Analysis on the Coupling Relationship between Smoke-Free City Community Public Service Function and Street Space

Xu Yiwen, Lecture
Chang Jiang, Professor
WangDongquan,Professor

Xu Yiwen, Doctor, Lecture in urban environmental design, College of Art and Design, Xuzhou University of Technology, Xuzhou, Jiangsu, China. Chang Jiang, Doctor, Professor in urban planning,School of Architecture & Design, China University of Mining and Technology, Xuzhou, Jiangsu, China. Wang Dongquan, Doctor, Professor in municipal Engineering, School of Mechanics and Civil Engineering, China University of Mining and Technology, Xuzhou, Jiangsu, China.Correspondence author: Xu Yiwen; xuyiwen0511@126.com

Objectives:In this study, with Gulou District, Xuzhou City, Jiangsu Province in eastern Chinataken as the research object,the coupling coordination model between the two subsystems, namely smoke-free city communitypublic servicefunction and street space vitality,was constructed based on the principle of synergy theory. Next, the measurement system of street space form in the research area was established with the aid of urban basic information data provided by the open data platform and the GIS technology. Furthermore, the related system was evaluated by the entropy method and the spatial syntax, and the results of multi-dimensional systematic evaluation indexes were visualizedby introducing the grid method. Finally, the internal coupling coordination relationship between smoke-free city communitypublicservice function and street space vitality was revealed to assistant smoke-freepublic service space design and optimisation and guide fine smoke-freecity planning practice. The following results were obtained. Population density and spatial integration are important evaluation indexes for measuring the coupling between public service function and street space vitality. Therefore, appropriate residential density and street traffic vitality are the key to promoting the development of community public service space. In view of this, this study can provide a quantitative basis for the construction of smoke-free public environment in healthy cities.

Key words: smoke-free environment; community public service; coupling degree; spatial syntax

Tob Regul Sci.™ 2021;7(6): 5273-5287
DOI: doi.org/10.18001/TRS.7.6.19

After the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) came into force in China in January 2006, the legislation of smoke-free environment in Chinese cities has shown a positive trend.By the end of 2018, 21 largest cities in China had implemented smoke-free environmental legislation, and nearly half of them basically met the requirements of the WHO FCTC. *The Outline of the Healthy China 2030 Plan* clearly states that the construction of smoke-free China is a necessary condition for achieving the strategic goal of healthy China.

The focus of smoke-free city construction is to create a smoke-free community public service space and build a satisfactory living environment for residents. Urban health space can be further optimized and the quality of urbanization can be improved at the same time.But as the downward pressure on the economy increases in recent years, urban construction gradually slows down. Urban community development and construction gradually shift to the connotative growth by reducing new construction land and tapping the potential of stock land. Different from incremental planning, stock planning means tapping the potential of the land that has been used for urban construction or idle land designed for use and underutilized land. Therefore, in the context of “stock” development, the objective analysis on urban street space vitality and the exploration for its coupling relationship with smoke-free community public service facilities from the perspective of urban function optimization are of great significance for the rational layout of smoke-free public service space and the better play of its role as a public service function provider.

The research on smoke-free environment mainly focuses on the implementation and construction of smoke-free environment in public places such as campus, hospital and restaurant.[1-3] Other researchers pay more attention to the behavior patterns of smokers in environmental space.[4-6]Previous researches on the relationship between community public service space and urban development generally fall into following fouraspects: [7-12] the research on fairness and accessibility of spatial distribution of public service facilities;[13-14] the research on the related influencing factors of the spatial distribution of facilities; [15-17] the research on the evaluationand [18-20] strategy of facility layout; [21-23] and the user satisfaction evaluation of service space. In summary, there are still few studies on the public service space of smoke-free community.

In this study, first, based on the coupling coordination model, the smoke-free community public service function and the street space vitality in Gulou District were comprehensively evaluated by the entropy method and the spatial syntax. Then, the coupling relationship between the two was analyzed and the inherent relationship between the service function of community public service function and the surrounding street space vitality was revealed. All of these can assist the design and optimization of community public service space and guide the fine smoke-free urban planning practice.

RESEARCH AREA

As shown in Fig. 1, Gulou District is located in the north of Xuzhou City, Jiangsu Province, China, with geographical coordinates of 30°16’N and 117°11’E. To its east, the East Third Ring Road borders the Xuzhou Economic and Technological Development Zone. To the west, the West Third Ring Road and the North Third Ring Road border Jiuli District. Its south isadjacent to Yunlong District and Qiushan District, with East Huaihai Road, North Zhongshan Road and South Huanghe Road being the boundaries. Its north extends to the Beijing-Hangzhou Grand Canal. The jurisdiction area of the district covers 64.6 km^2, and the population is about 380,000. The district comprises 7 sub-district offices, namely Pipa, Huanglou, Huancheng, Fengcai, Pailou, Tongpei and Jiuli, with a total of 64 communities (villages).

As shown in Fig. 2,the urban spatial layout of Gulou District can be roughly divided intothe core area, the inner edge area and the outer edge area.

The core area: the downtown area in the south of the North Second Ring Road, with a modern business service center as the main objective;

The inner edge area: the urban development area between the Second Ring Road and the Third Ring Road, with an ecological residential area as the main objective;

The outer edge area: the northern section of the city in the north of the Third Ring Road and the eastern section of the city in the east of the Railway hub with a modern industrial park and an independent industrial zone as the main objectives, respectively.

