$5+0-2-0=3$	$5-2-2-0=1$	$5-2-2+0=5$
C7	$5-2+0+0=3$	$5-2+0-2=1$	$5-2-1-0=2$	$5-2-1-2=0$
C8	$5+0-2+0=3$	$5+0-2+0=3$	$5+0-2+0=3$	$5+0-2+0=3$
C9	$5+0+0+0=5$	$5+0-2+0=3$	$5+0-2+0=3$	$5-2-2+0=1$
C10	$5-1+0-2=2$	$5-1+0+0=4$	$5-1-2-0=2$	$5-1+0-2=2$
Total	31	27	27	21

4.4 Feng-Shui analysis of the three types of Korean houses

Table 6 shows the average scores of the three housing types (traditional Korean houses, contemporary Korean style houses and contemporary architects' houses) applying key Feng-Shui indices.

The traditional Korean houses have an average score of 35.00. The contemporary Korean style houses have an average score of 33.25. And the contemporary architects' houses have an average score of 26.50, which is 6.75 lower than for the traditional Korean houses. This means that the contemporary Korean style houses have adapted more of the Feng-Shui theories into their designs than contemporary architects' houses.

Table 6 presents the average scores of the interior (C1~C4) and exterior indices (C5~C10) of the three housing types. Comparing the results of the exterior indices, the traditional Korean houses (17.00) have a much higher score than the contemporary Korean style houses (13.25) or the contemporary architects' houses (12.00). However, comparing the results of the interior indices, the contemporary Korean style houses have a higher score (20.00) than the traditional Korean houses (18.00) or the contemporary architects' houses (14.50).

Table 6. Feng-Shui scores of the three types of Korean houses

Average	Traditional Korean houses	Contemporary Korean style houses	Contemporary architects' houses
Total	35.00	33.25	26.50
Exterior	17.00	13.25	12.00
Interior	18.00	20.00	14.50

These results imply that the traditional Korean houses implement the key aspects of Feng-Shui theories in their interior and exterior designs with similar ratios (17.00:18.00). Meanwhile, the contemporary Korean style houses and the contemporary architects' houses have implemented those key aspects in their interior designs rather than their exteriors, as the most modern houses are located in the city, which makes it difficult to choose a suitable site as required by the Feng-Shui theories. Therefore, efforts have been made to complement the Feng-Shui theories in their interior space designs. On the other hand, the contemporary architects' houses have relatively low index scores as they have not considered Feng-Shui theories in their designs. In addition, the result showed that even though Feng-Shui theory had been utilised in the architectural planning for a long time in the past, the theory had been weakening its role as the architectural planning methodology until today. This would mean that many aspects and benefits of the theory were not supported by the scientific evidence.

5. CONCLUSIONS

Feng-Shui theories are being reinterpreted as an eco-friendly and sustainable architecture planning and design method in recent years throughout the world as well as in Korea. This study attempted to quantify the key aspects of Feng-Shui theories, which may not have been openly implemented in contemporary architecture planning and design due to their lack of objective methodological development. This study aims not only to determine the degree of implementation of Feng-Shui but also to verify the reliability of the quantification methodology by applying it on three different housing types.

Ten indices (four and six for the exterior and interior related spaces respectively) of the key architectural aspects of Feng-Shui theories have been developed. Each index has three sub-categories

in which each sub-category index has a maximum score of five according to the importance of each item. Therefore, this Feng-Shui quantification methodology with ten indices has been developed to have a maximum score of fifty.

Applying this methodology to the three different types of housing to quantify the degree of implementation of Feng-Shui shows that traditional Korean houses score highest among the three housing types, which is as expected. After that, the contemporary Korean style houses and the contemporary architects' houses follow. This result, as we can easily expect, is very likely to reflect the reliability and objectivity of this quantification methodology, which can be openly and widely used in architectural and urban design practices.

Comparison of the average scores of the interior and the exterior indices of the three housing types shows that the difference in traditional Korean houses is 1 point, but the difference in contemporary Korean style houses is 6.75 and in contemporary architects' houses is 2.50. This seems to reflect the reality of the site selection, which in most of the last two types of housing is limited in densely developed urban cities.

However, only twelve case study houses (four sample houses in each of the three housing types) were used to validate the quantification methodology, which thus requires further research. In further research, at least thirty sample houses for each housing type are required to allow for the generalization of this quantification methodology. Apart from the ten key indices, more indices need to be devised. If the verification of the quantification methodology and the indices of Feng-Shui are developed, Feng-Shui can then be applied in design practice as a scientific and objective architectural and urban planning and design methodology.

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