

## Research Article

# Urban Complex Public Space Design Method Based on Support Vector Machine

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Received 26 February 2022; Revised 24 March 2022; Accepted 29 March 2022; Published 16 April 2022

Academic Editor: Zaoli Yang

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Urban commercial complex is the product of social and economic development, as well as the inevitable trend of commercial development. The public space design of urban complex project is an important link in its development process, which is the link between the contact and the building, the city and the building, and the external image display of the complex. Therefore, choosing a suitable and excellent public space design scheme is of great significance to show the superiority of the complex project and improve the project satisfaction and the sustainable operation in the later stage. This paper first defines the concept of urban complex public space and focuses on the analysis of the urban complex public space from four aspects of constituent elements, functional classification, design theory, and principle. Then, the Delphi method is used to determine 26 evaluation indicators to evaluate the urban complex public space design scheme, and the relevant index data of 20 urban complex public space design schemes are collected. The grey correlation analysis method is used to analyze the correlation degree between each indicator and the scheme winning bid. The final evaluation system of urban complex public space design scheme is obtained after removing the 8 indicators with low correlation degree. Support vector mechanism was used to build the optimization model of urban complex public space design scheme, and its accuracy was verified, which provides a relatively simple and quantitative method for urban public space design in the future, helps to improve the city's business structure, improves the business environment of the city, makes the commercial complex more effectively play its own characteristics and advantages, effectively stimulates the vitality of urban space, and creates more perfect architectural space and urban space for people.

## 1. Introduction

Urban complex is one of the main driving factors of modern economic development. Excellent urban complex space design must have rich functional space and bright architectural design. In the process of urban construction and development, how to stimulate the vitality of urban space and improve the quality of the city has always been the subject of many scholars. The emergence of many successful commercial complex cases in recent years suggests that the quality of urban life can be improved by restoring the relationship between architecture and urban space, which provides a new perspective and approach to stimulate the vitality of urban space [1]. In this context, China began to build a large number of urban complexes with multiple urban functions and multiple urban resources. Commercial complex has large scale, wide occupation, large investment,

large flow of people, and complex supporting functions, which have an impact on regional economic conditions, urban infrastructure construction, and urban spatial image. Urban complex space is not only the space of its own function, but also an important part of urban public space. It plays a role of resting place for urban population. Moreover, due to the unique urban status and important functions of urban complex, especially in shaping cultural environment, it plays an important role in improving urban image and stimulating urban economy. Therefore, once the design fails, it will not only cause huge economic losses to the developer but also have a huge impact on the city where it is located and even the whole society, which requires us to create a high-quality space environment in a limited space [2]. Faced with a variety of design schemes, how to choose a better set of urban complex public space design schemes has become a subject that relevant researchers should study in depth.

Research on it can not only provide theoretical support for creating a good shopping space environment and reflect humanistic care but also, more importantly, systematically link its design with the design of urban public space, reflect the optimal allocation of urban resources, and create intensive, rationalized, and landscape urban space [3]. Looking at some classic foreign urban complex projects, advanced design concepts are established at the beginning of design, comprehensive market research and relatively innovative strategy research are carried out to better integrate architectural complex and urban space landscape, and people's consumer psychology is taken into account to make them have a strong appeal. On the whole, foreign urban complex design has a more mature design concept than domestic. From the literature review of domestic and foreign scholars on the research of urban complex public space, it can be found that most of the literature only discusses how to combine the construction of public open space with the city, without the spirit of further exploration on the basis of human scale and emotion. As a construction group, urban context has obvious radiation effect on the surrounding environment. It should be more connected with the public life of citizens, which requires a more suitable urban complex space design scheme. This paper tries to evaluate and select the optimal urban complex public space design scheme from this starting point.

The internal open space of commercial complex is a space system concept that comes into being with the gradual maturity of commercial system. However, as a space concept, it has not been incorporated into a system with commercial architectural design and has not formed a complete design concept due to the neglect of architectural designers [4]. Therefore, the study of it will improve the internal value of the open space inside the commercial complex from the perspective of architectural design and commercial marketing environment, and more importantly, it is a kind of promotion of humanistic value. With the further progress of urbanization in China, urban commercial complex is gradually becoming the most dynamic and popular public space in cities by virtue of its special location value and highly integrated functions. At present, the construction of commercial complex in China's cities is still in the development stage; there are some problems and deficiencies. Therefore, based on the relevant survey data of urban complex, this paper establishes and screens the indicators of public space design scheme by analyzing the elements and design principles of public space of urban complex, establishes a scientific evaluation index system of public space design scheme of urban complex, and then establishes the model by using the support vector machine (SVM) method. It classifies and evaluates the urban complex public space design scheme and finally makes an empirical analysis of the index system and model, so that the research has a certain theoretical and practical significance.

## 2. Overview of Design Theory

*2.1. Concept of Public Space of Urban Complex.* Urban complex is to combine more than three functional spaces of urban catering, exhibition, entertainment, commerce,

transportation, residence, tourism, and office and establish an interdependent and mutually beneficial dynamic relationship between each part, thus forming a multifunctional and high-efficiency complex [5]. Urban complex is a multicomponent concept, which is the intersection summary of multiorientation and multiangle definition, namely, the organic combination of urbanism, commerciality, comprehensiveness, and integrity. It is generally invested by a number of companies, unified development and construction, and adopts the management mode of owner, manager, and operator separation, the implementation of comprehensive and unified centralized management and decentralized management. The functional structure of urban complex is shown in Figure 1.