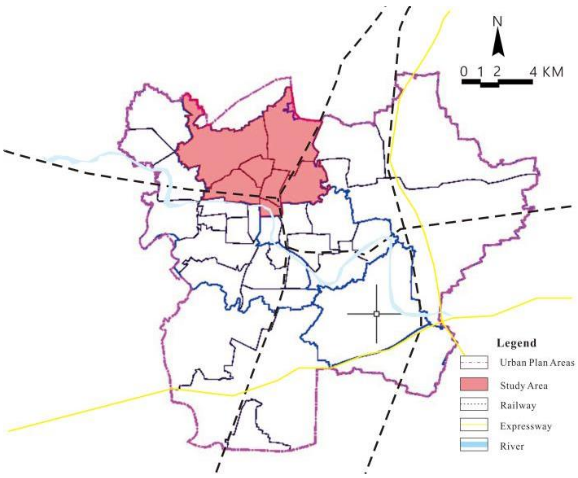

Fig. 1
Geographical location of Gulou District

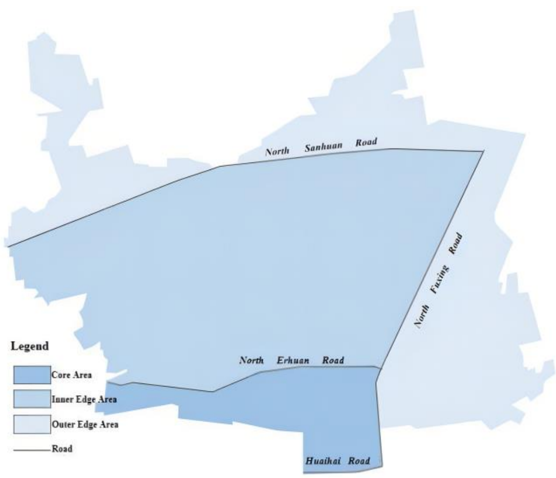

Fig. 2
Urban spatial layout of Gulou District

DATA ANALYSIS

Spatial Data Source

The data, including location of smoke-free community public service facilities, road traffic, street and population distribution, urban residential distribution, etc.are acquired and classified. The data acquisition and classificationare completed in accordance with thecurrent distribution map in Xuzhou's special planning, the satellite image data of Gulou District in 2020, the census data (as the basis) and field research (as a supplement).

Establishment of GIS Database

The GIS database is established according to the land use status, public facility planning and residential land planning of "Xuzhou City Master Plan (1994-2030)", and layout status map in the special plans of "Special Planning Optimization of Kindergarten Distribution in Xuzhou City", "Special Planning for the Layout of Medical and Health Facilities in Downtown Xuzhou" and "Layout Planning of Public Sports Facilities in Xuzhou". To be specific, the location of smoke-free community public service facilities, road traffic, street population distribution, urban residential distribution and other information are determined based on population census data and field investigation.

(1)Data processing of smoke-free community public service facilities

First, the current situation of the layout of various public service facilities in the special plans of "Layout Planning of Basic Public Service Facilities in Central District of Xuzhou City" and "Special Planning of Community Public Service Facilities Layout in Xuzhou City" is obtained. Next, the attribute data are sorted out, such as name, location and size of five types of community public service facilities whose accurate data are available (namely, kindergartens, health service stations, fitness parks, home care service centers and agricultural trade markets). Combined with field research, the spatial location of each facility in Google Earth is calibrated by the high-definition remote sensing image of Gulou District. A total of 239 public service facilities in the research area are determined and recorded into the ArcGIS database, including 56 kindergartens, 66 health service stations, 30 fitness parks, 56 home care service centers and 31 agricultural trade markets (Fig. 3).

(2)Establishment of the road network

The urban spatial axis maps are established based on the principles of spatial syntax map construction according to the road map of Gulou District in 2020, the image map of Gulou District in 2020 and the planning road network of Xuzhou City respectively. The main roads, secondary roads and residential roads of Gulou District are imported into the spatial syntax software and processed with the tool of unlink (Fig. 4).

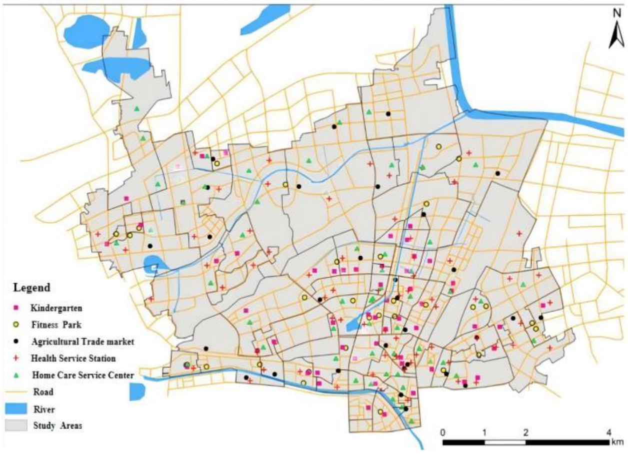

Fig. 3
Distribution map of smoke-free community public service facilities in Gulou District

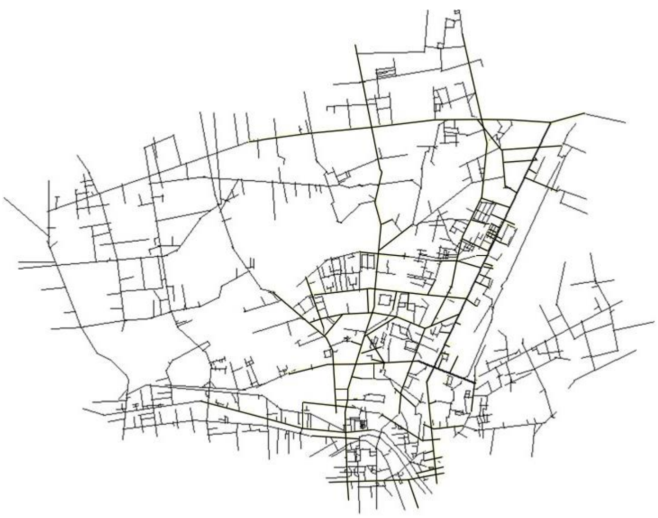

Fig. 4
Road network of Gulou District

METHODS

First, the research scale and the division of research units are firstly determined on the basis of data collection. Next, the relevant evaluation indexes are selected according to the connotation of smoke-free community public service function level and street space vitality. In GIS, the single index data are superimposed in accordance with their weights to calculate the comprehensive index of the two systems. Meanwhile, the accessibility of street space is quantified by the topological network of space syntax. Based on the above contents,the coupling coordination between the smoke-free community public service system and the street space system are evaluated with reference to the coupling coordination model.

