Formosa Journal of Sustainable Research (FJSR)
Vol.1, No.3, 2022: 479-498

Research on Street Characteristics Inside and Outside Cuiwei Village in Qianshan, Zhuhai Based on Depthmap

Junzhang Chen
City University of Macau, Taipa 999078

ABSTRACT: Based on the Cuiwei historical village in Qianshan District of Zhuhai, this study studies the street space inside and outside the village block. With the help of Depthmap and SPSS software, the complex Street axis space is quantitatively analyzed, including the analysis of synergy, spatial form and vitality, pedestrian interface and symbiosis, traffic flow correlation, topological depth and street spatial correlation. Draw relevant conclusions according to the analysis results. In order to provide reference and reference for government management personnel.

Keywords*:* Cuiwei village, spatial syntax, inner and outer streets, historical villages

Submitted: 5 August; Revised: 16 August; Accepted: 26 August

Corresponding Author: U19091105192@cityu.mo

DOI: https://doi.org/10.55927/fjsr.v1i3.890
ISSN-E: 2830-6228
https://journal.formosapublisher.org/index.php/fjsr

INTRODUCTION

Analysis of street synergy in Cuiwei historic district

That is, the correlation analysis between the integration degree correlation parameter and the historical location identification defines the coordination degree of the overall space and the local space organization as the synergy degree, which measures the potential index of the research scope to create sub interfaces, that is, whether there is the possibility of isolation between the internal roads and external roads in the research area, and reflects the aggregation degree of the spatial structure and the accessibility of space. In the theory of spatial syntax, when building the axis model, the x-axis is defined as the global integration degree RN, and the y-axis is defined as the local integration degree RN ', where the value of n' is 3, that is, R3, and the ratio of its synergy degree R3 to RN. The higher the R2 value, the better the correlation between the global integration degree and the local integration degree is. On the contrary, the correlation is weak, and the network system of historical blocks with high synergy tends to be close to the axis structure of a single core, It can be conducive to the gathering of people; Neighborhoods with low degree of synergy tend to be scattered and multi-core structures, and the core is unstable, which will lead to the separation of people.

The linear regression equation of global integration degree and local integration degree is constructed in Depthmap, and the ratio of the two is the degree of synergy, which measures the potential of creating sub interfaces in the research scope, that is, whether the internal streets of the research area are isolated from the external development. If $R2 > 0.7$ and $R2 < 1.0$, the degree of system synergy is high, and the pedestrian flow and vehicle flow in Cuiwei village block form good spatial characteristics, otherwise, it is low.

The scatter distribution diagram is shown in Figure 1. It can be seen that $R2 = 0.398$, and the red dot and yellow dot are far away from the straight line, indicating that the degree of synergy is low. Then import the data into SPSS, and then through table 1, it can be concluded that the Pearson correlation coefficient is 0.432. The figure can be seen that the distribution of points presents an irregular state, and Cuiwei village block is isolated from the outside world, so people cannot reflect the whole through local perception.

The poor coordination within the space indicates that Cuiwei historical block not only has obvious sub interfaces with the outside world, but also has weak spatial recognition and distinctive characteristics. The internal part cannot maintain relatively homogeneous and unified internal attributes, which is reflected in the weak core of the spatial network. From the above analysis of the overall integration and local integration, it can be found that the closed development mode in the rural area has protected the internal historical relics of the historical block within a certain period of time, avoiding the impact of the external development and construction of the block, especially in this area in recent years. The core of the space of the historical block is the straight street of the street. The distributed flow of people can make the space vitality of the street low, while the remaining street network does not play its due role in function and spatial relief. There are obvious sub interfaces with the outside

world, and this boundary also plays a certain role in crowd communication activities. The closure of space makes the people in the area form a fence on their own cognitive map.

With the sound of the horn of urban renewal in Zhuhai, the government has increased the investment in Qianshan area, and the infrastructure has been gradually improved, and more high-rise buildings have been built. There is a strong contrast between the internal and external environment of Cuiwei village. This space cannot establish a good unity and integrity between the spatial nodes in the village block and the overall system, and the local spatial environment is also difficult to reflect the characteristics of the spatial pattern of the overall historical block. The reason is that the spatial quality of each street and lane in the village is different, the difference is large, and the space is messy, which affects people's intuitive experience and makes the spatial agglomeration effect of streets and lanes poor. In view of the above problems, in the space integration of streets and lanes, we should take the main axis as the basis, extend the street space, and effectively connect the streets, lanes and lanes. At the same time, set up relevant signs beside the streets to enhance the recognizability of the blocks. In the reconstruction, we can reasonably divide the functional zones in combination with the street network, and enhan

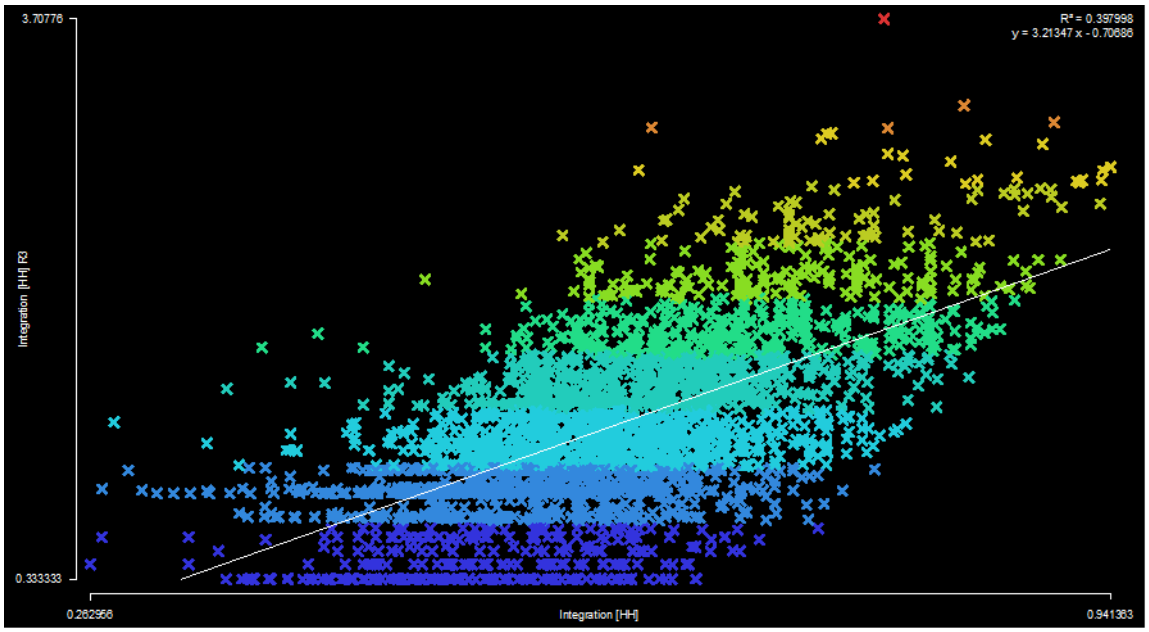


Figure 1. Synergy Analysis Diagram (Generated by Depthmap)