There are four development modes for urban commercial complex. One is the balanced development mode, that is, hotel, office, shopping, and apartment are basically in a balanced development; the second one is the development mode with office building as the core function; the third is the development mode with hotel as the core function; the last one is the development mode with commerce as its core function [6]. The study of the subject of urban complex external space environment is based on the business development model for the core function of complex; this kind of complex is generally located in the core area of the city. Traffic accessibility is better, for example, along the main road or along the metro lines, and foot traffic has the characteristics of strong business atmosphere. The internal open space of commercial complex is the public space for shoppers to walk and rest and carry out promotional activities or other social activities in the commercial complex, including the atrium, side court, inner square, guide space, indoor commercial street, and open-air commercial inner street, which have their own distinctive space system. The urban complex public space studied in this paper consists of inner and outer parts. The inner part refers to atrium, walkway, and other spaces. The exterior refers to the space formed by the enclosure or boundary of a single volume or multiple volumes. The two parts of the space link the city and architecture, organize functions and traffic, and provide places for people to rest and communicate, which has a strong urban social attribute [7]. It has dual attributes: it is private under commercial management, closely connected with commercial activities, and open to a certain extent, integrating with urban life. The commercial complex public space definition is shown in Figure 2.

*2.2. Urban Complex Public Space Design Theory.* The elements of public space of urban complex mainly include five parts: square, courtyard, commercial inner street, secondary ground, and building retreat space, which can be divided into four categories according to functions: transportation, rest, commerce, and assembly. The main design theories include four theories of dynamic space, urban aesthetics, intermediary space, and grey space. The principles of urban complex public space design mainly include the following:

- (a) Accessibility principle: as an evaluation standard for the external traffic environment of urban

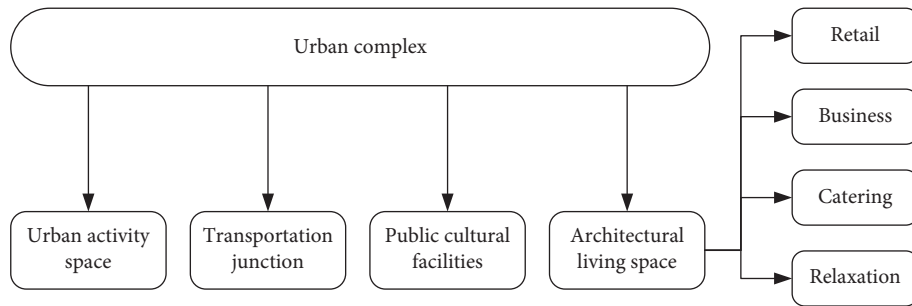


FIGURE 1: Functional structure of urban complex.

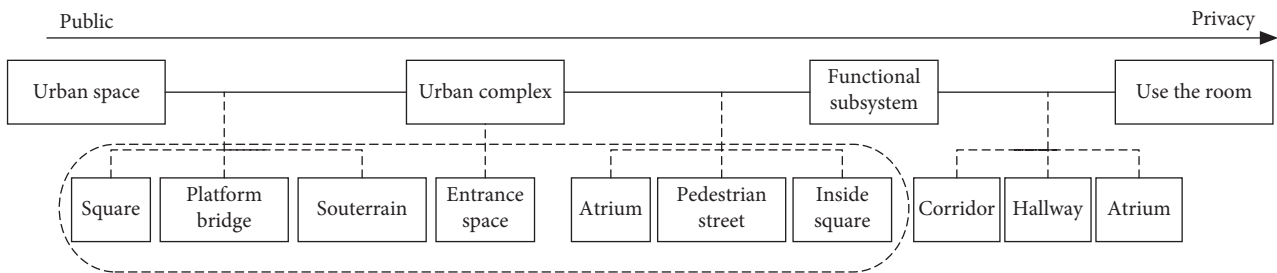


FIGURE 2: Commercial complex public space definition.

complex, accessibility is required not only at the entrances and exits of land but also at the entrances and exits of buildings and parking lots. Because of the needs of commercial, residential, and traffic functions of the complex, accessibility of the external traffic environment becomes an essential prerequisite for the economic benefits and comfort level of the urban complex. Generally speaking, the path is optimized and has convenient external traffic conditions [8]. Therefore, the site selection of urban complex becomes the top priority. We should not only consider the passenger flow density and geographical location conditions of the main body but also investigate factors such as supporting construction of public facilities and business district characteristics. Only by balancing in various aspects can the accessibility system of urban complex be improved.

(b) Openness principle: the publicity of space means that anyone can enter this space at any time and do whatever they want in this space within the scope permitted by law without restriction. Public space, but in actual operation, design, and daily management, without exception will have some inevitable factors, such as the space surrounding the hardware facilities and the boundary of the project is too rigid, and hard factors, such as processing will affect the publicness of the whole space and reduce overall openness, and these problems are usually ignored by designers [9]. For these reasons, it is particularly important to reflect the public nature of space in the design and take the principle of openness as the guide.

(c) Multidimensional principle: the establishment of urban complex is dependent on the three-dimensional urban traffic, according to the principle of external multidimensional transportation planning, under the conditions of rapid development of science and technology and increase of industrial productivity, urban traffic pressure is also increasing day by day. The emergence of urban complexes in major cities undoubtedly drives domestic demand and people flow, but at the same time, it also has a load on the urban traffic [10]. Therefore, the establishment of complex three-dimensional traffic level is urgent. Only by perfectly combining the vertical and three-dimensional separation layers of pedestrians and vehicles can the city's public space and urban traffic form space be integrated, public resources be optimized, and people flow and traffic flow through the vertical traffic space of each layer be controlled regularly, so as to reach the destination optimally and fastest. The emergence of three-dimensional level broke the traditional two-dimensional level, through the extension of each level, and laid a foundation for the ultimate realization of urban complex functional space.

(d) Diversity principle: the construction of urban complex, with the diversification of spatial functions as the main body and the diversification of spatial forms as the auxiliary, constitutes the public space form of urban complex [11]. Because of the performance of its functions, urban complex is divided into multiple comprehensive fields and rationally distributes commerce, residence, and transportation, thus reflecting the multiple phenotypes of public

activities. Multiple spatial forms are combined through the diversification of their functional spaces.