Spatial Axis Analysis

Space syntax, proposed by Bill Hillier, is a theory and method for quantitative study on spatial structure.

(1) Spatial integration:It represents the degree of road traffic accessibility in the research area, [24] reflecting the relationship between structural elements in road traffic and the efficiency of road network structure. The higher the degree of road integration is, the higher the accessibility is. The calculation formula is:

$$I_i = RA_i = \frac{2(MD_i - 1)}{n-2} \tag{1}$$

where n is the number of longitudinal axes or nodes in spatial system; MD is the average depth.

(2) Space intelligence: It represents the ability to perceive the whole space by the connectivity for local spaces. When the space intelligence is higher, the street space boasts better accessibility and permeability, and the street space system is clear and easy to understand. When the space intelligence is lower, [25]it is more difficult for the observer to perceive the spatial features of the whole road system through the local features of the street. It is calculated by:

$$R^2 = \frac{\left[\sum (C_i - \bar{C})(I_i - \bar{I})\right]^2}{\sum (C_i - \bar{C})^2 \sum (I_i - \bar{I})^2} \tag{2}$$

where $\bar{C}$ is the average value of connectivity for all unit spaces and $\bar{I}$ is the average value of global integration for all unit spaces.

Division of Evaluation Units

In the hope of obtaining valuable analysis results, it is necessary to minimize the unit area of spatial statistics and ensure that the overall coupling is obtained and the differences in coupling within the region are accurately shown. Thus, the micro-scale grid method is selected to divide the research units in the research area. In this way, the limitation of land use can be overcome to measure functional diversity. [26]At the same time, the uniform division of grid not only conduces to the analysis of different indexes on the same scale, but also enhances the readability and comparability of data.

Considering the actual traffic road conditions, Gulou administrative region is divided into a 250*250m grid, and the grid whose effective area does not exceed 50% of the grid area is regarded as an invalid unit and gets removed. Finally, 1,908 grids are obtained as evaluation units (Fig. 5).

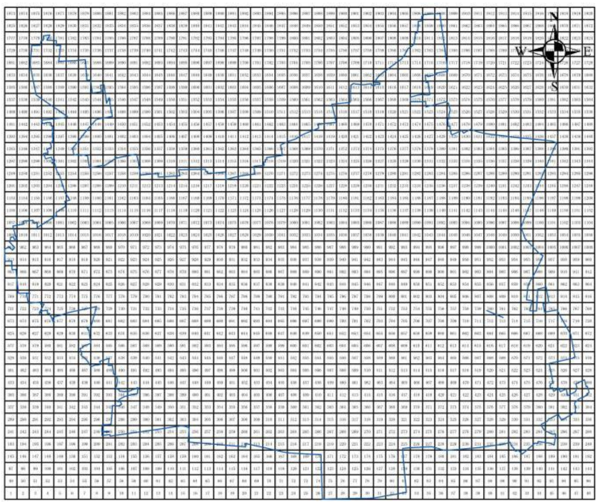

Fig. 5
Grid division in GIS

Evaluation Index Selection and Data Normalization

Due to the dimensional differences in the original data of each evaluation index, the data need to be processed by the extreme method to achieve normalization.

The positive index formula can be obtained by normalization:

$$x_{ij}^{'} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}} \quad (3)$$

The negative index formula can be obtained by normalization:

$$x_{ij}^{''} = \frac{x_j^{\max} - x_{ij}}{x_j^{\max} - x_j^{\min}} \quad (4)$$

where χ_{ij} is the original value of the index, $\chi_j^{\max}$ and $\chi_j^{\min}$ are the maximum and minimum values of the jth index, respectively. Negative values or small values may occur for some normalized data. To facilitate calculation and analysis, the normalized data are translated, thus avoiding the occurrence of negative values or small values:

$$x_{ij}^{''} = H + x_{ij}^{'} \quad (5)$$

where the value representing the translation amplitude H of the index equals 1.

No macro-scale related evaluation indexes are set during construction of the coupling coordination model. Two evaluation indexes in the public service function and two evaluation indexes in the street space vitality are selected respectively (Table 1).

Table 2 shows the weights and calculation methods of the evaluation indexes.

Construction ofCoupling Coordination Model

(1) Weight analysis of evaluation indexes

First, the data are nondimensionalized:

$$y_{ij} = \frac{x_{ij}^{''}}{\sum_{i=1}^{n} x_{ij}^{''}} \quad (6)$$

The entropy of the jth index is calculated by:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} y_{ij} \ln y_{ij} \quad (7)$$

The coefficient of difference of the jth index is:

$$g_j = 1 - e_j \quad (8)$$

Where $j = 1, 2, \text{L}\ \text{L}\ p$

The weight of the jth indexis:

$$\omega_j = \frac{g_j}{\sum_{j=1}^{p} g_j} \quad (9)$$

Where $j = 1, 2, \text{L}\ \text{L}\ p$

where $j$is the evaluation index;$e_j$is the information entropy of the jth index; and ω_j is the weight of an evaluation index.

Comprehensive scores are obtained by multiplying normalized data with weights:

$$Z_i = \sum_{j=1}^{p} \omega_j x_{ij}^{'} \quad (10)$$

where Z_i is the comprehensive evaluation value of the evaluation system; j is the evaluation index;each evaluation index; and $\chi_{ij}^{'}$ is the normalized value of the evaluation index.

(2) Coupling coordination model

The coupling system is based on the smoke-free community public service system and the street space system, and the coupling degree and coupling coordination degree are introduced as two evaluation indexes. The coupling degree reflects the degree of association between the smoke-free community public service function system and its street space system in terms of co-development. However, in some cases, the coupling degree fails to stably reveal the exact development stage in which the two systems reach coordination. In fact, the coordination reached in different development stages has varying meanings. Hence, a more stable index, i.e., [27] the coupling coordination degree, is adopted for accurately reflecting the level and state ofcoordinated development between the two systems. With reference to the capacity coupling model in physics, the coupling coordination model

Table 1
Selectionof evaluation indexesfor community public service function and street space

Evaluation index	Evaluation factor	Efficacy
Evaluation index of community public service function	Population density (10,000/km²) (a)	-
	Density of various public service facilities (facility/km²) (b)	+
Evaluation index of street space vitality	Road network density (c)	+
	Spatial integration (d)	+

Note.
Positive and negative effects refer to the positive or negative effects of factors on system ordering.

