A Multilevel Urban Landscape Measurement for Zoning Control – A case study of Gushan Kaohsiung in Taiwan

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Abstract: The zoning control in Taiwan is a legal regulation on land that emphasizes binding land use and density rather than landscape shaping of neighborhood, place, district etc. The current system of zoning and urban design guidelines in Taiwan lacks the perspective of urban landscape and results in high similarity of building and street-block's fabrics. The purpose of the study is to provide perspectives of urban landscape, architecture, street-network configuration for enhancing the ability of zoning control and urban design guidelines to describe and control urban form in Taiwan. This article firstly presents quantitative measurements to describe urban form and activities in the scales of streets, plots, blocks, and places. Three measurements are Choice measure of Space Syntax, building density measure by Spacemate, and land-use mixture level of Mixed-use Index (MXI). The data is obtained from the field survey into the detail of building form, uses of every floor, gross floor area of each land parcel of study area, Gushan District, Kaohsiung City, Taiwan. The result supports the information of building density, choice measure, land-use mixture levels in the scales of cadastral land parcels, blocks and places. The measurements and comprehensive classification from the overlay analysis help urban design guidelines of zoning control with the landscape perspective.

Keywords: Spacemate; Space Syntax; Zoning control; Urban Landscape

Introduction

Zoning control of urban planning is one of the most important legal tools that influence urban landscape. It is formulated in the regulations and urban planning regulatory documents under the relevant urban planning system in Taiwan. It mainly emphasizes binding land use and density instead of landscapes shaping in neighborhoods, places, and districts etc.

The current system of zoning and urban design guidelines in Taiwan lacks the perspective of urban landscape, and it results in high similarity of building and street-block's fabrics. Besides, it doesn't think about the relevance between urban physical environment elements (Lin, 2017；Ku , 2018). For example, in terms of land use intensity, Lu, Yueh-Tung (2017) proposed that the intensity of development for a zone decided by Taiwan's planning departments is mainly based on the width of the surrounding roads, no matter what kind of zones it is. When the surrounding roads are wider, the intensity of development is higher. And that means high floor area ratio and more allowable uses. It is a kind of planning thinking based on building management, and it does not take into account the spatial location, activity characteristics, configuration of infrastructures, development potential, and other physical environment elements of the area.

Urban design is also a part of zoning control in Taiwan, and it is implemented in urban renewal areas, land readjustment areas and specially designated urban design areas. However, most of Taiwan's urban design regulation documents are abstract concepts and lack the process of constructing a vision of the urban landscape. A urban design guideline is mostly presented in the form of text and partial drawings under a detail plan. The

urban design regulation lacks a more objective, direct and comprehensive way to be understand the landscape atmosphere of a neighborhood, place ,and district. That makes it difficult to grasp and discuss the overall spatial vision when planners draw up a detail plan and the principle of urban design in the local(Li, 2011). In addition, Taiwan's zoning control lacks the multi-scale discussion. Most of the regulations of zoning control, including the land use, allowable use, floor area ratio and building coverage ratio, are regulated in a block rather than a building lot. Taiwan's development mode is based on each cadastre, and a block usually has several cadastres in the most of regions excluding some big blocks in readjustment areas. That difference between the units in zoning control and development mode in Taiwan leads to the highly similar urban landscape in blocks.

Moreover, urban landscape includes the active landscape and the physical landscape. Hu and Yu (1984) proposed that from the point of view of *The Spirit of Place*, the active landscape is the soul of a place space, while the landscape of the physical environment is the body and skeleton that governs the soul. As a result, when we describe the urban landscape ,we need to analyze both physical landscape characteristics and the urban activities. And the compact development of the city makes vertical development a present and future trend, but the zoning and urban design regulation mainly discuss two-dimensional urban functions and tolerance without considering the impact of vertical space uses on urban landscapes.

Overall, the current system of zoning and urban design in Taiwan focuses on binding land use and building density. On the other hand, the system develops and analyzes the urban landscape respectively by independent fields of urban activities, buildings, landscapes, transportation, and so on(Yang, 2009). It is hard to shape the overall image of the city with the regulation and analysis of the separate elements. The purpose of the study is to provide perspectives of urban landscape, architecture, street-network configuration for enhancing the ability of zoning control and urban design guidelines to describe and control urban form in Taiwan. The study also shows the comprehensive results of overlapping the landscape characteristics in the scales of cadastral land parcels, street blocks and district areas, and the analysis can help urban design guidelines of zoning control with the landscape perspective.

Therefore, this study attempts to analyze the urban landscape of the Gushan District of Kaohsiung City in Taiwan from the perspective of quantitative urban landscape indicators at the cadastral land parcels, street, block, and place scales to understand the interaction between the elements of the urban physical environment and activities. Then it can help urban planners and designers grasp the overall living space of the city and understand the combinations of the elements of urban landscape at different scales. And it can be discussed what kind of landscape is shaped by the different levels of the diversity of vertical space activities.

Figure 1 Location map of the study area
(the left is the area of the Gushan District ; the right is the study area)

Studies and Perspectives of Shaping Built Environment

1. Built Environment Characteristics

The most extraordinary thing in the city is not that their morphological composition is so different, but that elements of their composition is so the same(Hillier, 1996). These elements that form the urban landscape are what this study would measure, analyze. The following discussion is about the elements of urban space and urban landscape in the views of .urban morphology and new urbanism.

From the point of view of Conzenian School, one of the main schools of urban morphology, Conzen (1960) proposed the term *townscape* as the subject of his research, analyzing the three-dimensional form of urban space by three systematic components: town plan, building fabric and pattern of land and building use. *Townscape* is called as *landscape* now. The townscape comprises the three components that are defined below. Town plan is the most spatially 'encompassing' of the three components, and it has become an integrated method named as Town-plan analysis(Oliveira, Marat-Mendes *et al*., 2018). Town-plan analysis investigates the patterns of streets, plots and buildings. *Building Fabric* can be analyzed and discussed by age, building type, construction materials, height and architectural style. *Land and Building Use* is generally considered to broadly recognizable categories such as residential, commercial, industrial, institutional, recreational activity or stand vacant. It shows the most small-scale spatial heterogeneity within the townscape. The three components of essential townscape elements form the physicality of the townscape. It is emphasized that the difference in stability or persistence between elements. As time go by, due to the difficulty in reorganizing and changing the ownership, the street is the most stable element, which refers to the urban street space between a block and a block. The second one is a plot. It can be divided into smaller plots by subdivision over time, or aggregated to form the same size as a block. Land use is the least persistent over time(Caniggia and Maffel 1984).