- (e) The principle of humanization: the concept of the subject of design is the classification of the use and implementation of human-centered design, which is tailored to the subject according to the ruler and purpose without exception. Otherwise, it cannot constitute the main elements of design. Because we design based on the specific use requirements of customers, we should give full consideration to the subjective initiative of design and combine the elements of function and appearance so as to reflect the social vane of the subject and the internal needs of people. Therefore, it can be seen that people are the core of the design concept. The public space design of urban complex should give more prominence to urban humanity and other characteristics [12, 13].

### 3. Design Evaluation Index Construction

#### 3.1. Selection Principle and Process of Evaluation Indicators.

Urban space is not only diversified in form but also has different functions and occupies different areas. It can not only be a relatively independent overall space but also be a spatial sequence connected with each other. For example, streets, shopping centers, landscape gardens, green belts, residential buildings, etc. have a certain system of interwoven sequence. Architectural space is an important part of urban space, and the public space of architectural space plays a decisive role in the overall space system of the city, so the design of architectural public space must consider the overall space system of the city. In order to present a good image of the city, the design of the external space environment should fully consider the needs of the overall space system of the city, so that it can better match the completion of the urban space system, complement each other, cooperate with each other, and improve together. Therefore, this paper will focus on the relationship between urban space and architectural space in the selection of practical evaluation indicators [14].

Mosaic projects are different from general buildings in view of the city, in the process of constructing the evaluation index system of public space design scheme of urban complex, in addition to considering the general evaluation index factors of ordinary building groups in the design scheme, it is necessary to combine the characteristics of urbanization and externality of public space according to the particularity of urban complex project., after in-depth study of the index system and comprehensive consideration of various related factors, the index with large correlation degree is finally selected to make the evaluation index system scientific and reliable and has practical significance. The specific index selection principles include six principles: target, comprehensiveness, scientific nature, emphasis, operability, and comparability [15, 16]. Based on the valuable experience of a large number of successful cases, the specific process steps are as follows when constructing the evaluation index system of urban complex public space design scheme by fully connecting with the construction situation of actual

projects, drawing on the strengths of others and combining with our own situation.

- (a) Selection and decision of evaluation indicators: first of all, from its own architectural form, functional positioning, and the urban space around the urban complex, very complex-related influencing factors should be removed, and a wide range of common index influencing factors should be selected in a planned way. Second, the valuable experience of previous successful project cases should be taken into full consideration, and the useful indicators should be evaluated and compared in combination with the engineering quantity of the project itself and the characteristics of its geographical location, so as to clearly describe the characteristics and advantages of urban complex [17]. In combination with the target expectation of the project, this paper selected a reasonable evaluation index after summarizing and analyzing a large number of literatures and collecting relevant useful information about the public space design of multiple urban complexes.
- (b) Determine the evaluation object factor set: according to the design principle of the above design scheme, it is necessary to make a comprehensive and macroscopic analysis and decision on the influencing factors, so as to avoid the imbalance of the evaluation system caused by only considering unilateral factors [18]. The evaluation index system of urban complex public space design scheme is composed of six levels: transportation convenience, spatial artistry, rationality of planning and layout, perfection of service facilities, appreciation of green landscape, and main technical and economic indicators. Secondary evaluation indexes are established for each level. They together constitute the evaluation index system of urban complex public space design scheme. The construction process of evaluation index system of urban complex public space design scheme is shown in Figure 3.

3.2. Construction of Evaluation Indicators. As urban complex is a highly intensive block building group with various functions of the city, which interact with each other and complement each other in the value chain, this characteristic determines that the influencing factors of the spatial design of urban complex include multiple aspects. How to construct the evaluation index system scientifically has important influence on the selection of the final design scheme. According to the design process of public space of urban complex, combined with relevant literature and design theory, this paper summarizes evaluation index factors involved in the whole design process after consulting the opinions of 30 experts and scholars who are familiar with and have participated in the design of public space of urban complex projects. Finally, 26 index factors in 6 aspects of urban complex project public space design scheme are obtained. In order to better evaluate the indicator system established in the above section and screen out the most core

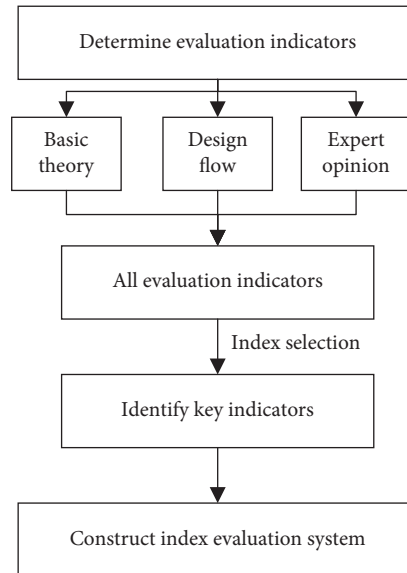


FIGURE 3: Construction process of evaluation index system of urban complex public space design scheme.

indicators, the author collected 20 design schemes similar to urban complex projects, denoted as A~T (the same below). These schemes include 10 space design schemes which have not been awarded and 10 space design schemes which have been awarded. These schemes are evaluated according to the index system constructed above [19]. As for the quantitative indicators of the 20 sets of schemes collected, the author obtained the data of 9 quantitative indicators by calling the design institution and referring to the official website of the project to obtain relevant information. However, in order to match the data of the 7-point system of 17 qualitative indicators mentioned above, traditional normalization or standardization methods cannot be used to exclude the effects of dimension and order of magnitude. Therefore, the idea of classification and segmentation is adopted, that is, to make full use of the collected data of 20 items; each quantitative index will have 20 values. Sort according to the size of these 20 values, and adopt a standardized calculation formula:

$$x_{ij} = \frac{x_{ij} * 7}{\text{sum}(x \cdot j)}, \quad (1)$$

where  $1 \leq j \leq 20$  is the number of schemes and  $1 \leq i \leq 9$  is the number of variables.