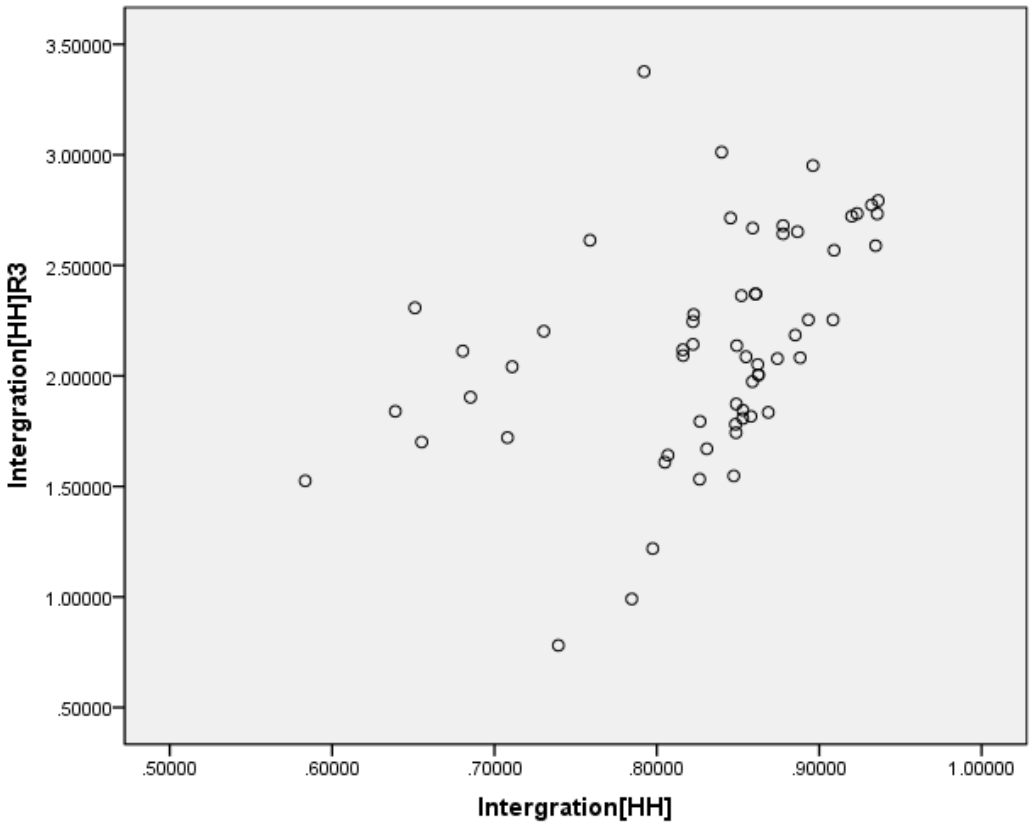


Figure 2. Scatter Distribution Diagram of Global and Local Integration Degrees (Generated by SPSS software)

Image source: drawn by the author

Table 1. Correlation Analysis Between Global Integration and Traffic Flow in Cuiwei Village

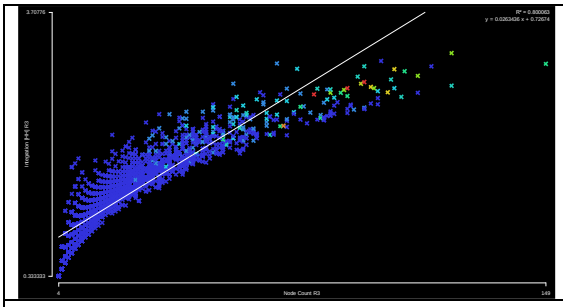
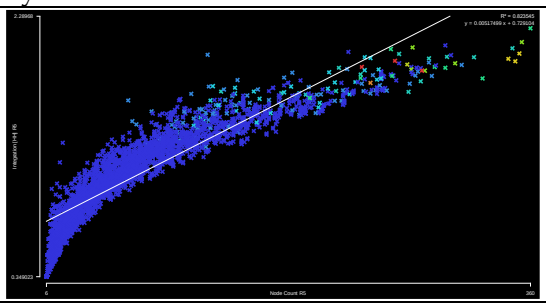
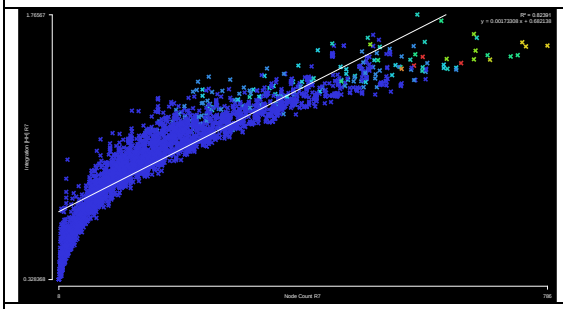
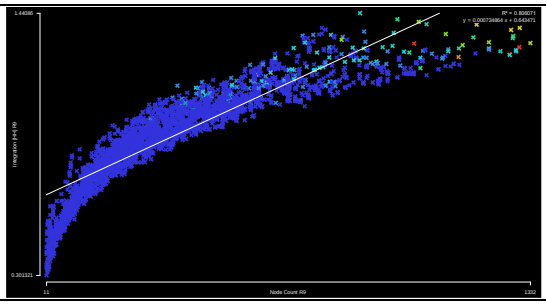
		Global integration	**Local integration**
Global integration	Person correlation	1	0.432
	Significance (bilateral) n		0.001
	(number of cases)	60	60
Local integration	Person correlation	0.432	1
	Significance (bilateral) n	0.001	
	(number of cases)	60	60

Correlation analysis of spatial form and vitality of Cuiwei historical block

In order to further explore the spatial connection and self-organization of Cuiwei historical block, the number of street segments and the degree of integration under different radii are analyzed and studied. The article calculates the correlation between the number density of street segments and the degree of local integration under the parameter radii of 3, 5, 7 and 9, as shown in Table 2. When the parameter radius r=7, r2=0.82391, the correlation is the highest, and r=7 is the radius of the historical city, That is to say, the density and integration of the road network within the historical urban area are the most relevant.

When r=9, r2=0.80607, the correlation decreases. It can be seen from the data that the more complex the block roads are, the more labyrinthine they are, the lower the average degree of integration will be, and the accessibility of the streets will become weak. The road shape of historical blocks and the intensity of communication between people do not show a linear trend. In a certain area of the block, there will be an aggregation effect, forming an external activity site. When it exceeds a certain walking radius, the value will weaken.

Table 2. Analysis on the Correlation Between Spatial form and Vitality of Cuiwei Village
Source: drawn by the author

	
R^2=0.800063 Y=0.026436X+0.72674 Radius 3	R^2=0.823545 Y=0.00517499X+0.729104 Radius 5
	
R^2=0.82391 Y=0.00173308X+0.682138 Radius 7	R^2=0.806071 Y=0.000734864X+0.643471 Radius 9

Intelligibility

Intelligibility reflects the degree of correlation and unity between local fabric and the whole within the village space system. The value of intelligibility can be expressed by R2, which can be divided into local intelligibility and global intelligibility, reflecting whether the space is easy to be recognized by people, that is, local and global intelligibility.