And the Italian architect Saverio Muratori (1963) proposed the *operational histories* as the basic theory of his architectural design to study the *types*, *organisms* and *urban fabric* for cities of different periods. Gianfranco Caniggia, who inherits the philosophy, continues Muratori's research with *typology* which takes the building

type as the root element of the urban form. And then the philosophy contribute to an important school in urban morphology which apply *typo-morphology* to study urban landscape, such as Giancarlo Cataldi, Gian Luigi Maffei, Maria Grazia Corsini, Paopo Maretto, and Giuseppe Strappa. Most of them continually use this concept to study urban patterns in Italy and other places(Moudon, 1997).

Combining the ideas of the main schools in urban morphology for elements of urban landscape, there are some important elements as follows. Conzenian school mainly uses streets, plots, architectural structures, and land use as the main elements of the study, and Muratorian school emphasizes the types of buildings in order to study the urban patterns in different periods.

In addition, under the wave of new urbanism and rationalism, more and more scholars discuss that the formation of urban space is closely related to the diversity of urban activities. They believe that the diversity of urban activities helps shaping good space of a city. Jane Jacobs (1961) proposed that urban streets and the surrounding land use constitute the urban space. The diversity of land use is important for the quality of urban public life and improving urban vitality, and it also stimulates the vertical development of the physical environment. Strict and single land use can make urban life disappear (Jacobs, 1993; Hoek, 2008). Following the context, the concept of compact city has also arisen. It has a great impact on urban design, emphasizing the importance of mixed use, high-density development, and development of mass transit to the city.

Integrating the aforementioned the ideas of urban morphology and new urbanism, this study considers that the elements of urban landscapes include streets, buildings, land uses.

2. Measuring Urban Forms

Besides, there are some researches about urban landscape by measuring some indexes. Space syntax , Spacemate and Mix-use Index are the most common methods to use in researches of urban landscape. Space syntax combines scientific analysis with people-oriented concepts, spatial analysis method based on spatial topology. Lots of researches use it to analyze the spatial configuration, connection of road network, space potential, etc. It is used to explain how human and architectural space are connected and the influence of space on social relationships and behaviors. It also classifies the space with spatial logic and establishes rules for the conversion of roads and passages into axes(Hillier and Hanson, 1984;Hillier, 1996).

Spacemate is a 3-dimensional spatial matrix The researches on Spacemate are mostly to discuss the different proportion of negative space and positive space. Spacemate focuses on various types of density on the urban block such as Floor Space Index (FSI), Ground Space Index (GSI), Open Space Ratio (OSR), and the number of floors (L). Spacematrix is a method created by the same people as spacemate. It has one more analysis than spacemate, and that is network density (N).

Burton (2002) believes that the mixed use of land should provide a variety of facilities and services in terms of urban functions. For urban residents, the mixed use of land should be a way of using land facilities that can accommodate both living and employment (Jacobs,1961).

Some studies discuss the combination of quantitative landscape analysis tools, such as Space Syntax, Spacematrix and Mixed-used Index (MXI) as a set of quantitative assessment tools for urban design (Ye and Van Nes, 2014). That has been applied to the assessment of urban design schemes in related research(Ye, Yeh *et al*., 2016). There are not many studies about discussing urban form in Taiwan by using a method of combining spacemate(or spacematrix), space syntax, MXI. Lee (2016)uses Spacematrix and space syntax as two research methods to discuss urban forms in different periods. That replaces traditional research in urban morphology. With quantitative analysis methods, it can help planners to understand the urban form under the more diverse and faster development of cities now. The results of the above two case studies explain the relationship between

the socioeconomic status and urban form of a certain place. And the results help planners to observe the changes in urban density in different periods and learn the speed and shape of urban development at that time.

Methods

1. Conceptual Framework

Looking at the above studies about measuring urban forms, this study uses a conceptual framework as seen in Figure 2 that analyzes the urban landscape through quantifying the elements of *streets*, *buildings* and *land use*. This study would discuss about the individual results of three elements in the cadastral, streets and blocks scales for the study area. Then it shows the integrated results of the three elements and different forms of places.