Through the above processing of qualitative and quantitative indicators, the evaluation results of 26 indicators in the evaluation index system are unified. As mentioned above, it is known whether the 20 design schemes collected are successful, so the dependent variables can be obtained as follows:

$$Y_1 = \begin{cases} 0, & \text{win a bid,} \\ 1, & \text{lose a bid.} \end{cases} \quad (2)$$

In this paper, the above four first-level indicators affecting the low-carbon design of urban complex are subdivided. Among them, the site planning indicators include

six second-level indicators: building texture coordination degree, external public space utilization rate, regional population density, per capita consumption expenditure, existing traffic carrying capacity, and the degree of improvement of supporting foundation. Architectural design indicators include commercial proportion, office proportion, apartment or residential area proportion, other area proportion, building window wall ratio, body shape coefficient, floor area ratio, building density, vertical space utilization rate, building orientation and ventilation, and building structural system twelve secondary indicators. The traffic index includes eight secondary indexes: number of parking spaces, load degree of road network, number of routes, transfer convenience, order degree of streamline organization, interweaving degree of format organization, number of vertical traffic, and suitability of walking distance. Landscape design indexes include landscape environment optimization degree and greening rate [20].

## 4. Design Scheme Optimization Model

**4.1. Basic Theory of Support Vector Machines.** SVM is a new machine learning algorithm based on statistical learning theory. It has unique advantages in dealing with small sample learning problems. SVM has the advantages of strict theory, strong adaptability, global optimization, high training efficiency, and good generalization performance. It can deal with the problem of pattern recognition and regression very successfully and is further extended to the fields of prediction and comprehensive evaluation [21]. The regression SVM is more suitable to solve the prediction fitting problem and finally find the optimal hyperplane. The schematic diagram of SVM is shown in Figure 4.

Using the SVM model to predict the basic principle of the new sample, the sample space by a hyperplane is divided into two parts. This hyperplane should make the difference between the two parts as obvious as possible, and at the same

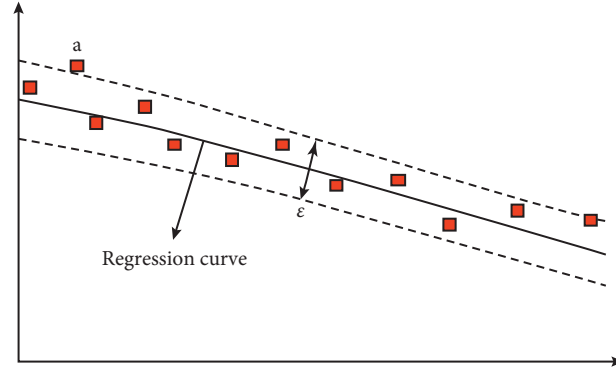


FIGURE 4: Schematic diagram of optimal partition hyperplane.

time, the same type of sample data should be classified in the same space as much as possible, in order to predict the probability of new samples on the two spaces to achieve the purpose of new sample classification [22]. The SVM model is selected as the optimal model of urban complex public space design scheme, which has the following advantages:

- (a) Able to deal with nonlinear problems: in the selection of public space design scheme of urban complex project, the complexity of influencing factors is a prominent problem. The reason why the influencing factors are complicated is that the influence of these factors on the scheme is not limited to linear processing. However, when support vector mechanism is used to build the model, the traditional linear thinking method is abandoned and its final decision function does not need too many support vectors to determine, which can not only better solve some nonlinear problems but also avoid dimension disaster, resulting in data processing difficulties.
- (b) The problem of local extremum is avoided: local extremum refers to a local but not global optimal result of the output of the built model. The local extremum problem usually appears in the neural network model, and its appearance often reduces the accuracy of the whole model. The model based on support vector mechanism can solve the problem of local extremum exactly, and it can solve the Lagrange

duality problem in convex quadratic programming problem, so as to output a global optimal result.

- (c) We can learn from a limited sample: the SVM model still has good learning ability for samples with limited sample size and can find a perfect balance between spatial complexity and prediction accuracy, so it is very suitable for dealing with the problem of multiple scheme comparison. Also, SVM has a good theoretical basis and a wide range of research basis and, in the actual application of scheme selection, has a good promotion ability.

In order to improve the prediction accuracy and avoid large errors in the SVM model, two relaxation variables are introduced in this paper on the basis of the study of relevant literature:  $\xi_1, \xi_2^* \geq 0, i = 1, 2, \dots, l$ . Therefore, the optimization equation is

$$\min \frac{1}{2} \|\omega\|^2 + C \sum_{i=1}^l (\xi_i + \xi_i^*). \quad (3)$$

Constraints are as follows:

$$\begin{aligned} \langle \omega \cdot x \rangle + b - y_i &\leq \xi_i + \varepsilon, \\ y_i - \langle \omega \cdot x \rangle + b &\leq \xi_i^* + \varepsilon, \\ \xi_i, \xi_i^* &\geq 0, \quad i = 1, 2, \dots, l. \end{aligned} \quad (4)$$

In order to solve equation (3) under the above three constraints, the Lagrange function is introduced:

$$\begin{aligned} L(\omega, b, a, a^*) &= \frac{1}{2} \|\omega\|^2 + C \sum_{i=1}^l (\xi_i + \xi_i^*) - \sum_{i=1}^l a_i (\xi_i + \varepsilon - y_i + \langle \omega \cdot \varphi(x_i) \rangle + b) - \\ &\quad \sum_{i=1}^l a_i^* (\xi_i^* + \varepsilon - y_i + \langle \omega \cdot \varphi(x_i) \rangle - b) - \sum_{i=1}^l \eta_i (\xi_i + \xi_i^*), \end{aligned} \quad (5)$$

where  $a_i, a_i^* \geq 0, i = 1, 2, \dots, l, C$  is related to the goodness of fit of the model, and  $\varepsilon$  is a control variable.