(1) Local intelligibility: in spatial syntax theory, when constructing the axis model, the x-axis is defined as the connection value, and the y-axis is defined as the local integration RN ', where the value of n' is 3, that is, R3. The higher the R2 value, the easier it is for people to infer the perception of space from part to whole, and it is easier to establish their spatial perception image from part to whole, that is, the cognition of the whole space from part. When analyzing the intelligibility of Cuiwei village's historical block, it is suggested to use the experience of walking. In Depthmap, the R2 value is calculated to be 0.51602,

ranging from 0.5 to 0.7. The data is imported into SPSS. The scatter diagram is shown in Figure 3. From table 3, it can be concluded that the Pearson correlation coefficient is 0.813, which is close to 1.

(2)

Table 3. Correlation Analysis Between Connection Value and local integration degree of Cuiwei Village

		Connection value	Local integration
Connection value	Person correlation	1	0.813
	Significance (bilateral)		0.000
	n (number of cases)	60	60
Local integration	Person correlation	0.813	1
	Significance (bilateral)	0.000	
	n (number of cases)	60	60

Source: drawn by the author

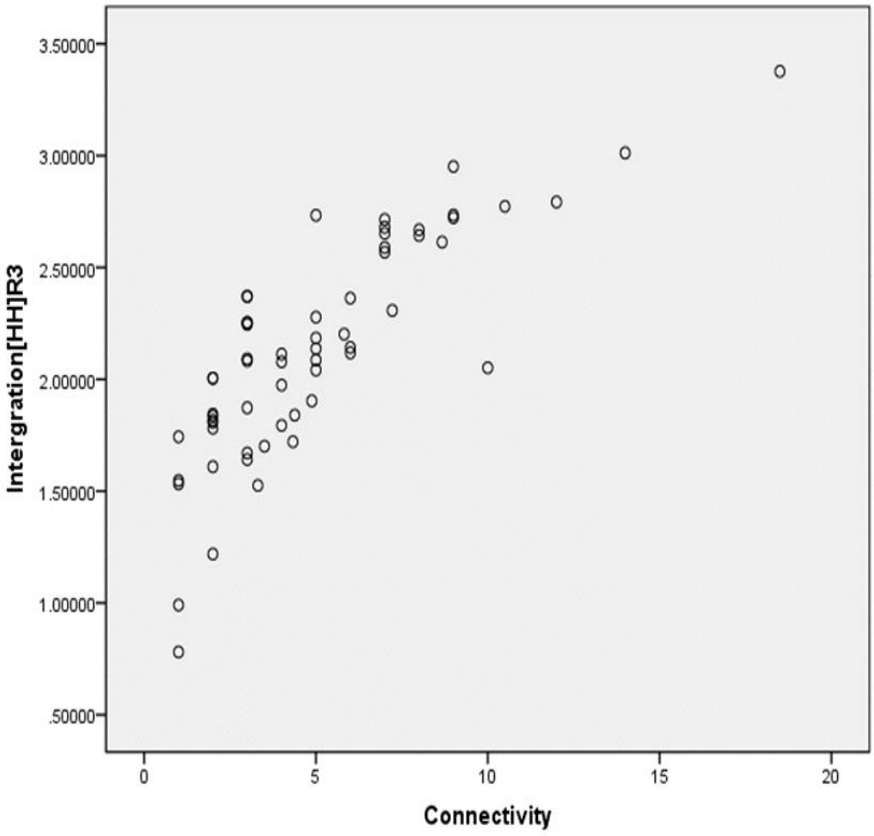


Figure 3. Scatter Diagram of Connection Value and Local Integration Degree (Generated by SPSS software)

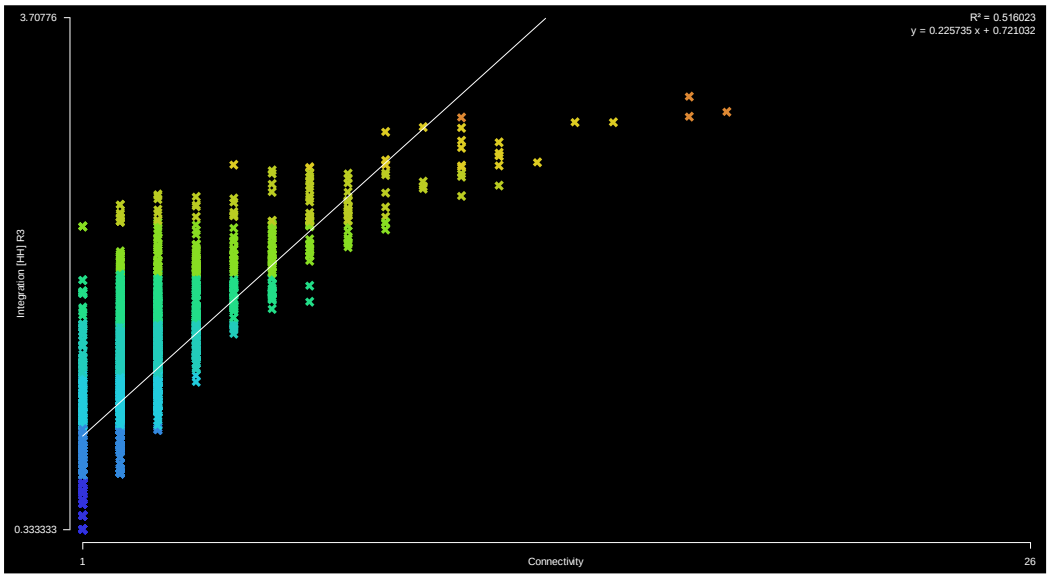


Figure 4. Intelligibility Analysis Diagram (Generated by Depthmap)

Image source: drawn by the author

Cuiwei village, they can predict the spatial form around their location. From the north-south direction, they can walk out of Cuiwei village well along Cuiwei street, street straight street and Dafang street. From the east-west direction, they can also walk out of Cuiwei village along Changshui street. However, it is difficult to grasp the overall spatial form of the region, so sometimes some tourists are easy to lose their way. On the one hand, for Cuiwei village, its block is spontaneous and there is no obvious organization law to follow. Each street is crisscrossed, and the connection and transformation of each street are diverse. When people enter another street from one street, the spatial perception changes greatly, resulting in the low comprehensibility of the block as a whole. On the other hand, along the direction of Cuiwei street, to Dafang street, this street is relatively straight, It can make people clearly judge its spatial direction, so it is easier to judge the spatial morphological characteristics of the front and back of the street, and has better local recognition.

(2) Global intelligibility: construct the linear regression equation of global integration and connectivity, and observe the degree of correlation between the two. If R2 $<$ 0.5, the correlation between global integration and local integration is poor, indicating that tourists and villagers cannot better sense the spatial characteristics of the whole block system through the local spatial characteristics of the block, that is, it is difficult for people to obtain information from the local space to correctly guide the planning and design of the space, It is incomprehensible for people to establish the whole space system.

It can be seen from Figure 5 that r2=0.1195 $<$ 0.5. The analysis chart shows that the distribution of scattered points presents a form of nonlinear layout. The reddest point is far from the straight line, and the overall dispersion is far from the fitting degree curve. The two are completely irrelevant, indicating that Cuiwei historical block is completely lack of spatial characteristics, and the

intelligibility is poor, that is, local space does not have the guidance of walking direction, and it is easy to get lost, The overall spatial laws or characteristics are not obvious and prominent enough, and residents or tourists are not easy to perceive the macro composition of the block space according to the environment composed of the micro elements of the local space.