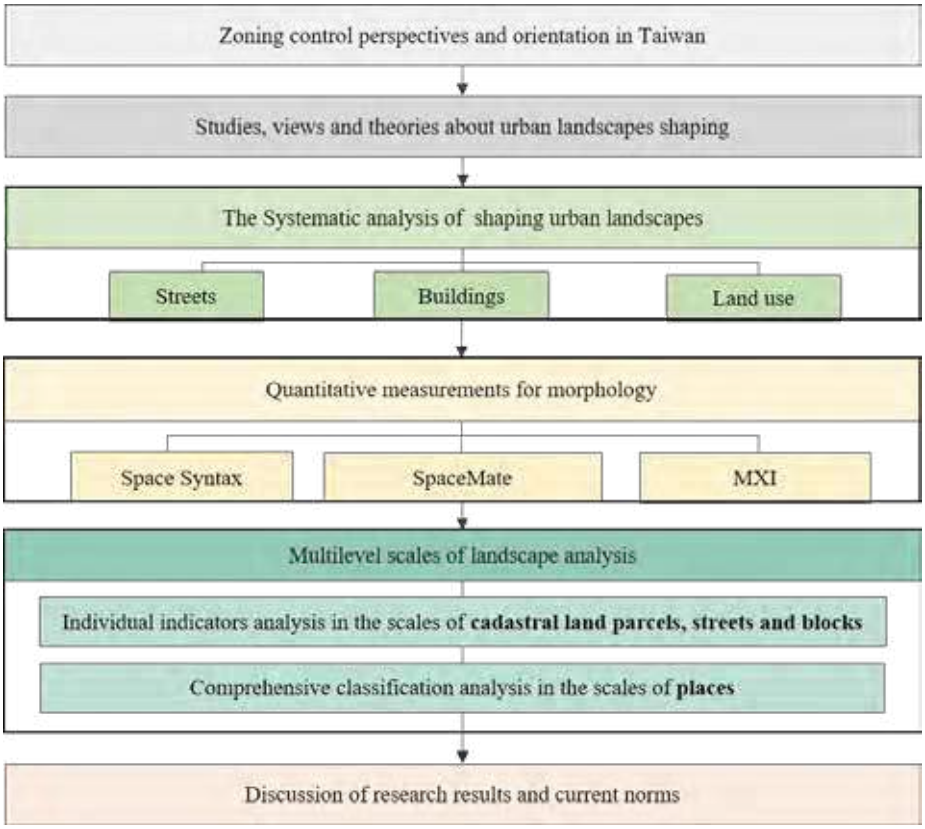

Figure 2 Conceptual Framework

2. Space Syntax

Space syntax is the architectural analysis theory developed by Professor Bill Hillier at University College London in the 1970s. Combining scientific analysis with people-oriented concepts, spatial analysis method based on spatial topology, he develops a set of indicators that can explain the spatial configuration. It is used to explain how human and architectural space are connected and the influence of space on social relationships and behaviors. It also classifies the space with spatial logic and establishes rules for the conversion of roads and passages into axes(Hillier and Hanson, 1984; Hillier, 1996).

Hanson (1999) discussed the forms of residential buildings in different eras with Space Syntax, and then Alasdair Turner assisted in the development of DepthMap software that integrates all the theories and techniques of spatial structure, increasing the production of visual graphics, speeding up the calculation, and automatically drawing Axis diagrams, etc. After the software emerged, Space Syntax is widely used in the researches in the architectural or urban scale(Huang, 2017), and become one of the main quantitative methods for studying Urban Morphology.

In this study, the choice which's indicators of Space Syntax focuses on measuring the extent of use of the road network. Hillier and Yang *et al*. (2012) pointed out that the *Integration* represents number of turns for selecting the another node as the destination from the starting point. *Choice* represents the number of times for the node being selected in all movements. These two indicators are both essential elements for measuring spatial mobility potential. Space Syntax can reproduce the moving characteristics of people in space. The areas where the integration or choice are relatively high are the locations that are easy to reach and pass in the space, but these values do not represent the actual distance (Hillier and Hanson, 1984).

The values of Integration and Choice are based on the least length, fewest turns, or the least angle respectively to calculate the shortest path. Choice is more suitable to reflect and predict human movement patterns (Peponis, 1989;Turner, 2016). In addition, Turner (2016) proposed that the angular segment analysis algorithm shows a better correlation with observed vehicular flow than the standard axial analysis and block-distance measures. Because this study will explore the relationship between land use patterns and street activities, it uses choice as a measurement for this area. Simply speaking, choice is to calculate the number of times for a node being selected, and therefore choice can also seen as the ability of a space to attract people. In general, most urban activities choose the shortest topological path, being calculated based on the total angles of the turn to reach the destination. This study uses the segment map which is converted from the road centerline of the local road network map of Gushan District, Kaohsiung City as seen in Figure 3 to calculate choice by angular segment analysis. The result of choice is recorded in the Cadastral map of the study area as seen in Figure 4 in the scales of cadastral land parcels.

Figure 3 Route Map of Gushan District, Kaohsiung City

Figure 4 Cadastral map of the study area

3. Spacemate

Spacemate is a quantitative method derived from the request of a typical post-war urban suburbanization in Amsterdam, the Netherlands. It assesses the density of buildings in the urban space. The density of buildings and building types are used to evaluate the urban environment during the process of planning and designing. They affect the various aspects of urban planning(Berghauser Pont and Haupt, 2005). Spacemate is a classification of regions of different urban forms by four quantitative indicators : Floor Space Index (FSI), Ground Space Index (GSI), Open Space Ratio (OSR), Layer (L). It is worth noting that the above indicators use the actual Floor area ratio and building coverage ratio rather than the ratios of legal regulations. The four indicators are placed in the 2-dimensional spatial matrix. According to the values of these four indicators, the study divides the matrix into sub-regions to represent different urban forms. That can help to understand how different combinations of four indicators of urban building density will form the urban form and create the classification of the built environment.

In this study, the data processing of Spacemate calculation is divided into the building density and building type. The building density of this study is adopted Floor Space Index (FSI), Ground Space Index (GSI), and the number of floors (L) as indicators for quantifying building density. The types of building are divided into three types: point type, strip type and block type. The buildings of point type are such as single-family building. The buildings of strip type are such as terraced houses. The buildings of block type are such as high-rising buildings. In addition, the analysis is divided into two scales: cadastral land parcels and blocks. The indicators and purposes are different between the analysis in two scales. The analysis in the scale of blocks is used to overlay the MXI and Space syntax results while the analysis in the scale of cadastral land parcels is used as a reference for observing detailed urban patterns.

Table 1 The data used for spacemate analysis

Analytical scale	index	Value/type	Data processing oriented
blocks	Floor Space Index (FSI)	FSI = floor area of all buildings in a block divided by the area of a block	Building density
	Ground Space Index (GSI)	GSI = The area of all buildings in a block divided by the area of the area of a block	Building density
cadastral land parcels	Average number of floors (L)	L = The total number of floors of all buildings in the a land parcel divided by the number of buildings in a land parcel	Building density
	building types	point type/strip type / block type	Building Type

4. Mixed-use Index (MXI)

The concept of compact city is on the rise with Mixed-use Index (MXI) to study the urban type, urban design, urban activities. Some studies use the elements such as work, residence, facilities as the main classification, and each plot can be comprehensively judged by the degree of mixed-use (Ye and Van Nes, 2014;Ye, Yeh *et al*., 2016). The further analysis of the degree of urban spatial vitality, urban development, and urban types with the overlapping analysis of MXI and other morphological quantitative indicators. Besides, using Shannon's diversity index (SHDI) to determine land use diversity is a method of calculating the values of the entropy based on the concept of the biodiversity in ecology. The method has been used in land in recent years to judgments on the diversity of the land uses(Frank, Sallis *et al*., 2010; Dhanani, Tarkhanyan *et al*., 2017).