The function  $L$  gets an extreme value under the following conditions:

$$\begin{aligned} \frac{\partial L}{\partial \omega} = 0 &\longrightarrow \omega = \sum_{i=1}^l (a_i^* + a_i) \varphi(x_i), \\ \frac{\partial L}{\partial b} = 0 &\longrightarrow \sum_{i=1}^l (a_i^* - a_i) = 0, \\ \frac{\partial L}{\partial \xi_i^*} = 0 &\longrightarrow \gamma - a_i^* - \eta_i^* = 0, \end{aligned} \quad (6)$$

$$b = y_i - \sum_{j=1}^l (a_j - a_j^*) K(x_i, x_j) - \varepsilon a_i \in [0, C],$$

$$b = y_i - \sum_{j=1}^l (a_j - a_j^*) K(x_i, x_j) + \varepsilon a_i^* \in [0, C].$$

Thus, the Lagrange dual problem of the original optimization problem is

$$\begin{aligned} \min_{a_i, a_i^*} & \frac{1}{2} \sum_{i=1}^l \sum_{j=1}^l (a_i - a_i^*) (a_j - a_j^*) K(x_i, x_j) \\ & - \sum_{i=1}^l y_i (a_i - a_i^*) + \varepsilon \sum_{i=1}^l (a_i + a_i^*). \end{aligned} \quad (7)$$

By solving the duality problem, the optimal solution  $\bar{a} = (\bar{a}_1, \bar{a}_1^*, \dots, \bar{a}_l, \bar{a}_l^*)^T$  is obtained and the function  $f(x) = \sum_{\text{Support vector}} (\bar{a}_i - \bar{a}_i^*)^T K(x_i, x_j) + b$  is constructed from the obtained nonzero vector. In this new function, there is a multisensory to correspond each support vector to the component function in the new function [23].

**4.2. Design Scheme Optimization Model.** Based on the theoretical basis of support vector machine, the construction of urban complex public design evaluation model in this paper mainly includes the following:

- (1) Preliminary construction of urban complex public space design evaluation index system: according to the design process of public space of urban complex, combined with relevant literature and design theory, after consulting the opinions of 30 experts and scholars who are familiar with and have participated in the design of public space of urban complex project, the evaluation index factors involved in the whole design process are summarized. Finally, 27 index factors in 6 aspects of urban complex project public space design scheme are obtained [24].
- (2) Determine the final evaluation index system: after preprocessing each index data, the grey correlation analysis method is used to screen the indicators, and then the 18 indicators with the highest correlation with the evaluation results are obtained. Thus, the evaluation index system of the design scheme is constructed.
- (3) Selection of appropriate training sets: 20 sets of public space design scheme data of urban complex

projects collected during index screening are selected for training, and study samples are selected according to the data of urban complex project design scheme.

- (4) Selection of model parameters: select the appropriate kernel function and its parameters.
- (5) Operation of SVM classification model: the SVM classification model is used to classify and evaluate sample schemes [25–27].

The schematic diagram of support vector regression model is shown in Figure 5.

In the face of multiple public space design schemes for an urban complex project, it is necessary to conduct preliminary screening of these schemes and eliminate unreasonable design schemes. The bid winning of the design scheme is not only the objective data obtained, but also the expression of evaluating the bid winning possibility of this scheme in the actual situation. In order to obtain the training of the model results, this paper selects 20 urban public space design scheme of complex project training, in order to get the most appropriate model parameters. After the filter is not reasonable design scheme, the rest of the plan has to be preferred, so you need to get the solution integrated assessment, which can clearly and intuitively compare the advantages and disadvantages and differences between the selected schemes, and the comprehensive score is the subjective data obtained, and it is also the expression of the expected score of experts on the scheme. Therefore, in order to obtain the training of the model results, in the scheme selection vector machine model, 20 public space design schemes of urban complex projects used in the scheme selection vector machine model in the previous section are also selected for training, so as to obtain the most suitable model parameters [28, 29].

The accuracy of scheme screening and classification is shown in Figure 6. It can be seen from the figure that the comprehensive score of 20 schemes is classified by the optimal parameter combination: 1 group of classification accuracy, 2 group of classification accuracy, 3 group of classification accuracy, 4 group of classification accuracy, 5 group of classification accuracy, 6 group of classification accuracy, and 7 group of classification accuracy is 100%, very high classification accuracy. Because of difficulty in data processing, this paper only chose option 20 sets of data for training, although the sample size is more accurate in theory, but because training and testing processes have similar urban complex project data, they can make the classification accuracy higher, so this also reflected the model is very suitable for such scheme classified merit.

## 5. Case Analysis

The project of impression city in Nantong, invested and developed by a certain group, is located on the industrial and agricultural road, the north-south axis of a city, in the golden area of the city center with obvious geographical advantages. The total construction area of the project is 290,000 square meters, covering 150,000 square meters of shopping center,

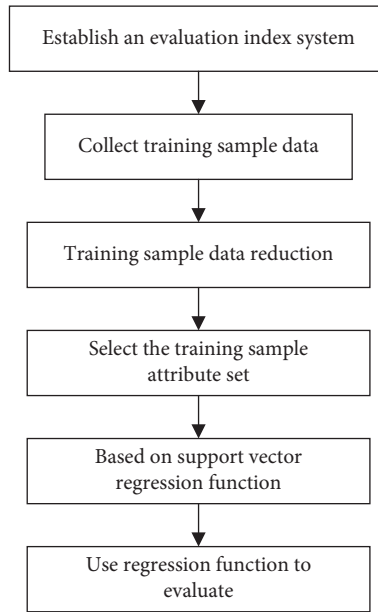


FIGURE 5: Schematic diagram of support vector regression model.