Through the analysis of the geometric properties of the axis model, it is found that the spatial characteristics of the texture of the streets and lanes in the historical block show irregularity, and the coefficients of T-shaped roads and guillotine roads such as Zhonghe Li, Renhe Li, Tengfeng Li and Nanming Li are obviously high, which also confirms the trend of fragmentation of the seventh street, the seventh lane and the first lane, resulting in many places connected with local space can not be well integrated into the overall space system, Therefore, the conclusion based on such visible streets is easy to make tourists and village residents have a poor understanding of the whole system space, which is misleading. Therefore, people's activities show randomness, which greatly reduces the predictability.

Import the data into SPSS, and the scatter diagram is shown in Figure 6. It can be seen from table 4 that the Pearson correlation coefficient is 0.166, which is close to 0. It shows that pedestrians cannot perceive the overall system space when they pass through the local space of Cuiwei village.

Through further observation, it is found that the Yellow scattered points in the system show a state of nonlinear distribution, and are separated from the correlation trend line. The slope is small, indicating that the understandability of the core part of Cuiwei historical block is low, and its spatial system is difficult to be perceived by tourists and villagers, that is, the possibility of being understood by people is very low. In addition, it can be seen from Figure 5 that the Yellow scattered points are located on both sides of the fitting line, There are more yellow points above the straight line than below, and the red points are far away from the fitting line, indicating that the intelligibility of Cuiwei core streets and lanes is quite different from the overall intelligibility, which means that the level of ideality of this historical block will be less prominent in the whole block, and the recognizability of its site features has obvious disadvantages in spatial structure. The sense of place security is poor. In real life, such a space system can often give people unclear direction coordinates.

Table 4. Correlation Analysis Between the Connection Value of Cuiwei Village and the Overall Integration Degree

		Connection value	Global integration
Connection value	Person correlation	1	0.166
	Significance (bilateral)		0.206
	n (number of cases)	60	60
Global integration	Person correlation	0.166	1
	Significance (bilateral)	0.206	
	n (number of cases)	60	60

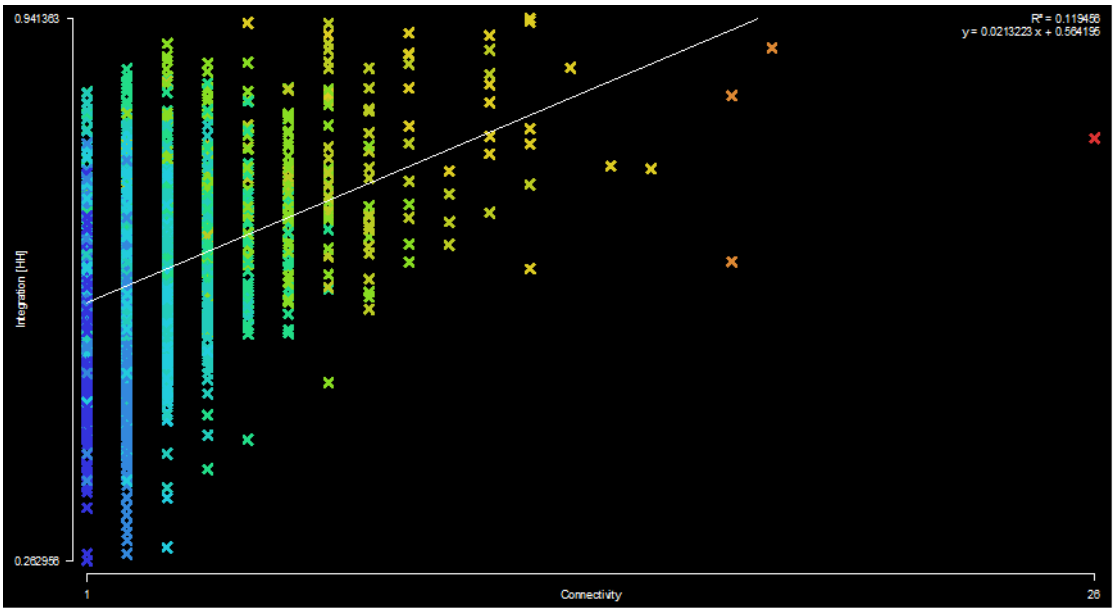


Figure 5. linear Regression Equation of Global Integration and Connectivity (Generated by Depthmap)

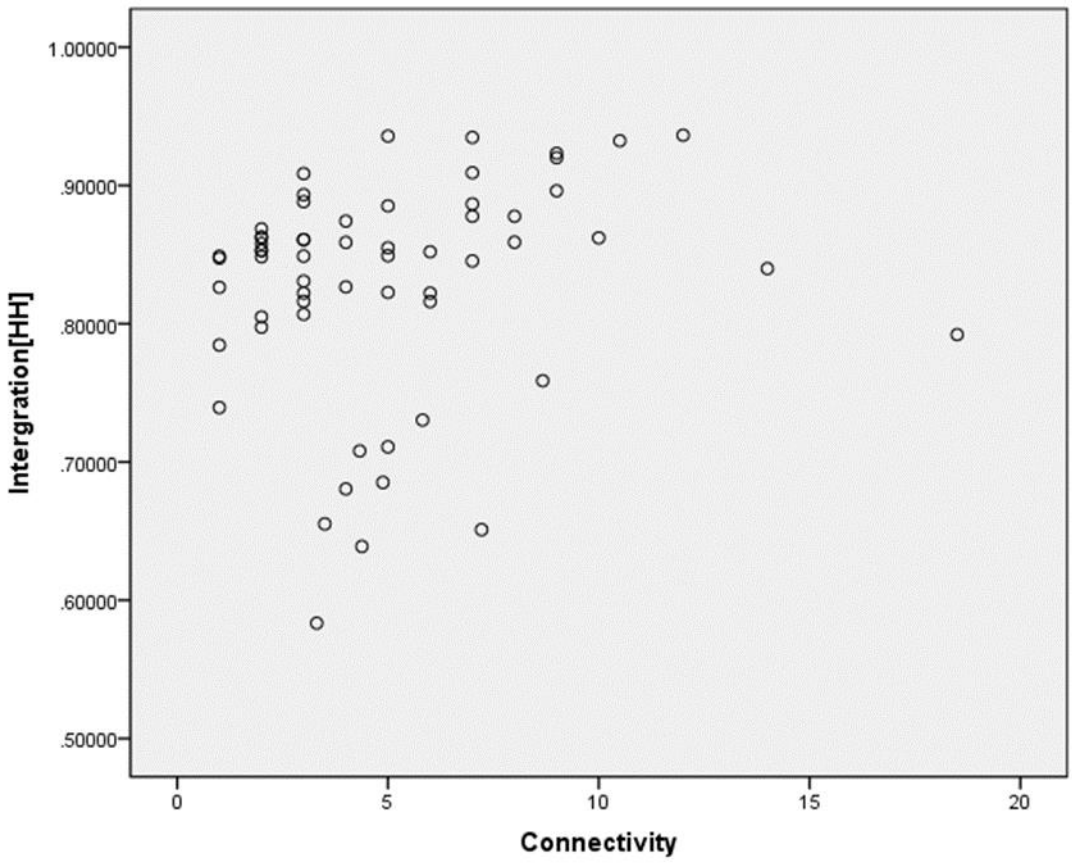


Figure 6 scatter distribution diagram of global integration and connectivity (generated by SPSS software)
Image source: drawn by the author