In order to judge the mixed use of urban land in Taiwan, this study is based on Taiwan's land use survey classification and actual observations. And the land uses is classified into residential, commercial, productive, infrastructure, and other use.

Table 2 The contrast between the classification of this study and Taiwan's land use survey classification

Classification of Land use in the study	Taiwan's land use survey classification
Residential (R)	Residential
Commercial (C)	Business
Productive (P)	Manufacturing, warehousing
Infrastructure (I)	Institutions, schools, health care, social welfare facilities, public facilities, environmental protection facilities, cultural facilities, park green space, leisure facilities, road related facilities
Other use(O)	Vacant land, religion, funeral, other construction land

This study explores the entropy of land uses. Zhang (2007), Frank and Pivo (1994), Cervero (2004), and Song and Knaap (2004) used the entropy of land uses for the studies of mixed land use. The more uniform and disordered the system is, the larger the representativeness is, and the larger the relative entropy is. The more systematic the system is distributed, the smaller the representativeness is. And the smaller the relative entropy value is. The significance of the entropy value on the block scale is the proportion of the land use in the blocks. The larger the entropy value, the more uniform the distribution of various land uses. The more mixed types, the more diverse urban activities occur in the spatial scale of the street. The entropy formula is below.

$$-\sum_{i=1}^{n} MXI_i * ln\, MXI_i$$

Where i represents the different land use classifications of blocks

Calculate the entropy values of the various blocks and classify them through the number of times distribution maps through ArcGIS as a way to judge the degree of mixed use of the blocks.

Multilevel scales of landscape analysis and result

1. Analysis of urban landscape at the scale of streets with Space Syntax

The result in the block scale of Space syntax is as seen as Figure 5. The study calculates choice by the road network map via DepthmapX. In this study, the result of the road network is divided into eight categories according to the number of times as seen as Figure 6. The red lines in Figure 5 mean that there are highest values of choice on these roads such as Zhonghua 1st Road and Mingcheng Rd. The two roads are both the main road that can fast be passed through and get to other regions as seen as Figure 7 and 8.

Figure 5 Angular choice analyses of the study area with Space Syntax

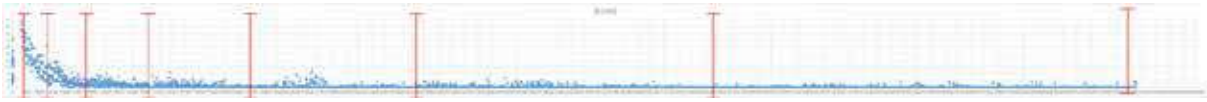

Figure 6 The distribution map of the choice value of the road network

Figure 7 Zhonghua 1st Road

Figure 8 Mingcheng Rd

2. Pattern of urban landscape at the scale of cadastral land parcels

The landscape at the scale of cadastral land parcels can be discussed by the results of Space Syntax, spacemate, and MXI. First, the study uses the result at the scale of the streets of the Space Syntax as seen as Figure 5 and outputs the result that contains 8 levels of choice values to ArcGIS software to overlap with the Cadastral map. Number 0 is the lowest level of choice value while number 7 is the highest level of choice value. The choice values of the segments are as the basis for coloring each cadastral land parcel. The result of Space syntax at the scale of cadastral land parcels is as seen as Figure 9. The land parcels by the highest level of choice values are colored red. It's obvious that the large plot of land where Kaohsiung Museum of Fine Arts is located and the land parcels on both sides of Meishu East 2nd Rd and Mingcheng Rd are also red.

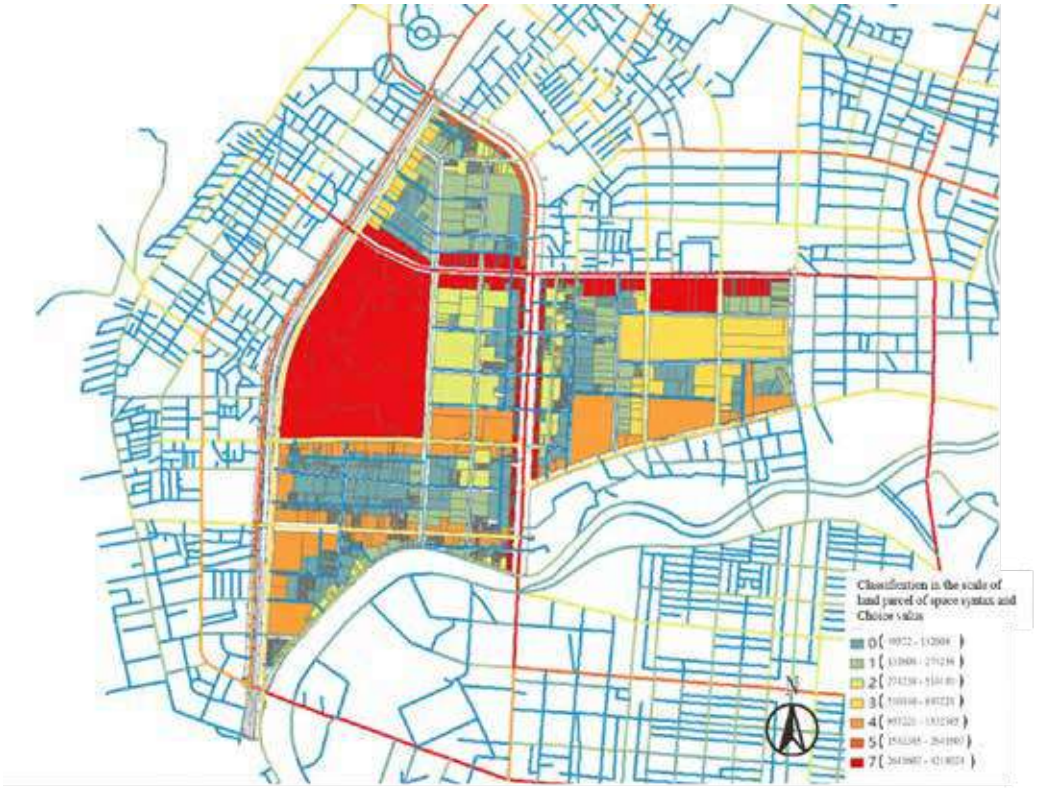

Figure 9 The result of Space Syntax by calculating choice values in the scale of cadastral land parcels

The analysis of building density uses the average number of floors of buildings and building types in each cadastral land parcel. The number of floors is divided into low level (0~2 floors), medium level (3~9 floors) and high-rise level(over10 floors), according to the common building forms in Taiwan.