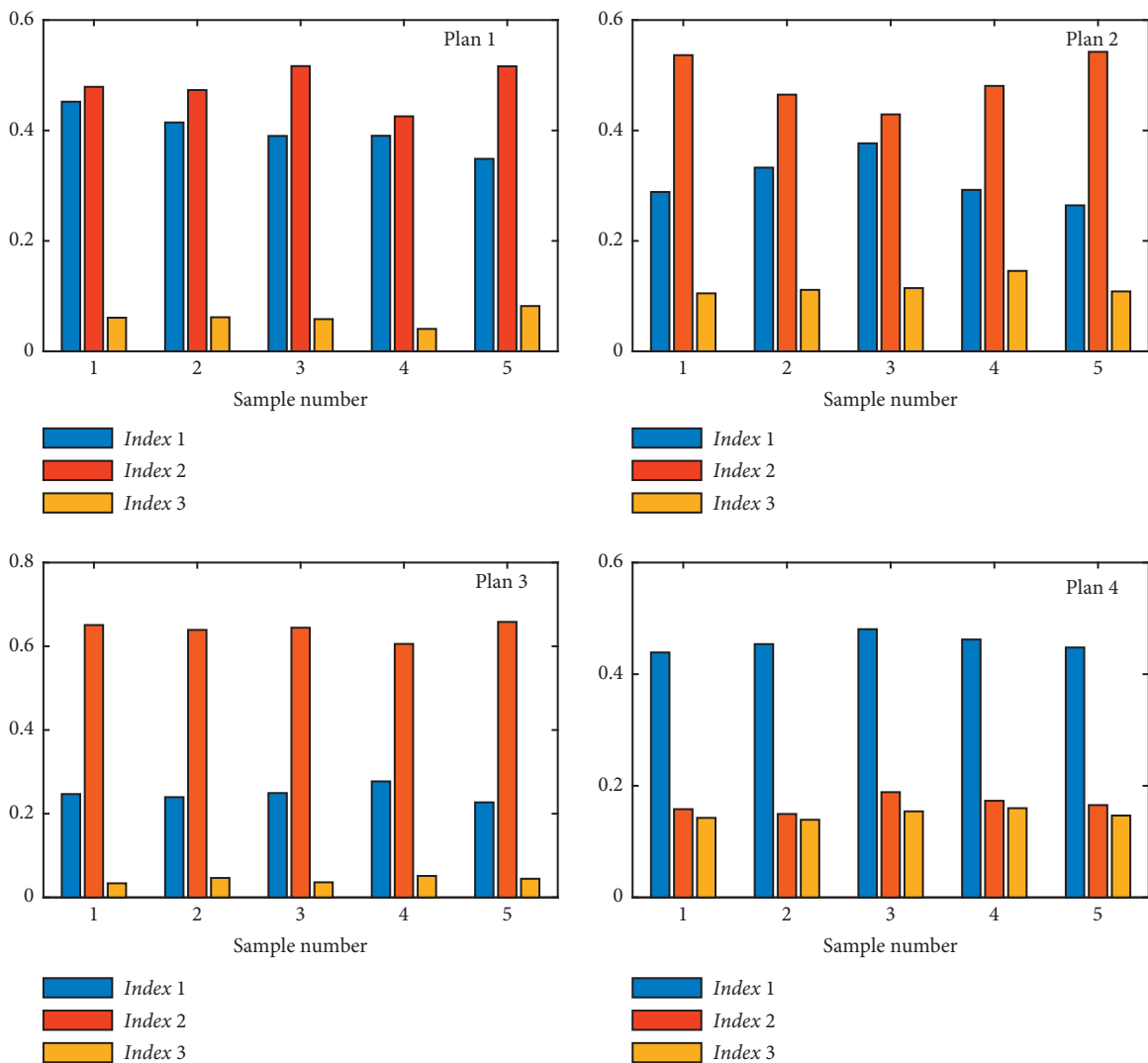


FIGURE 6: Accuracy of scheme screening and classification.



3.5 square meters of ecological office building, 3.5 square meters of impression mansion, and 37,700 square meters of impression block characteristic supporting business. It covers an area of 247,000 square meters above ground and 97,000 square meters underground, with a total investment of about 2.5 billion yuan. Because of the large scale of development investment, it has become a key project of the government since the project was established. After completion, it can promote the development of urban commerce, improve the quality of life of urban residents, and drive the appreciation of surrounding land, which is a highly representative and valuable urban complex project. In the preliminary planning and design stage, the design institute formulated three sets of public space design schemes of different styles according to the actual situation and characteristics of the project, and each scheme had its own redeeming features for developers to choose from. According to the actual situation, this project is taken as the application example of the optimization model of urban complex public space design scheme established in this paper to optimize three sets of schemes [30].

The classification results of scheme screening model are shown in Figure 7. It can be seen from the diagram that scheme 1 does not meet the actual bid-winning requirements, while scheme 2 and scheme 3 meet the basic bid-winning conditions, so they pass the screening. The scheme classification results were obtained by using the scheme optimization SVM model. The score of scheme 1 is only 1, which is the lowest. Meanwhile, since scheme 1 has been eliminated in the scheme screening SVM model, the analysis results of the two SVM classification models are consistent, indicating that it is reasonable to eliminate scheme 1, while scheme 2 has a classification score of 4 and scheme 3 has a classification score of 3. Therefore, scheme 2 is obviously chosen as the final winning scheme. Accurate positioning is the key to the success or failure of urban complex. First, the layout difference between urban commercial volume and local commercial volume should be considered, and the construction of urban complex volume needed by the city should be considered. Second, the policy support should be considered. As an important fixed asset investment, urban complex has a long recovery cycle and high capital flow risk. Therefore, it must be positioned accurately and reasonably based on the policy situation. Finally, determine the consumption demand, clarify the amount that the market can support, implement differentiated competition strategies, make a qualitative judgment on the commercial real estate of urban complex from the factors such as site selection, scale, target customers, commodity structure, operation mode, and service function, summarize the scale and function of urban complex in the region, identify different positioning, and form urban complex with different characteristics.