Analysis of human flow interface and symbiosis degree
Flow interface analysis

By analyzing the correlation between the integration degree of people's activity trend and the choice degree of people's choice of path possibility, it is concluded that the flow interface can reflect the degree of the combination between the internal flow of people and the overall flow of people in Cuiwei historical block. The larger the value of the pedestrian flow interface, the more likely the pedestrian flow is to gather and cross. The attraction of this space is higher, and the smaller the value of the pedestrian flow interface, the less likely the pedestrian flow is to gather and cross. The attraction of this space is low, and the block space network is not conducive to the aggregation of pedestrian flow, which has an adverse impact on the improvement of the spatial vitality of the whole village block. In the spatial syntax theory, when constructing the axis model, the x-global integration degree and the y-axis are defined as the degree of selection (Fig. 7-8). From the overall space, the R2 value is 0.115, both lower than 0.5. The data are imported into SPSS (Table 5), and the Pearson correlation coefficient is 0.085, which is close to 0.

Table 5. Correlation Analysis Between Selectivity and Overall Integration of Cuiwei Village

		Selectivity	**Global integration**
Selectivity	Person correlation	1	0.085
	Significance (bilateral)		0.000
	n (number of cases)	3211	3211
Global integration	Person correlation	0.085	1
	Significance (bilateral)	0.000	
	n (number of cases)	3211	3211

It shows that the correlation is poor, indicating that the global integration degree of the block does not match the global selection degree. This means that Cuiwei historical block tends to separate the flow of villagers and tourists inside the village from the overall flow of people across the block.

From the perspective of economic significance, this trend may lead to the low efficiency of commercial profits in the village under people's "walking economy", which will have an adverse effect on the development of the vitality of the finishing block. From the perspective of cultural significance, this trend is conducive to creating a space with strong cohesion, so as to ensure that the villagers' daily life and learning always play a role in continuing the village culture, and the overall space of the village cannot have a more positive impact on the mobility of the internal space; From the perspective of sociology, this trend may greatly reduce the possibility of gathering and communicating between local villagers and outsiders in the block, which is not conducive to the development of the vitality of Cuiwei historical block and the feedback of the characteristics of the block to people. This means that the core block as a whole presents a state of defense, and the spatial morphological characteristics are cohesive.

According to the investigation and analysis, shengtangli, Cuiwei street, street direct street and Dafang Street are densely distributed, with good commercial functions and human space, high selectivity, and large flow of people passing through. However, the square area in the north of the block for people to rest and stay is small, which greatly reduces the time people stay in the space and affects the overall spatial benefits of the whole Cuiwei block, It has a negative impact on the shared space.

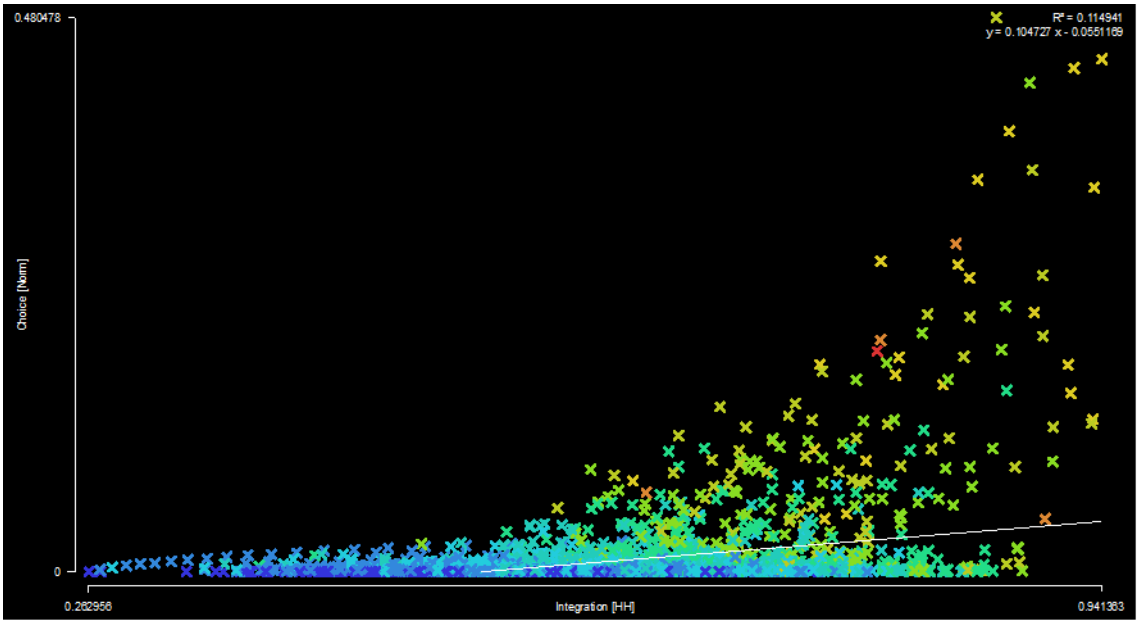


Figure 7. Flow Interface Analysis (Generated by Depthmap)