Table 2
Weights and calculation methods of evaluation indexes of community public service function and street space vitalit

Monomial factor	Meaning	Weight	Calculation method	Formula
Population density	Population concentration in the research area	0.634	Permanent resident population/total land area	
Facility density	Facility concentration in the research area	0.366	Total number of facilities/total land area	
Road network density	The morphological intensity of traffic space	0.306	Total road length/road area	
Spatial integration	Accessibility of road traffic	0.694	Relationship between one space and all other spaces	

between smoke-free community public service function and its street space is established:

$$C = 2\left[\frac{U \times G}{(U+G)^2}\right]^{\frac{1}{2}} \tag{11}$$

where C is the coupling degree; U and G are the smoke-free community public service function and the comprehensive evaluation value of street space development, respectively. The value of C, which lies within the range of 0-1, represents the degree of correlation between smoke-free community public service function and street space. When the value of C approaches 1, the degree of correlation is higher; when it approaches 0, the degree of correlation is lower.

The comprehensive evaluation coefficient is expressed as:

$$T = \theta \times U + \gamma \times G \tag{12}$$

where θ and γ are the weights of the two subsystems respectively, and they equal 0.5 in this paper.

The above model is extended to obtain the coupling coordination model:

$$D = \sqrt{C \times T} \tag{13}$$

RESULTS

Spatial Distribution and Evaluation of Community Public Service

Population density analysis

As illustrated in Fig. 6, the population density of Gulou District follows the order:the inner edge area>the core area>the outer edge area. The residential population in the research area is mainly concentrated in the area in the east of the North Second Ring Road, Benteng Avenue and North Zhongshan Road. The inner edge area where a large number of residents live is home to a large quantity of industrial land, many ordinary residential buildings and some villages in the city. Migrant workers also choose to live here because of the convenient transportation and relatively low housing prices. Resultantly, the population density in this area is as high as 113,000 people/km². Ordinary residential buildings are densely distributed on the residential land in the core area, and the population density in this area resembles that in the inner edge area. For lack of industrial function, the population density in the outer edge area is about 10,000-20,000 people/km², much lower than those in the other two areas.

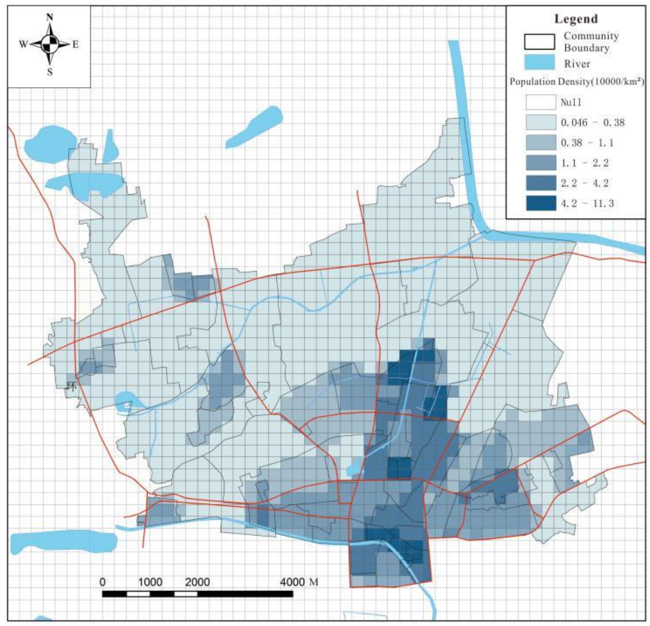

Fig. 6

Features of net population density distribution in Gulou District

Facility density analysis

As displayed in Fig. 7, the features of facility density distribution are consistent with the analysis results of the spatial distribution of community public service facilities in Gulou District. The facility density of Gulou District follows the order:the inner edge area>the core area>the outer edge area. The high density of businesses, office, service and other buildings in the core area, together with high development intensity, severely limits the selection of land for community public service facilities. The inner edge area is the urban development zone which primarily serves as an ecological residential area. Besides, it also undertakes the industries that migrate outward from the core area. In this area, residents' supporting service facilities are arranged along the northern and eastern sections of the District government, with the facility density being up to 4 facilities per 0.625 km². Since the outer edge area has low land development intensity and lowpopulation density, its density of service facilities is generally 1 facility per 0.625 km².

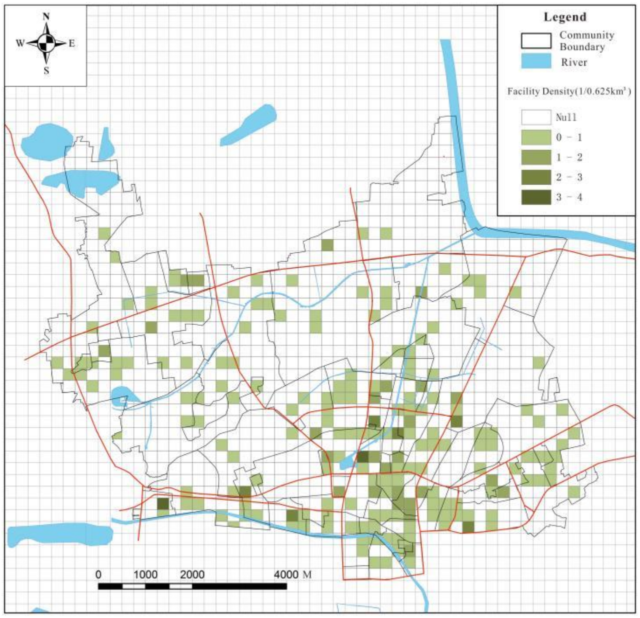

Fig. 7

Features of public service facility density distribution in Gulou District

Evaluation of Street Space Vitality

Road network density analysis

As exhibited in Fig. 8, the road network density of Gulou District follows the order:the core area>the inner edge area>the outer edge area. The concentrated industrial lands in the core area form the largest business center in the downtown of Xuzhou City. The east-west main roads in the downtown of Xuzhou City, i.e., Huaihai Road and the North Second Ring Road,cross the core area, with the road network density being up to 24 km/km². The road network density in the inner edge area where industries are relatively concentrated is slightly lower than that in the core area. In contrast, the general blocks are generally of low road network density, below 5 km/km² on the whole.