There are three categories based on the building types. The building types are divided into point type, strip type and block type, as seen as Table 3. The buildings of point type are such as single-family building. The buildings of strip type are such as terraced houses. The buildings of block type are such as high-rising buildings. In this study, the value of the open space and vacant land is listed as another category. The Table 3 shows the building density categories which combine the 3 types of building forms and 3 categories of the average number of floors of buildings.

It can be seen as Figure 10 that the open space and vacant land are mainly distributed on the east side of the study area, and Aozihdi Forest Park and its surroundings form a distinct distribution of the building density as seen as Figure 11. The northwest side of the study area is dense, and the numbers of floors of buildings there are basically over 10 layers as seen as Figure 12. So the map shows a clear dark color for the high building density.

Table 3 Building Density Categories

Building Density Categories	Basis of Classification
High (3)	medium level with the strip type, medium level with the block type, high-rise level with the block type
Medium (2)	medium level with the point type, high-rise level with the point type, high-rise level with the strip type
Low (1)	low level with the point type, low level with strip type, low level with the block type
Vacant land and open space (0)	no buildings

Figure 10 The distribution map of building density categories in the scale of cadastral land parcel

Figure 11 Aozihdi Forest Park and its surroundings

Figure 12 The northwest side of the study area

The result of MXI at the scale of blocks shows below. I (Infrastructure) is obviously the largest category of the main use category in the study area, such as the main park, art museum. The second is the R (residential) category because there are many residential buildings in the study area. Even if the first floor of some buildings is for commercial use, the main use is residential. P (productive) is concentrated in the southern half of the study area, and its use mainly in warehousing and manufacturing. O(other) is based on the use of open space or vacant land.

The distribution of mix-use levels in Figure 13 to 18 below can be seen that the proportion of different vertical uses in the scale of cadastral land parcels. Then the main land use of a single parcel is known. Most of the parcels beside the main roads and parks are mixed-use, and there are usually commercial or infrastructure use in the low floors in those parcels. According to the survey data of this study, the distribution of different land uses

on each floor can be colored on several maps. Those maps can become the reference of the database when planners reformulate or adjust the local plans for urban design and land use control in the future.

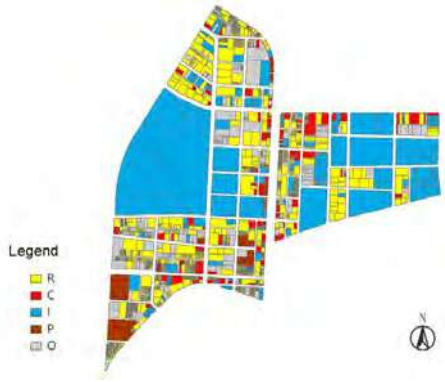

Figure 13 Main land use distribution map at cadastral scale

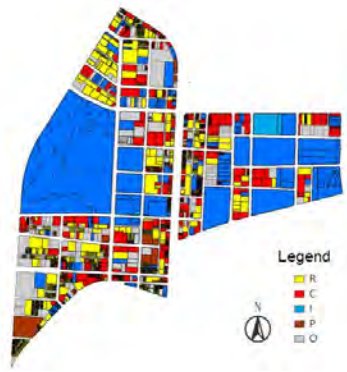

Figure 14 Distribution map of land use status on the ground floor

Figure 15 Distribution map of land use status on the 2nd floor

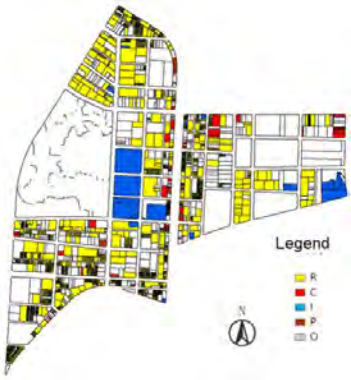

Figure 16 Distribution map of land use status on the 3rd floor

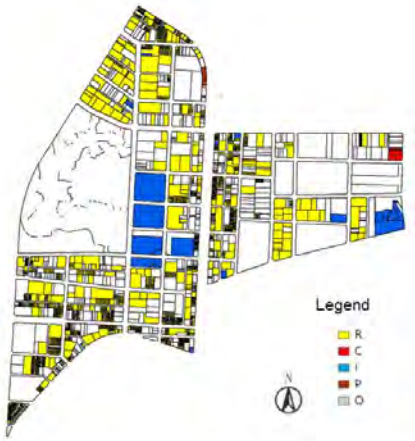

Figure 17 Distribution map of land use status on the 4th floor

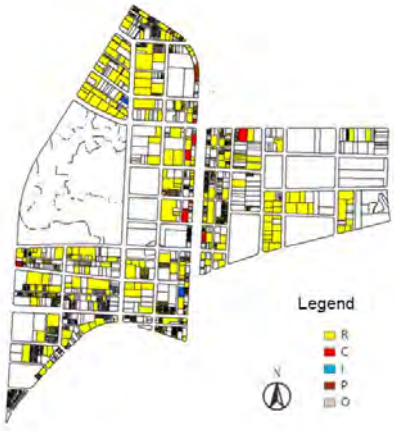

Figure 18 Distribution map of land use status on the 4th floor above

3. Pattern of urban landscape at the scale of blocks

The landscape at the scale of blocks can be discussed by the results of Space Syntax, spacemate, and MXI. First, the study selects the highest choice value surrounding the blocks as the basis for coloring those blocks as seen as Figure 19. Compared with the actual local development situation, the result shows that the areas with the highest choice value are indeed highly developed than the other areas with a low level of choice. The road network of

the area with the lower value of choice mostly serves the neighborhoods and the communities. The blocks surrounding by the roads with the highest choice value are usually highly developed, while those with a lower value of choice are mostly surrounded by residential buildings.