The classification result diagram of scheme preference model is shown in Figure 8. Through the comparative analysis of the scores of 18 indicators at six levels of the three sets of public space design schemes, the scores of indicators at four levels of scheme 2, namely, transportation convenience, spatial artistry, ornamental landscape facilities, and main technical and economic indicators, are all higher than those of the other two schemes. Therefore, it is reasonable to choose scheme 2 as

the winning scheme through the calculation results of the model. At the same time, scheme 2 is slightly weaker than scheme 3 in terms of the perfection of supporting facilities and rationality of planning layout, and the index score of internal walking convenience is also low. Therefore, while selecting scheme 2 as the public space design scheme of impression city, further optimization design can be made on the completeness of supporting facilities and the rationality of planning layout. The optimization focuses on the continuity of internal path interface, the convenience of internal walking, and the number of public toilets and rest seats. We can learn from the design of reference scheme 3 in these aspects. Under such a design planning, interpersonal communication, increasing, also makes the relationship between people more harmonious and at the same time, can realize the mutual influence between different streams of traffic, which can promote consumption, and such distribution integration also further increases the efficiency for complex space.

In principle, complex outer space as part of the urban public space, its design should comply with the principles of fairness and equality, not ruled out any kind of purpose as user groups, but in reality, the influence factors of commercial complex design are very complex, citizens demand is just one of them. Therefore, the designer should speculate the composition of users according to the service scope in advance, and make the external open space at least meet the needs of the main user groups after weighing the interests of all aspects. For mosaic outside of the city commercial space, whether on weekdays and weekends or holidays, young people generally account for the highest proportion of user composition, middle-aged, accordingly; the designers should not only make through adequate rest sit facilities and green space to meet the needs of the people to have a rest, they should also try to increase the share of business functions and the related business services level; the introduction of other functions, such as exhibitions and gatherings, is considered in combination with the space type. The functions inside the complex are organized and arranged in combination with the external open space, and the space sequence inside the building is compressed in the position facing the external space, so as to make some commercial functions close to and open to the external space as much as possible, so that the boundary between indoor and outdoor is blurred and the internal commercial space is expanded. The placement of retail, catering, and other functions will bring a variety of activity types to the external space, and the user's activity itself is one of the attractive elements of the space. The analysis of the perfection of supporting facilities is shown in Figure 9.

In the study of the external space of commercial complex based on urban transportation, on the one hand, the external space of commercial complex plays a role from the macro- and microperspective of the city: integrating various functional units of the city, transforming internal and external traffic flow lines, stimulating new urban space mode, and transmitting social information; on the other hand, the three-dimensional development of urban transportation and the integration of public transport priority and other development concepts with architectural space make people realize the importance of the connection between the two. In

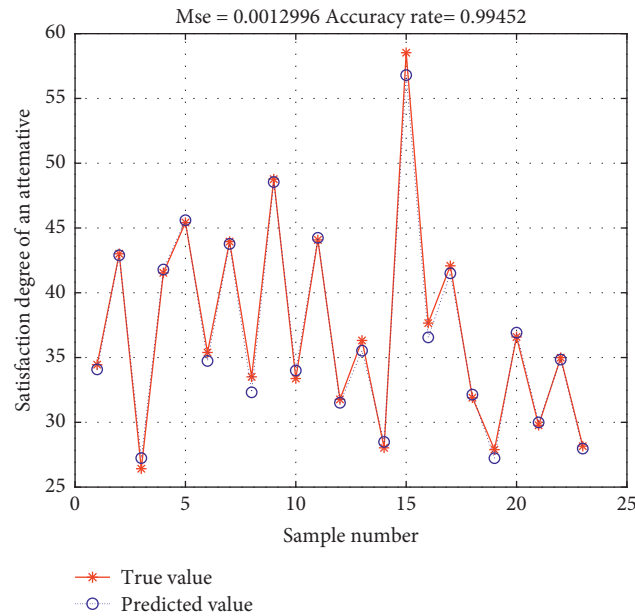


FIGURE 7: Classification results of scheme screening model.

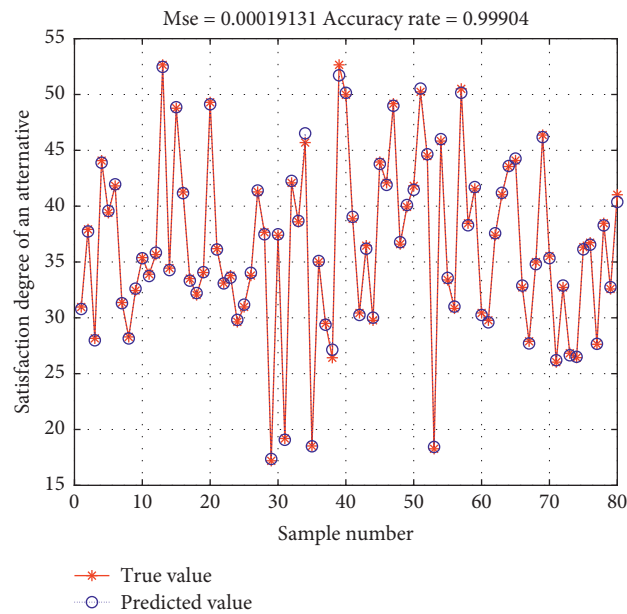


FIGURE 8: Classification result diagram of scheme preference model.