Spatial accessibility

Spatial integration can be understood as the relationship between the entire spatial structure and roads in an area. The vehicle lane is selected as the main element to draw the road CAD axis map of the whole area. After the correctness of Node Count is verified, Depthmap syntax analysis is conducted to establish the urban space syntax axis map of Gulou District, and the results of street integrationanalysis areobtained (Fig. 9).In Fig. 9, the warm-color axes, such as orange and red, represent highly integrated roads. The analysis results are assigned to each grid, and the results of the spatial accessibility distribution of the grid are obtained (Fig. 10).

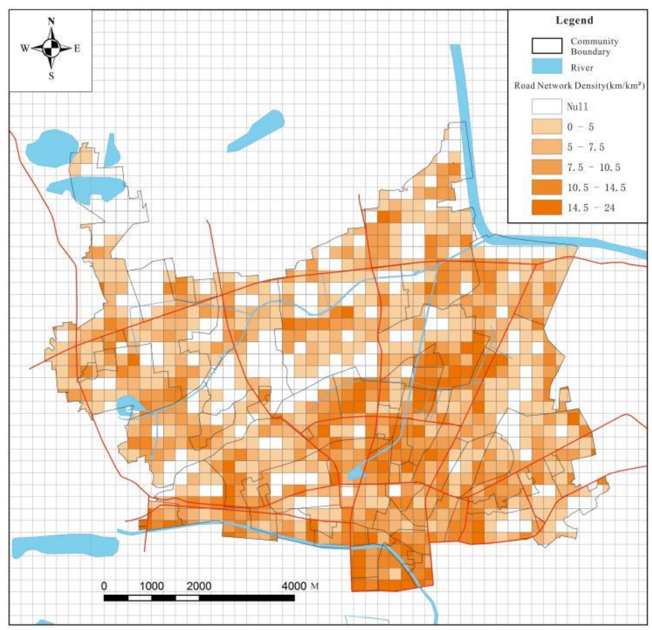

Fig. 8

Features of road networkdensity distributionin Gulou District

Fig. 9

Results of street integration analysis in Gulou

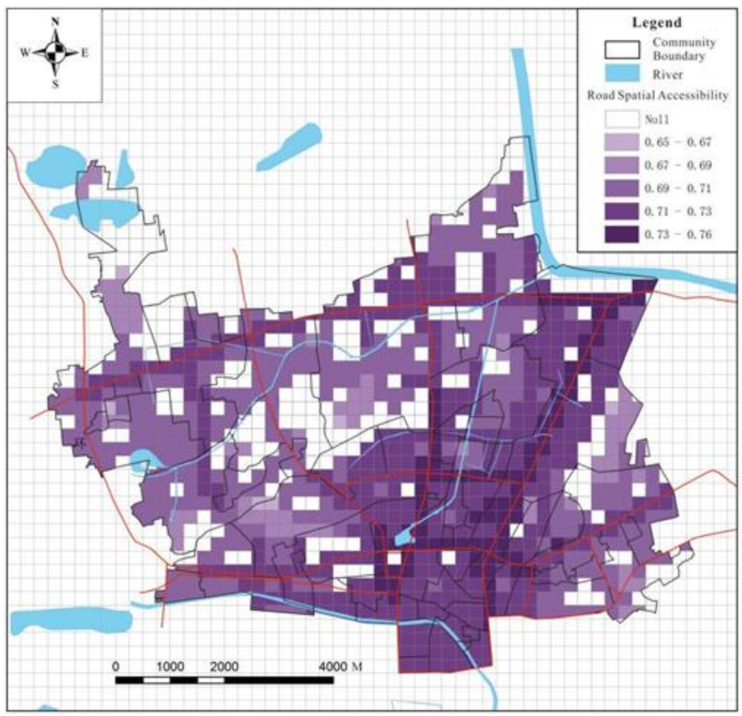

Fig. 10

Features of road spatial accessibility distribution in Gulou District

The statistics of accessibility values disclose that the north-south North Fuxing Road-Meigang Road and the eastern section of the east-west North Second Ring Road boast the highest spatial accessibility in Gulou District. North Fuxing Road-Meigang Road, which is the main road in Gulou District, is connected with many branches, resulting in a high density of road network. The eastern section of North Second Ring Road is connected with North Fuxing Road, serving as the main east-west channel of the city. Business, entertainment, service and other functional lands are distributed on its south, while the population density is high on its north. Besides, north-south roads, including North Zhongshan Road, the southern section of West Machanghu Road, etc., form a secondary traffic axis in Gulou District, and the cross sections of the above two roads and North Zhongshan Road also boast high accessibility. Meanwhile, as the city continues to develop dynamically, road infrastructure construction gradually extends to the outer ring, leading to high accessibility of the North Third Ring Road. Overall, the road space in the southeast of Gulou District is highly integrated with high accessibility.

Spatial intelligibility analysis

The road CAD axis map of Gulou District is imported into the Depthmap software, and the intelligent scatter diagram of street space is obtained (Fig. 11). The local spatial structure is used to predict the whole structure, and the numerical values obtained are relatively accurate. The structural features of other spaces can be grasped without external information. If the R^2 value is between 0 and 0.5, the system is of low intelligence; if it is between 0.5 and 0.7, the system is intelligent; if it is between 0.7 and 1.0, the system is highly intelligent. According to Fig. 11, the linear regression model of spatial intelligence in Gulou District is y=2.50573x-0.859849, R^2=0.585153, so the system is intelligent.

The most intelligent roads are North Zhongshan Road, Meigang Road, North Fuxing Road, Benteng Avenue, the main road of the North Second Ring Road and its nearby branches (Fig. 12).The urban system spatial accessibility is highly accessible through these local street spaces. Observers can further obtain the overall spatial accessibility by observing the spatial connectivity for the branches.