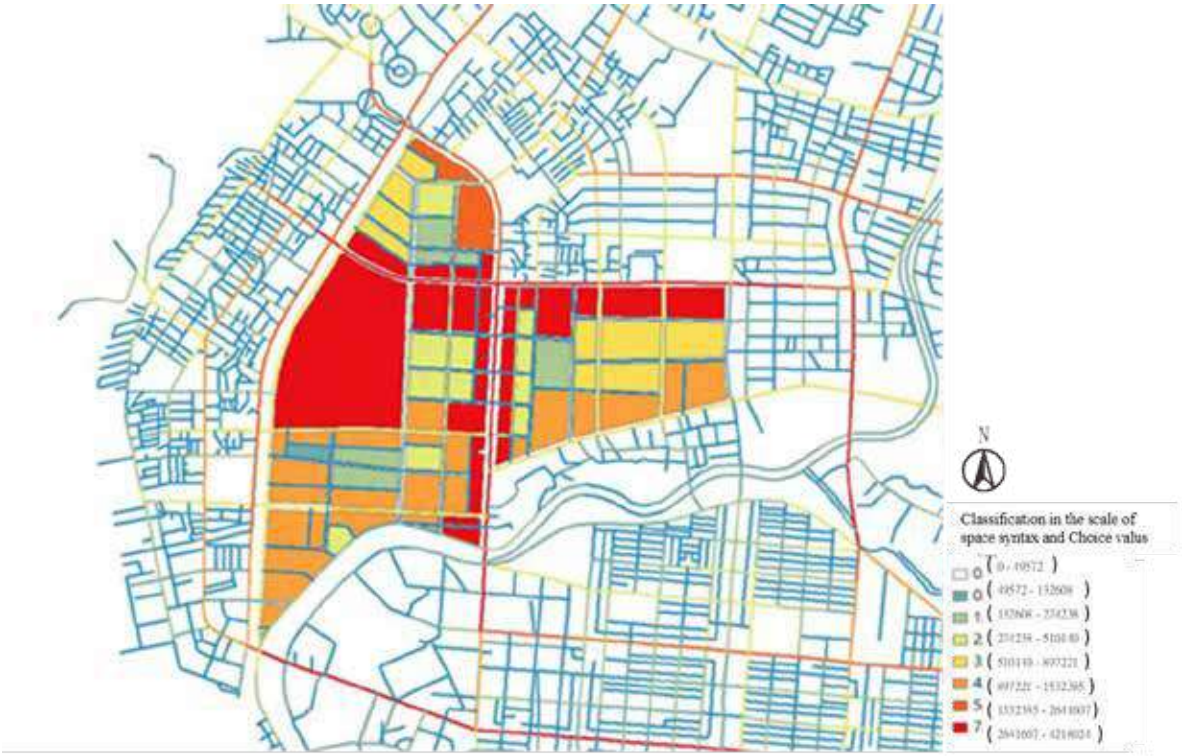

Figure 19 The result of Space Syntax by calculating the value of choice at the scale of blocks

The results of Spacemate at the scale of blocks are based on the analysis of the indicators such as the average Floor Space Index(FSI) and Ground Space Index(GSI) of each block. The indicators are used to describe the different spatial density distribution of blocks. The FSI is the description of the influence of the elevation of blocks on the urban system, and the result is as seen as Figure 20. FSI corresponds to the actual floor area ratio, and the GSI corresponds to the actual building coverage ratio in the built environment. Through the scatter map and the actual observation of the types of the blocks, the study divides the street blocks into five types such as low building coverage ratio with low floor area ratio, medium building coverage ratio with low floor area ratio, medium building coverage ratio with medium floor area ratio, medium building coverage ratio with high floor area ratio, and high building coverage ratio with low floor area ratio.

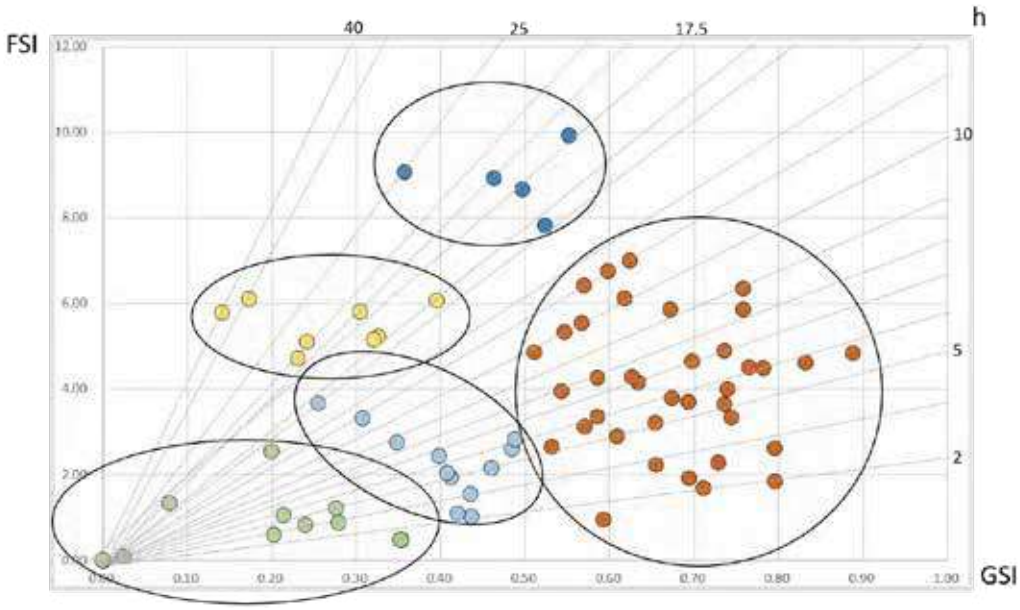

Figure 20 Spacemate classification matrix in the scale of blocks

Through the above five classification results, the spatial distribution map is as seen as Figure 21. Within the scope of the study, the blocks beside the river which is located at the southernmost part of the study area are mostly with high building coverage areas. The followed areas are by the two sides of Zhonghua Road. The areas of low building coverage ratio with low floor area ratio are distributed around the Kaohsiung Museum of Fine Arts and near the Forest Park.