combination with the current development situation, it is found that there is a lack of connection between the two in the society, such as low integrity of external space, low traffic accessibility, lack of coherence with surrounding land and traffic, and poor travel experience of residents. Therefore, on this basis, suggestions and benefits for vigorously developing the two are put forward, such as the two complement each other to promote each other, promote urban vitality, and expand the urban space. The outer space of commercial complex is divided into square space and street space from the spatial form of the outer space. This paper studies the

influence of urban traffic on the two outer space from the perspective of traffic flow line and resident behavior. Although the spatial morphology of the two is different, there is commonality and mutuality between them. In a word, under the environment of vigorous development of commercial complexes in China and more and more integration of other urban functions, no matter which aspect is preferred for development, all functions should deal with each other harmoniously and act synergistically. Finally, a human-oriented outer space of commercial complex that is compatible with social development and meets its own needs will

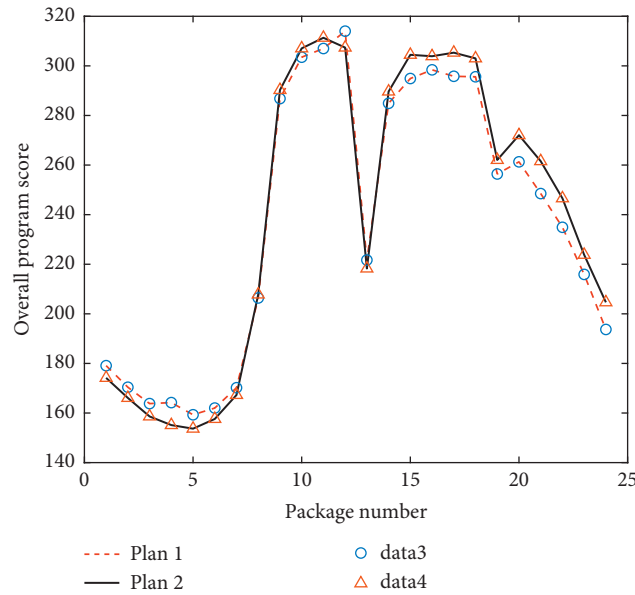


FIGURE 9: Analysis of the perfection of supporting facilities.

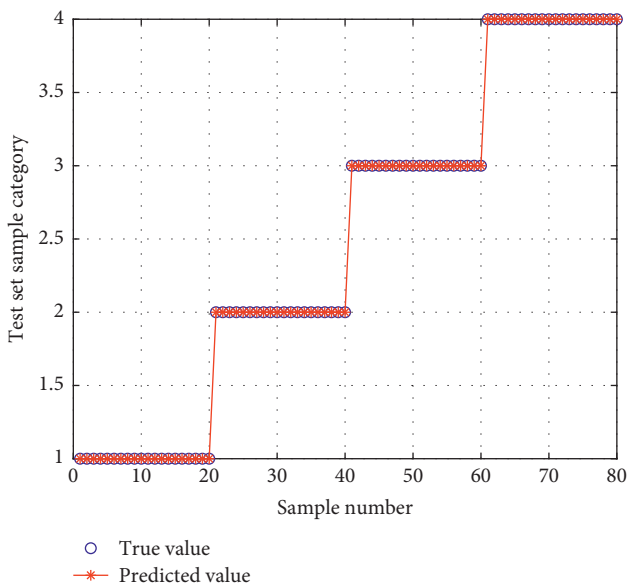


FIGURE 10: Main technical and economic indicators' classification result chart.

be formed. The main technical and economic indicators' classification result chart is shown in Figure 10.

### 6. Conclusion

In the face of the current urban complex construction boom, if developers want to improve the project operation capacity in the later stage, they need to strictly control all aspects of the project in the early stage, and the design control includes the design of single buildings and public space. The public space of an urban complex project is the link between the contact and the building, the urban space and the architectural complex, and the external image display of the

complex, which needs to reflect its humanized and public characteristics in the design. A suitable and excellent public space design scheme can better show the superiority of the complex project, improve the satisfaction of the project, and lay a foundation for the continuous operation of the later project. Guided by public space design theory and using scientific decision-making theory, this paper studies the optimization of urban complex public space design scheme, and the main conclusions and achievements are as follows:

- (a) The principle of planning and design of public experience space for large-scale commercial comprehensive construction projects is people-oriented, and it should pay attention to the actual needs of urban residents, respect the consumer psychology of potential customers, and meet the consumption demands of urban residents for relaxation, fitness and entertainment, shopping, sightseeing, catering, office work, and other aspects.
- (b) The planning and design of public experience space of large-scale commercial comprehensive building projects should uphold the design standards of diversification, interaction, and integration, share the urban functions reasonably, connect the original urban area with the new urban area, and promote the supporting and improvement of urban public infrastructure.
- (c) In the planning and design of the public experience space of large-scale commercial comprehensive construction projects, attention should be paid to the planning and design of the surrounding traffic roads and the horizontal and vertical spatial structure design of the interior of the building.

Urban complex is closely related to urban development, and the formation of space has its limitations of the time. The completion of a large urban complex will bring some

changes to the urban texture, and the luster at the beginning of the completion should still not be the most important. What is important is whether the space of the urban complex can leave a good impression and still be found in the project many years later. Therefore, as urban architects, we should make unremitting efforts to pursue pleasant space. Through the study of urban complex public space design, this paper builds a scheme selection model and has achieved certain achievements, but there are still the following aspects to be further discussed:

- (1) Because different types of complex projects may have different characteristics, such as tourism complex, commercial complex, and cultural complex, the focus of their public space design is also different, so the index system needs to be adjusted according to the actual situation of the project when evaluating the design scheme.
- (2) In order to ensure the reliability and accuracy of the established optimization model in practical application, whether the evaluation subjects can be selected from the perspective of different stakeholders, such as developers, governments, designers, and citizens, needs to be further verified.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgments

This work was supported by the Philosophy and Social Science Planning Project of Henan Province, Study on Color Comfort of Traditional Villages in Northern Henan Province (2018BYS007).

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