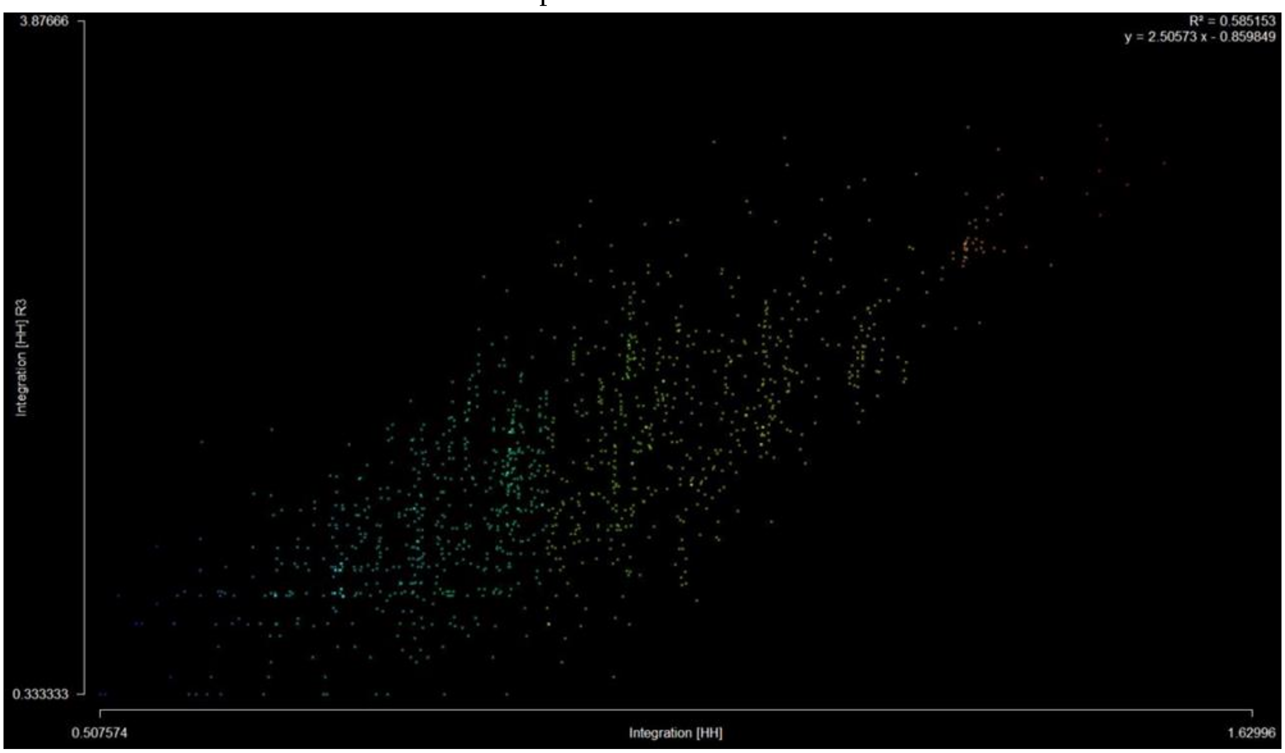

Fig. 11

Intelligent scatter diagram of street space in Gulou District

Fig. 12
Street space distribution map with a high intelligence value in Gulou District

DISCUSSION

Determination of Index Weights and the Comprehensive Evaluation Index

After dimensionless normalization of the indexes, and the entropy method is used to calculate their weights. Ultimately, the comprehensive evaluation index is obtained . As given in Table 3, population density and spatial integration boast the highest weights, indicating that these two indexes differ the most notably in different areas. Therefore, improving population concentration ability and street accessibility is the key to promoting the development of smoke-free community public service space.

Table 3
Determination of single factor weight by coefficient of variation

Evaluation index	Monomial factor	Entropy	Coefficient of difference	Weight
Evaluation of public service function	Population density (10,000 people/km^2)	0.999433	0.000567	0.634469
	Facility density (facility/0.625 km^2)	0.999673	0.000327	0.365531
Evaluation of street vitality	Road density (km/km^2)	0.997999	0.002001	0.306145
	Spatial integration	0.995466	0.004534	0.693855

Table 4
Classification of coupling coordination degree

Coupling coordination (D)	Evaluated degree
0.00-0.29	Severely misaligned
0.30-0.49	Mildly misaligned
0.50-0.59	Barely coordinated
0.60-0.79	Mildly coordinated
0.80-1.00	Well-coordinated

Evaluation of Coupling Coordination

[28-30] In the light of the evaluation criteriaof coupling coordination degree in relevant literature,the coupling relationship between the public service function of the community in Gulou District and its street space is defined (Table 4).

The coupling coordination degree of public service function and street space in Gulou District can be directly obtained by substituting the above comprehensive evaluation values of public service function and street space into the constructed coupling coordination modelbased on the Matlab software (Fig. 13).

The coupling coordination degree between public service function and street space vitality in the research area follows the order: the inner edge area>thecore area>theouter edge area. The results show that there are 49 well-coordinatedgrids, accounting for 4.15% of the total; 830 mildly coordinated grids, accounting for 70.33%; 6 barely coordinated grids, accounting for 0.50%; 22 grids mildlymisaligned, accounting for 1.89%; and 273 severely misaligned grids, accounting for 23.13%. Overall, the coupling between public service facility functionand street spacein the research area is relatively coordinated.

It can be seen from Fig. 14 that the well-coordinated residential space is mainly in the east side of North Zhongshan Road, the north bank of the ancient Yellow River, the middle section of North Second Ring Road and the north of Benteng Avenue.It gradually extends outward along the axial direction of the land between North Zhongshan Road and North Fuxing Road, forming large-scale spatial agglomeration.Moreover, the living space spreads around from the commercial center (Gupeng Business Circle, Milan International Plaza and Junsheng Plaza) on the main road of North Zhongshan Roadat its core. In addition, the well-coordinated residential space is scattered around Meigang Road and Xiadian Road. It can be concluded that the regions with good coordination between smoke-free community public service functions and street space in the main urban areas mainly feature two development patterns: first, development along streets with concentrated commercial functions; second, development along important transportation routes such as railways.