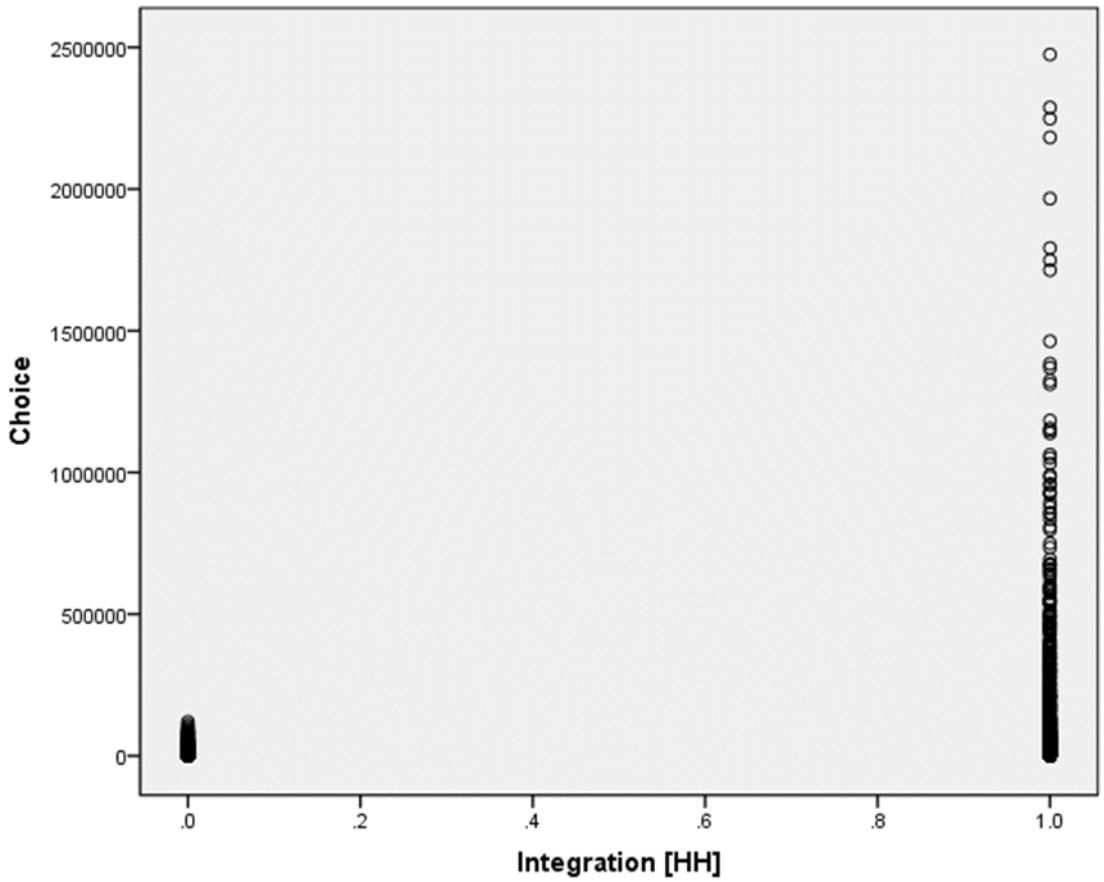
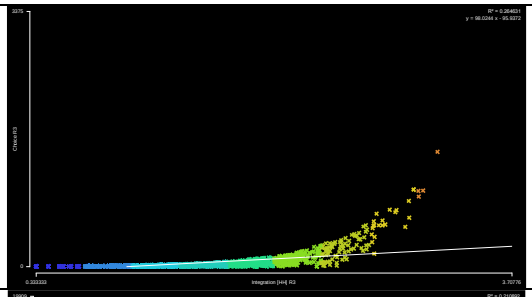
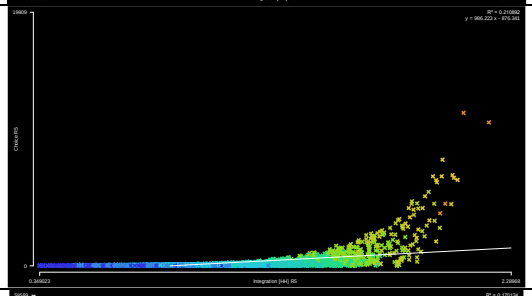
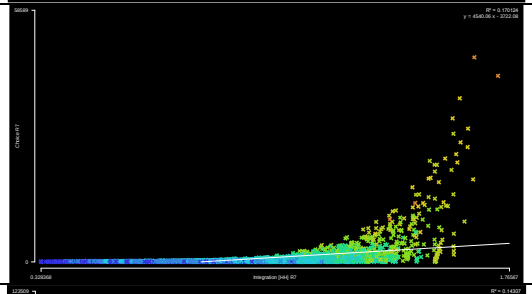
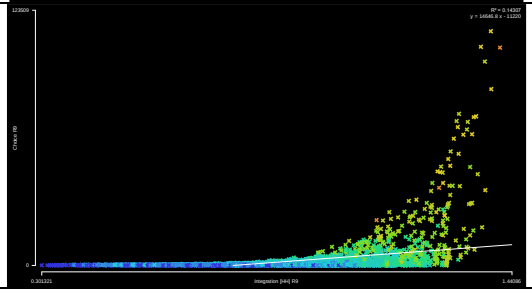


Figure 8. Scattered Distribution of Local Integration and Selectivity
(Generated by SPSS Software)
Image source: drawn by the author

Symbiosis analysis

Construct the linear regression equation (Table 6) of the selectable degree of the integration degree of different scales, which is expressed by the symbiosis degree to describe the size of the local space carrying the mixed function of the region. The larger R2, the greater the mixed function of the region, otherwise the single bearing function of the region is strong. It can be seen from the table that with the increase of the topological radius r value, the regression coefficient decreases, indicating that the mixed function of the lot is small. After investigation and analysis, the types of shops along the street in the lot are relatively single, mainly retail and catering, while there are health clinics, hardware, real estate and other formats that have a negative effect on the vitality of the space. As the flow of people is mostly concentrated on the street interface, the mixing of horizontal dimensions is an important embodiment of the functional layout of Cuiwei historical block.

Table 6. r=3,5,7,9 Symbiosis Analysis Diagram

Topological radius	Scatter diagram	regression coefficient
R=3		R^2=0.26
R=5		R^2=0.21
R=7		R^2=0.17
R=9		R^2=0.14

Traffic flow relevance

Pearson analysis method imports the values related to X and Y into spss19.0, analyzes whether there is a close relationship between variables, obtains the Pearson correlation coefficient, mean value, sample size and standard deviation after analysis, observes the correlation degree of variables, and generates a scatter diagram (Figure 9). The results show that if the Pearson correlation coefficient | R | ≥ 0.8 between two variables, X and y are highly correlated, and if | R | ≤ 0.3, X and y are not correlated. Both sides are significantly correlated at the level of 0.01, otherwise, they are not correlated.

This study analyzes the correlation between the spatial form of Cuiwei village block and traffic flow, and mainly studies the statistical analysis of traffic flow in the streets, including the flow of people and vehicles. The statistical time is January 2020. This statistic can well reflect the density of

people and vehicles. Among them, the evaluation of traffic flow includes the aggregation and dispersion statistics of people flow and vehicle flow outside the block. The total traffic flow parameters of people flow and vehicle flow are combined with the global integration degree (Table 7), and the global integration degree and traffic flow related parameters are introduced into spss19.0 for comparative analysis (table 14). The Pearson correlation coefficient is 0.835, close to 1, The two-sided value is 0.019, indicating that the overall integration degree outside the village is significantly related to the traffic flow.

After field investigation and analysis, the road outside the village has a large traffic flow during the morning and evening rush hours, often accompanied by congestion. There are large high-rise residential buildings, businesses and schools nearby, and the traffic flow is large. Therefore, the Cuiwei historical block will be reasonably and effectively planned. In the future, it will be a land with high gold content and commercial value, which will attract a large number of businesses to invest and settle in order to increase the capacity of the area.