Figure 21 Spacemate classification map in the scale of blocks

On the other hand, the result of MXI in the scale of the blocks shows below. According to the distribution map of the entropy value of blocks as seen as Figure 22, the study divides blocks into five levels, which represent low mixed-use, medium-low mixed-use, and medium mixed-use, medium-high mixed-use, high mixed-use.

Through the above five levels, the spatial distribution map is as seen as Figure 23. The high mixed-use blocks are distributed in Zhonghua 1st Road and Mingcheng Road along the street segments. Due to some undeveloped areas and the existence of two large green open space in the study area such as Kaohsiung Museum of Fine Arts and Aozihdi Forest Park, the low mixed-use is obviously distributed around them.

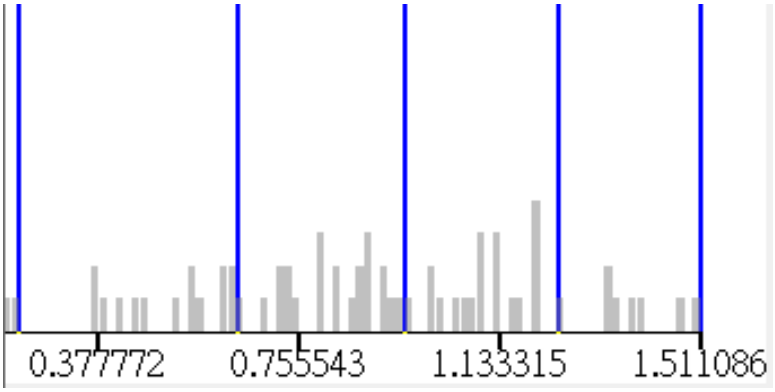

Figure 22 The distribution map of the entropy value of blocks

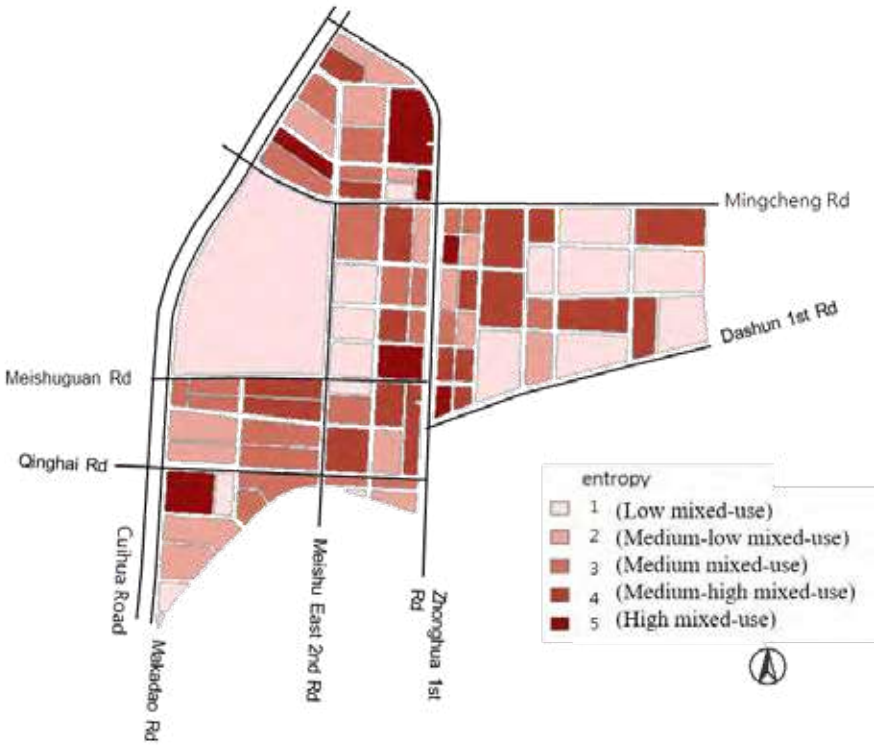

Figure 23 The spatial distribution map of the entropy value of blocks

4. Comprehensive classification analysis in the scales of places

Combining the results of the previous individual indicators, this study combines those results to classify different types of places. Blocks and road networks are relatively difficult the landscape to adjust in a short-term,

so the study combines the results of the three quantitative methods at the scale of blocks to analyze the regional potential and mixed development by using the choice of the road network as main reference basis of classification.

The study area is firstly divided into high potential, medium potential, and low potential by choice values of the road network, then obtaining the final classification through combining the level of development and attributes of blocks. The classification as seen as Figure 24 includes six sorts like low-potential area, single-land-use development medium-potential area, and mixed-use development medium-potential area, low-development high-potential area, medium-development high-potential area, high-development high-potential area.

High-development high-potential areas are mostly with the high level of choice values, building density, and mixed-use. As seen as Figure 25, buildings in the area are mostly over 10 floors and have over one kind of land use excluding residential use. And they all face main roads in the study area. The FSI and GSI values of medium-development high-potential area are mostly higher then low-development high-potential area. As seen as Figure 26 and 27, the difference between the two areas is the actual building coverage ratio.

It's clear that there is the buildings in mixed-use development medium-potential areas are mostly three- or four-story terrace houses and have commercial or other uses on the ground floor while the buildings in single-land-use development medium-potential areas are mostly the same use on every floor, such as residential use, as seen as Figure 28 and 29.