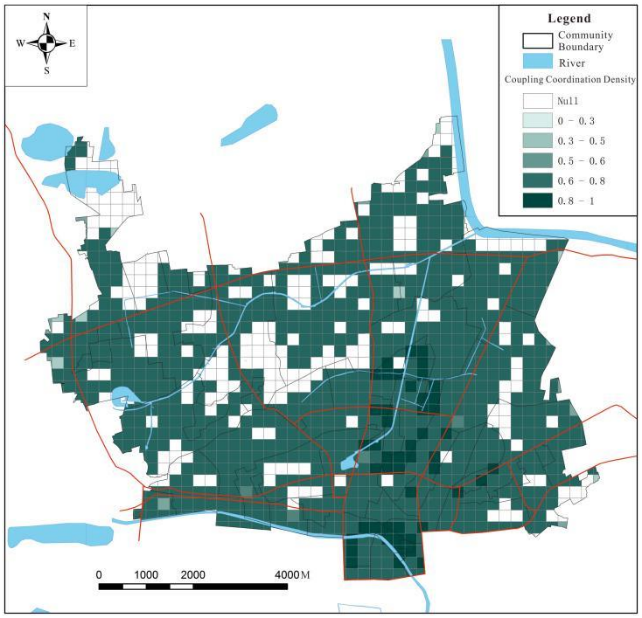

Fig. 13 Measurement results of coupling coordination degree between community public service function and street space in Gulou District

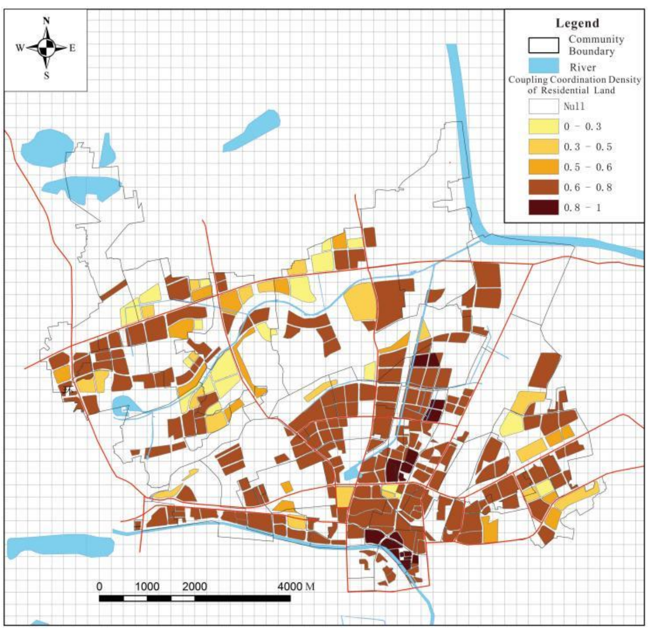

Fig. 14

Measurement results of coupling coordination degree of residential in Gulou District

CONCLUSIONS

The evaluation method of coupling coordination of two systems proposed in this paper is carried out in an ideal state. The main purpose is to grasp the overall distribution scope and characteristics of smoke-free city community public service facilities, and provide guidance for the decision-making of smoke-freespatial resource redistribution.

Community plays an important role in smoke-free city development. The improvement of public service function in surrounding areas can promote the optimization of health urban space. Thus, it is of great practical significance to improve the public service function around the community. The research shows that population density and spatial integration are important indexes for comprehensively evaluating community public service function and street space vitality. Improving population concentration ability and street accessibility are the key to promoting the development of community public service space. Therefore, in the functional optimization and special planning of smoke-free city community public service facilities, comprehensive planning should be carried out while focusing on the development status of surrounding streets by the principle of putting people first. These will improve the accessibility of street space, promote the vitality of traffic space, and enable residents to enjoy the high-quality smoke-freepublic service around the community in a more convenient way. Meanwhile, with respect to spatial agglomeration, the mixing of multiple functions can contribute to community space vitality. The goal of spatial functional mixing is to provide and meet the needs of residents' daily activities at a smaller spatial scale, and improve land use efficiency and compactness. Scientific and effective mixed land usecan be realized and a highly integrated life circle smoke-freecommunity can be created by establishing a multi-level,multi-dimensionalliving, commercial and public service and other urban space environment, optimizing the street space and guiding orderly land development under the sound land use and management system.

Conflicts of Interest Disclosure Statement

The authors declare no conflict of interest in the authorship or publication of this work. The authors declare no sponsored financial sources for the undertaken study.

Acknowledgement

This workwas supported by Jiangsu Universities Philosophy and Social Sciencesof China(Grant No. 2021SJA1124).

Author Declaration

This research is not funded by any organization related to tobacco production.