Table 7. Analysis of Traffic Use in Cuiwei Village

Road name	**direction**	**traffic (pcu/h)**	**Space Syntax**
			Global integration
Renmin Road	East to West	2325	0.93471
	West to East	2532	
	average value	2428.5	
Mingzhu Road	South to North	4143	0.93633
	North to South	3541	
	average value	3842	
Cuiqian Road	South to North	2583	0.896123
	North to South	2251	
	average value	2417	
Cuiwei Road	East to West	1605	0.92002
	West to East	2089	
	average value	1847	
Cuijing Road	East to West	889	0.82200
	West to East	751	
	average value	820	
Dafang Road	South to North	452	0.86213
	North to South	464	
	average value	458	
Cuizhu 4th Street	South to North	379	0.85491
	North to South	383	
	average value	381	

Source of the table: the author collates the data from the renewal planning summary (2019) of the reconstruction project of Cuiwei old village in Xiangzhou District, Zhuhai

Table 8. Correlation Analysis Between Global Integration and Traffic Flow in Cuiwei Village

		Global integration	traffic flow
Global integration	Person correlation	1	0.835
	Significance (bilateral)		0.019
	n	7	7
traffic flow	Person correlation	0.835	1
	Significance (bilateral)	0.019	
	n	7	7

Source: drawn by the author

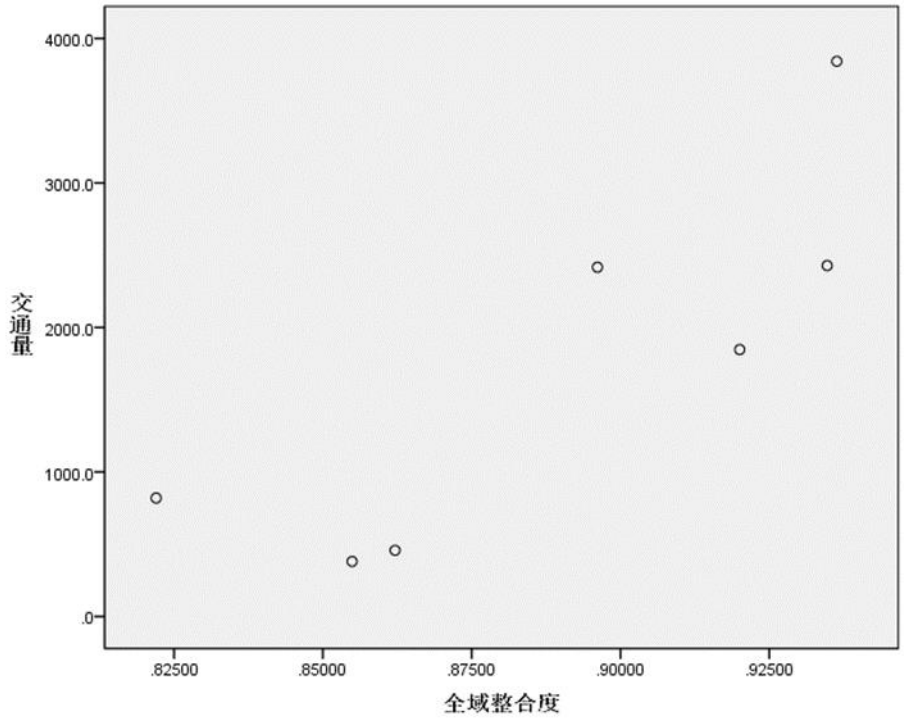


Figure 9. Scatter Diagram of Global Integration and Traffic Flow (Generated By SPSS Software)
Image source: drawn by the author

Local perspective analysis

Topology depth

Through the depth value, we can analyze the accessibility and dispersion of the block. The average depth is the minimum number of steps required to go from a node in the space to other nodes. The smaller the average depth is, the higher the accessibility of the space is, and vice versa.

This study selects the average value suitable for the walking scale and topological depth to analyze the Cuiwei historical block. The average value of the topological depth of the walking block is 16.1463, and the street with the lowest average depth in the internal roads of the block is the street straight street, with a value of 11.4000. Therefore, in the internal roads of the village, the

accessibility of the street straight street is high. The second is Dafang street, with a value of 11.6249, which indicates that people have less turning times to reach these roads, so it is easier to reach these roads, and the difficulty is low. In the actual investigation, these two roads, together with the north and south of Cuiwei village, have been an important traffic fortress since the formation of Cuiwei village. They are also the only way for migrant workers and villagers, and the businesses on both sides are relatively prosperous, According to the pictures taken by Baidu time machine in different years (table 10), the business functions on both sides of these two roads are constantly changing, which plays a huge role in the whole village. Every night, more vendors set up stalls in this time, and many migrant workers will have a midnight snack here, thus gathering more people. The spatial integration of the road is also the area with the highest spatial integration of the village.

Table 9. Pictures of the Current Situation of Street Straight Street and Dafang Street in Different Periods

	
Current situation of street market straight street in July 2014	Current situation of street market straight street in December 2017
	
Current situation of Dafang street in July 2014	Current situation of Dafang street in October 2015
	
Current situation of Dafang street in October 2016	Current situation of Dafang street in December 2017

Source of the form: the author intercepted it from Baidu time machine

Among the external roads, cuiqian road a has the lowest average depth, with a value of 10.6327, indicating its good accessibility, followed by Mingzhu Road,

with a value of 10.6844. In the field investigation and visit, cuiqian road a is on the right side of Cuiwei village, and Mingzhu road is on the west side of Cuiwei village. The two roads have good traffic convenience and large traffic flow. Mingzhu road has three bus stations, namely Mingzhu north station, Cuiwei station and Cuijing Industrial Zone Station, There are 17, 20 and 16 lines respectively; Cuiwei Road has three bus stops, namely Jiayuan, south of China Merchants garden city and Henglong school, with 3, 5 and 6 lines respectively, and the bus accessibility is good (Figure 10).

道路名	站点名	线路数	经停公交线路
人民西路	翠屏路	4	20、45、55、994
	上冲	18	1、5、 6、 20、22、 23、 43、204、602a、602、687、993、B3、B6、B7、B9、k11、k4
明珠路	明珠北	17	1、5、16、22、 23、 31、 36、41、42、45、204、 602a、602、931、B3、B8、B9
	翠微	20	1、 5、16、22、23、31、36、41、42、45、204、 602a、 602、687、931、B3、B8、B9、k11、k4
	翠景工业区	16	5、8、16、18、31、36、41、42、45、204、602a、602、931、B3、B8、B9
翠微路	嘉园	3	19、22、23
	招商花园城南	5	1、 8、 18、 42、 687
翠前路	恒隆学校	6	8、15、20、56、68、992
	翠微市场	6	8、15、20、56、68、992
	招商花园城	8	8、15、 20、 35、46、56、68、992
翠景路	翠花苑	3	46、35、68

Figure 10. Distribution of Bus Lines Outside Cuiwei Village
Image Source: The Author Intercepts from the Summary of Renewal Planning (2019) of the Reconstruction Project of Cuiwei Old Village in Xiangzhou District, Zhuhai City

Analysis of spatial correlation degree of streets and lanes

Taking into account the influence of walking scale, the depth value is calculated by selecting seven streets, seven Li and one lane of Cuiwei pedestrian block. In the spatial syntax theory, when constructing the axis model, the x-local integration degree and y-axis are defined as the depth value, and the correlation analysis of its construction function model is carried out. The analysis results show that as the main axis of Cuiwei pedestrian block, its R2 value is only 0.3298 (FIG. 11), and the data is imported into SPSS (table 10), The scatter diagram is shown in Figure 12, and the Pearson correlation coefficient is 0.417, which is close to 0.