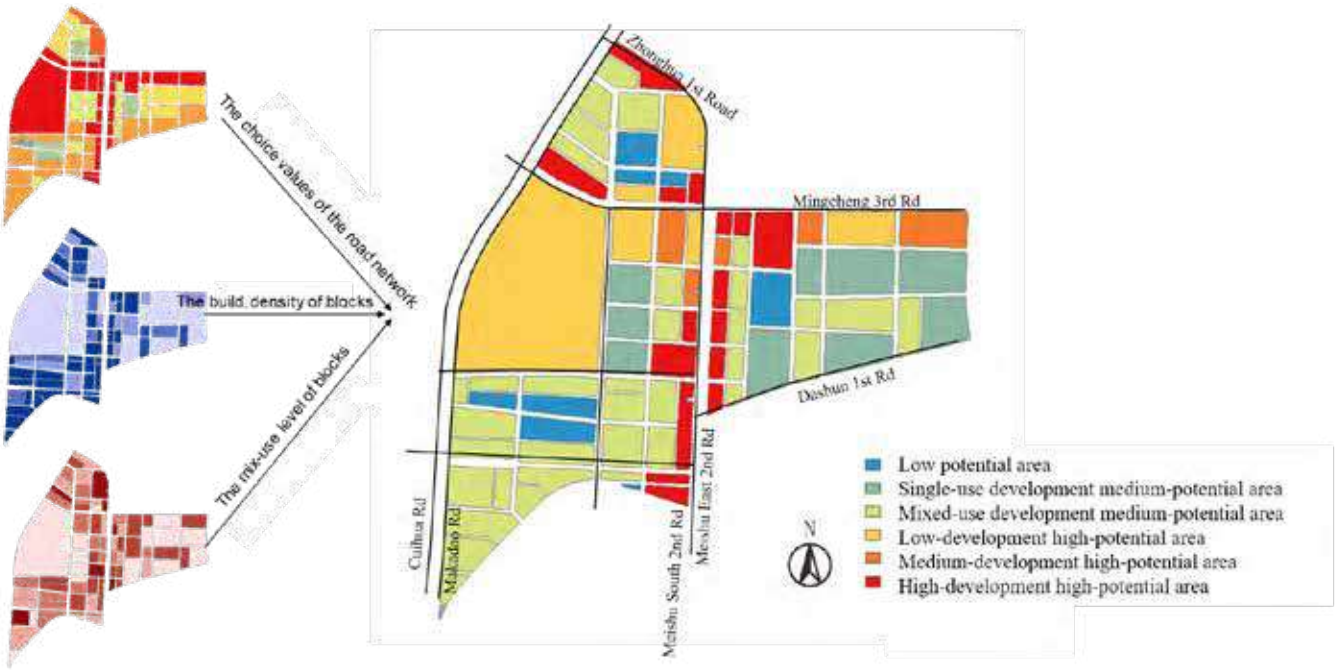

Figure 24 Development level map

Figure 25 High-development high-potential area

Figure 26 Medium-development high-potential area

Figure 27 Low-development high-potential area

Figure 28 Mixed-used development medium-potential area

Figure 29 Single-land-use development medium - potential area

Figure 30 Low potential area

Discussion and Conclusions

The purpose of the study is to provide perspectives of urban landscape, architecture, street-network configuration for enhancing the ability of zoning control and urban design guidelines to describe and control urban form in Taiwan. At the scale of the streets, the result of choice value of Space Syntax can be used to describe numbers of times that roads are passed through for. Most of lands by the roads that have high choice values are highly development, and the landscapes on them are tall buildings and commercial shops.

From the perspective of cadastral scale, it can be understood the relationship between land use of each cadastral land parcel and the neighboring road network in the analysis of the more detail scale. And that can help planners to formulate a more detailed plan on land. The results of Space Syntax, building density, the land use survey at the scale of cadastral land parcel, as seen as Figure 9, 10 and 13, show that the roads with the highest choice values are mostly the main roads in the study area. That means that the plots beside those roads have high development potential and more diversity of land use. Conversely, road segments with lower choice values are more suitable for residential use. In the future, it may be suggested that the lands by those roads can be planned for more suitable landscape.

The analysis of landscape at the cadastral scale can tell more precise details than the analysis of landscape at the scales of blocks and places. Compared with the true landscape, the result at the scale of blocks may be a little distorted due to the average values for all land parcels at the same block. However, it also needs to have an overview for the whole landscape when planners make the zoning control and urban design guidelines. Analysis at the scale of blocks is useful for zoning control and urban design guidelines in Taiwan now because the related

regulations of zoning control and urban design guidelines are mostly based on conditions of blocks and streets either than cadastral land parcels.

As mentioned in the previous literature, the urban landscape includes the active landscape and the physical landscape(Hu and Yu, 1984). The comprehensive classification analysis at the scales of places is important for completely grasping the landscape of each place in a region. For example, the low-development high-potential area mostly faces the main roads and filled with open spaces, one-story houses, or just undeveloped vacant lands. The area may be a kind of places that are flexible to adjust its zoning control and urban design guidelines to let it develop faster and suitable for its context. Through the comprehensive analysis at the perspectives at the scale of places, it can be known the shapes, the diversity of activities, and potential of the place.

There are two limitations to this study. One of the limitations encountered is that it's impossible to obtain the latest cadastral map, road network map, digital topographic map which are published in the same year. And the existing land use survey results record only the main use of land. There's no record of three-dimensional land use. Therefore, the three-dimensional pattern of urban activities cannot be accurately described. Another limitation occurs when performing the Spacemate analysis. The shape and area of buildings on the digital topographic map are not accurate due to the incomplete registration of construction or illegal construction. So this study takes lots of time to measure the actual area of buildings.

In addition, the study is based on the empirical investigation of in a readjustment area in Kaohsiung that revolves around the art museum, which is an important regional infrastructure. Relatively speaking, the result should be different from other urban areas, such as CBD and suburbs. Therefore, the future research classification criteria can be decided by the conditions of locations.

In the end, the development approach in Taiwan is based on cadastral land parcels. There are different architectural forms for each construction project of the different developers. Although this study has conducted three systems of landscape indicators such as *streets*, *buildings* and *land use* surveyed by the scales of cadastral land parcels and blocks, the final analysis results are based on the block scale. The analysis based on the block scale is carried out to understand the urban landscape of the places and blocks. The future study can use the construction project of the same developers as a unit to conduct quantitative landscape analysis, and compared with the project that belongs to other developers and locations. Then that can help to understand the urban landscape of different actual development bases more clearly and directly.

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