References

1. Giang Kim Bao et al. Improvement in Compliance With Smoke-Free Environment Regulations at Hotels and Restaurants in Vietnam After an Administrative Intervention. *Environmental Health Insights*.2020;14:1178630220939927-1178630220939927.
2. Mena Guillermo et al. The hospital as a smoke-free environment promotion center: implemented strategies for a tobacco control. *Revista espanola de salud publica*.2020;94.
3. Seitz CM,KabirZ, GreinerBA, DavorenMP,McIntyreSC.Enforcement of Smoke/Tobacco-free Policies at Public Universities in the US.*Tobacco Regulatory Science*.2018;4(4):22-31(10).
4. Heather N Platter, Steven B Pokorny. Smoke-free signage in public parks: impacts on smoking behaviour. *Tobacco Control*. 2018;27(4).
5. WhiteAugustus M,OssipDeborah J,SnellL. Morgan,LiDongmei,HoetgerCosima,O'Connor Richard,Lester Rebecca C,Croft Daniel,Underwood Megan,McIntosh Scott,Breland Alison,Schneller Liane,Cobb Caroline O,Barnes Andrew J.Tobacco Product Access Scenarios Influence Hypothetical Use Behaviors. *Tobacco Regulatory Science*.2021;7(3):184-202(19).
6. Clendennen SL, Vandewater EA,Loukas A, Perry CL, Wilkinson AV.College Students' Exposure and Engagement with Tobacco-related Social Media.*Tobacco Regulatory Science*.2020;6(1): 38-53(16).
7. WANG Juan, YANG Guiqing. Evaluation Research on Accessibility of Community Public Service Facilities from the Perspective of Community Differentiation − Take High-density and Aging Communities in Shanghai as Examples.*Housing Science*.2021;41(01):26-32.
8. WEI Wei,YANG Huan,TAO Yu.Analisis on the Deman-supply Matching of Community Health Service Facilities and Planning Strategies from the Perspective of Homo-urbanicus: A Case Study of Wuhan.*Modern Urban Research*.2020;05:38-45.
9. ZENG Wen,XIANG Li-li, ZHANG Xiao-lin.Research in Spatial Pattern of Accessibility to Community Service Facilities and Spatial Deprivation of Low Income Community in NANJING.*Human Geography*.2017;32(01):73-81.
10. Wang Wei,Zhou Zihao,Chen Jun,Cheng Wen and Chen Jian.AnalysisofLocation SelectionofPublicServiceFacilitiesBased on Urban LandAccessibility.*International journal of environmental research and public health*.2021;18(02).
11. Bo Zhang, Enyi Zhou.The Evaluation of Spatial Distribution Equity of Public Service Facilities in Coastal Cities.*Journal of Coastal Research*.2020;103.
12. Tannous Heba O, Major Mark David.Furlan RaffaelloAccessibility of green spaces in a metropolitan network using space syntax to objectively evaluate the spatial locations of parks and promenades in Doha, State of Qatar.*Urban Forestry & Urban Greening*.2021;58.
13. GAO Jun-bo, ZHOU Chun-shan.The Research on the Social Differentiation of the Urban Community Research Allocation in Transitional China: A Case Study of Guangzhou. *Modern Urban Research*,vol.26,no.(07),pp.14-20,2011.
14. ZHAO Jing,MA Xiaoya, ZHU Ying. Study on the Provision, Requirement and Influence Factors of Public Facilities in Community with Dense Non-Registered Population: A Case Study of Yinxiang Community in Nanjing. *Modern Urban Research*,no.(03),pp.14-21,2017.
15. Panter J,Jones A and Hillsdon M.Equity of access to physical activity facilities in anenglish city.*Preventive Medicine*.2008;46(04):303-307.
16. Lotfi Sedigheh, Koohsari Mohammad Javad.Measuring objective accessibility to neighborhood facilitiesin the city A case study: Zone 6 in Tehran, Iran.*cities*.2009;26(03):133-140.
17. Meihan Jin,Lu Liu,De Tong,Yongxi Gong, Yu Liu.Evaluating the Spatial Accessibility and Distribution Balance of Multi-Level Medical Service Facilities.*International Journal of Environmental Research and Public Health*.2019;16(07).
18. Wang Xingping, Hu Pan, Shen Sisi, Lu Yu, Shao Dian,Huang Nanqi.Spatial Characters Of Public Service Facilities From Social Differentiation Viewpoint.*Planners*.2014;30(05):17-24.
19. LI Haiping,LIANG Zihao.Research on Spatial Equilibrium of Urban Community Elderly Care Facilities and its Configuration.*Journal of Geo-information Science*.2021;23(03):467-478.
20. Tao Zhuolin,CHENG Yang,DAI Teqi, Qingjing.Research Progress and Prospect of Public Service Facilities Layout Optimization Models.*City Planning Review*.2019;43(08):60-68+88.
21. Xu Yiwen,Chang Jing.Research on Urban Public Cultural Facilities from the Perspective of Residents’ Cultural Consumption Behavior:A Case Study of XuZhous.*Modern Urban Research*.2018;03:66-73.
22. Yuan zhou, Liu Tian and Shaolei.The Physically Disabled’s Accessibility Needs and Satisfaction Study of the 15-minute Community Service Circle in Beijing.*Planners*.2019;35(04):25-31.
23. Chen Hongxia,Zhang Bo,Li Dezhi.Satisfaction evaluation of public service in large scale security community:Take Nanjing granite community as an example.*Urban and Rural Development*.2018;(22):46-48.
24. HAN Han.Spatial Correlation Between Rail Transit Structure and Commercial Vitality in Shenzhen.*ECONOMIC GEOGRAPHY*.2021;41(03):86-96.
25. LUO Zhanfu,Xu Jing,GONG Xiao,HE Xin, FAN Yuanyuan.Characteristics Analysis of Urban Road Network Based on Spatial Syntax in Lanzhou City.*Journal of Northwest*

Norman University (Natural Science).2018;54(03):105-111+118.

26. DENG Yuanyuan,CHANG Jiang, YANG Fan.Land Potential Evaluation in Old Industrial Areas from the Perspective of Self-organization:A Case Study of Gulou Districe of Xuzhou City.*Modern Urban Research*.2017;(04):59-67.

27. Li Ran,Cao Mingming, Hu Sheng, Ji Qiaojuan.On Coordination Development of Ecological-Environment and Economy Based on Coupling Degree Model:A Case Study of Yulin City.*Journal of Northwest Norman University (Natural Science)*.2014;44(02):285-291.

28. WANG Shu-jia,KONG Wei,REN Liang,ZHI Dan-dan, DAI Bin-ting.Research on misuses and modification of coupling coordination degree model in China.*Journal of Natural Resources*.2021;36(03):7793-810.

29. Zhang Yang,Liu Zhiqiang,Wang Jundi,Hong Genwei.Coupling of Park-Construction Land System in Yangtze River Delta City Based on Grey Relational Analysis.*Journal of Chinese Urban Forestry*.2021;19(01):6-11.

30. MIAO Yi,SONG Jin-ping,XIU Fang-rui, WANG Xiang-yu.Rural Development Pattern and Optimization in County Region Based on Coupling Relationship:A CASE Study of Hanting District.*Human Geography*.2021;1(177):6-11.