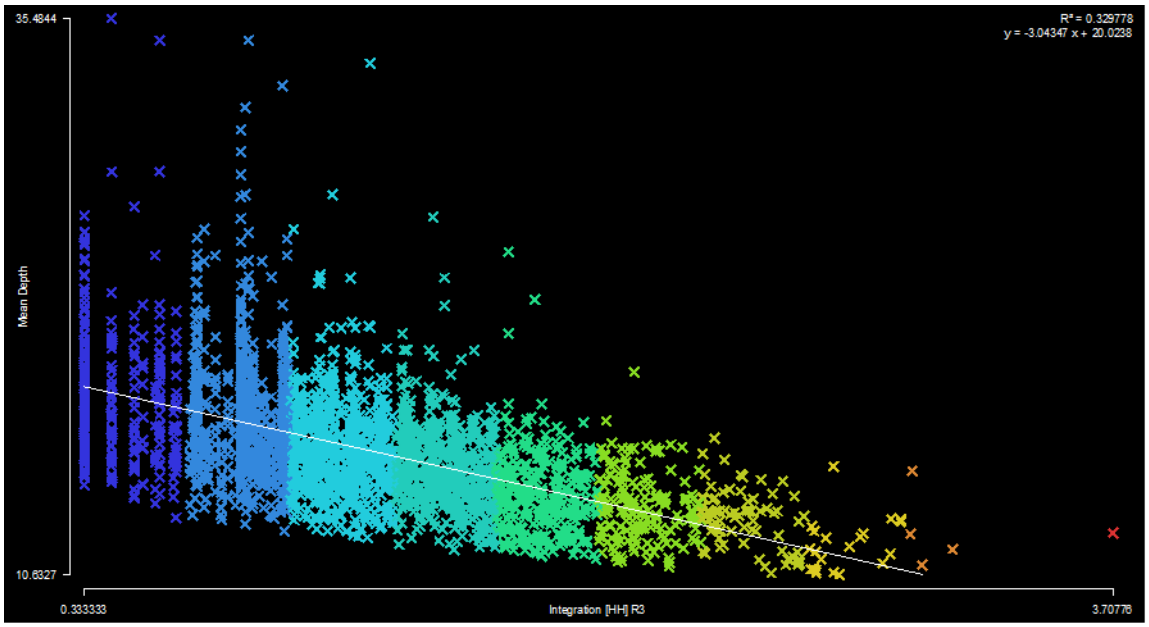


Figure 11. Correlation Analysis Between Depth and Local Integration of Cuiwei Village

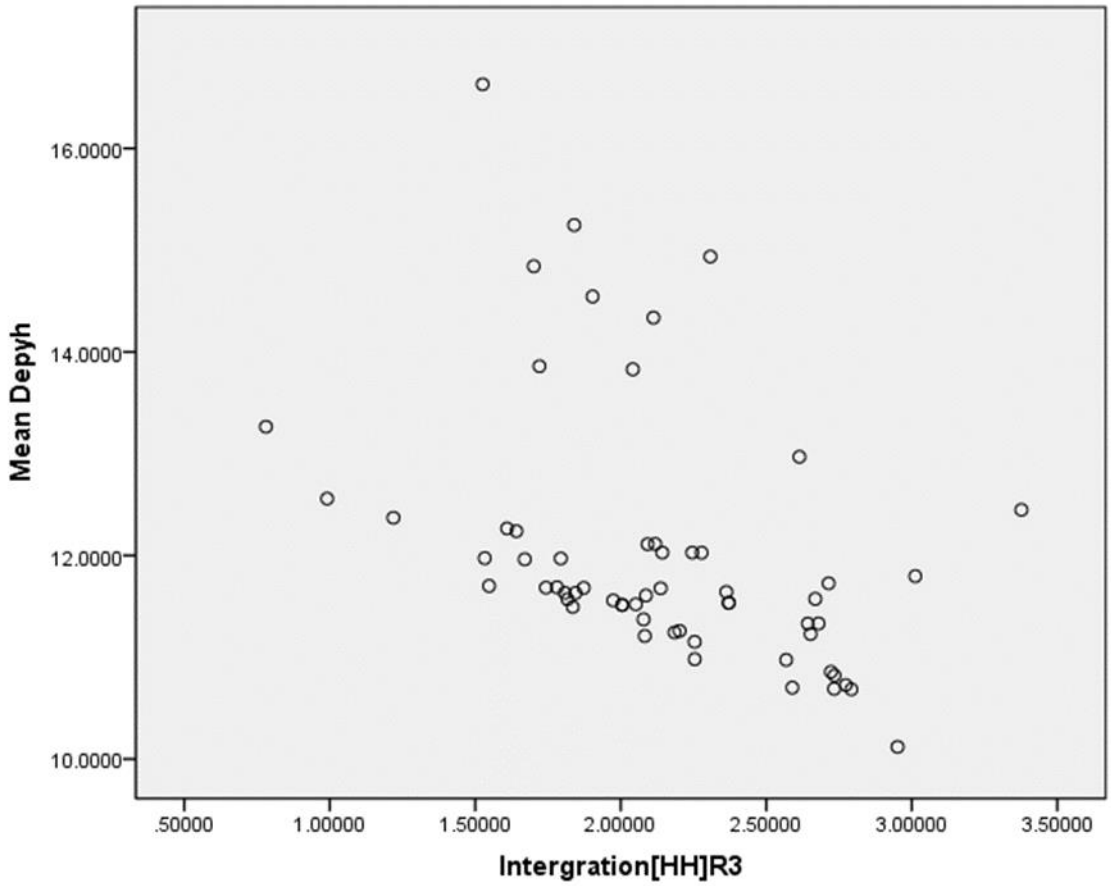


Figure 12. Scatter Diagram of Depth and Local Integration (Generated by SPSS software)
Image source: drawn by the author

Table 10. Correlation Analysis Between Depth and Local Integration of Cuiwei Village

		depth	Local integration
depth	Person correlation	1	0.417
	Significance (bilateral) n (number of cases)		0.001
Local integration	Person correlation	0.417	1
		0.001	
	Significance (bilateral) n (number of cases)	60	60

ADVANCED RESEARCH

This paper studies the street characteristics inside and outside Cuiwei village in Qianshan, Zhuhai. However, each region has its own architectural identity and different cultural heritage. Our current direction in the future can only be borrowed from historical villages of the same type or buildings in the same area. This is also a limitation. In the future, you can also try to add quantitative research methods to make design decisions more scientific.

Table 1. Three Box Method

Score	**Criteria**
50,00 – 100,00	Low
100,01 – 150,00	Medium
	High

REFERENCES

Hillier, B. (2007). Space is the machine: a configurational theory of architecture. Space Syntax.

Flach, P. A. (2003). The geometry of ROC space: understanding machine learning metrics through ROC isometrics. In Proceedings of the 20th international conference on machine learning (ICML-03) (pp. 194-201).

Chen, Y., & Chen, J. (2022). Analysis and Research on Spatial Nodes of Historical Villages based on Spatial Syntax Theory: Cuiwei Village in Qianshan Area of Zhuhai as an Example. Journal of Computer Science and Technology Studies, 4(1), 07-34.

Chen, J., & Chen, Y. (2021). Analysis and Research on the Process of Industrial Development and Transformation of Historical Villages——Taking Cuiwei Village in Zhuhai City as an Example (No. 6455). EasyChair.

Chen, J., & Chen, Y. (2021). Research on the Spatial Features of Cuiwei Historic District Based on Space Syntax (No. 6457). EasyChair.