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The Integration of Vertical “Compound” Concept and Modern Campus Architectural Design Based on Data Calculation and Analysis--Taking Beijing Jiaotong University Xiongan Campus An Assessment Center as an Example

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Abstract University campus architecture is an important type of contemporary architecture, and due to the need for large-scale construction, existing studies have mainly focused on the overall planning of campuses and new buildings. With the concept of vertical “compound” and modern campus architecture design as the guide, this article proposes a structural system for the security assessment center of Beijing Jiaotong University's Xiongan Campus as an example. For the effectiveness of the building design, this paper designs the corresponding evaluation index system, and introduces the entropy weight method to solve the index weights, and combines the fuzzy comprehensive evaluation to carry out the calculation and analysis. It also combines the quantile regression model to explore the influencing factors of the design of the safety evaluation center of Xiongan Campus of Beijiao University. The calculation results show that the comprehensive evaluation score of the design of the Xiongan Campus Security Assessment Center of Beijiao University is 4.006, which is at the level of good grade. And the geographical environment, campus planning, site conditions and faculty and student needs all have a positive influence on the construction of the Security Assessment Center of Xiongan Campus of NJTU at the 1% level. Therefore, it is necessary to build an overall planning and design framework from a global perspective, and pay full attention to the quality of the built environment, so as to ensure that the architectural design of the Center of Xiongan Campus of Beijiao University is more in line with the needs of the campus buildings.

Index Terms vertical “compound” concept, entropy weight method, fuzzy comprehensive evaluation, quantile regression, Beijing Jiaotong University Xiong'an Campus

I. Introduction

At the present stage, China is paying more and more attention to the issue of education and takes education as one of the core contents of development. In order to create a high-quality campus environment, the modern campus building design program has attracted a lot of attention, and designers have explored in depth, striving to enhance the characteristics and aesthetics of the campus to meet the needs of teachers and students [1], [2]. In the actual process of campus construction, courtyard campus architecture has become one of the core contents of the current construction design [3]. Courtyard, as a unique form of different building enclosure, with the help of the interface of the enclosure, not only provides cover and protection for the space, enhances the overall security, but also builds a rich psychological depth of space [4]-[6]. In addition, the popularization of courtyard-style architecture is more obvious, with inward-looking characteristics, so it can meet the needs of most buildings, including campus construction and enterprises with certain spiritual connotations [7]-[9]. With continuous improvement and optimization, the courtyard form has undergone certain changes, and the integration between it and the natural environment is stronger, and the building group can adapt to the natural environment, so different courtyard forms have also appeared [10]-[12]. Among them, the expression of vertical “compound” can be described as a courtyard wall plus building monoliths, the internal enclosure by a number of courtyard walls continue to form the basic functional areas such as “lectures, book collections, rituals” [13]. Vertical “compound” concept and modern campus building design integration, help to improve the aesthetics of campus buildings, but also to a certain extent to improve the unity of campus buildings and norms.

This paper proposes a modern campus architectural design method based on the concept of vertical compound, and selects the building of the An Assessment Center of Beijing Jiaotong University Xiong'an Campus as an example to construct the architectural structure system of the An Assessment Center. The feasibility of the system is reflected by designing the evaluation index system, solving the index weights by using the entropy weighting method, and then analyzing the comprehensive evaluation scores of the design of the An Assessment Center of Xiong'an Campus of Beijing Jiaotong University by combining the fuzzy comprehensive evaluation. Finally, a quantile regression model is established from the four independent variables, namely, geographical environment, campus planning, site conditions and faculty and student needs, to explore the degree of influence of the independent variables on the design of the An Assessment Center of Xiong'an Campus of Beijiao University, and to propose an optimization strategy for the design of the An Assessment Center of Xiong'an Campus of Beijiao University.

II. Design of the Security Assessment Center based on the vertical compound concept

Campus complex design is an important method to improve the efficiency of campus space utilization, in line with the objective demand for land resource tension, is the main direction of future campus building development. Today, in the development of comprehensive education and functional complexity of universities, campus building design and construction operation has also exposed problems such as relatively single function, low efficiency of connection between functions, and insufficient spatial interactivity, which affects the living experience and spatial feeling of the modern campus, and urgently requires more detailed targeted research.

II. A. Vertical Compounds and Modern Campus Building Designs

II. A. 1) The vertical “compound” concept

Vertical courtyard concept is an innovative attempt in modern high-rise building design, realizing the extension and innovative expression of traditional courtyard culture through vertical space layout. Its core idea is to create a high-rise public space with both cultural connotation and ecological function through the combination of architectural form and ecological technology. The specific features are as follows:

(1) Cultural inheritance and spatial reconstruction, a vertical expression of the traditional courtyard. The vertical courtyard draws on the “resemblance” and “meaning” of traditional architectural courtyards, and extends the horizontal courtyard space to the high-rise building through façade design and spatial sequences. For example, it adopts the symmetrical structure of traditional courtyards and borrowed landscape techniques to form a vertical public space with Chinese flavor. It is also a modern interpretation of cultural symbols, incorporating traditional architectural elements such as sloping roofs, corridors, and leaky windows into the vertical courtyards, and simplifying and abstracting them in combination with modern architectural language, so as to retain the cultural genes and meet the modern aesthetic demands.

(2) Ecological function and green design to assist the construction of natural ecosystem. The Vertical Compound focuses on interaction with the natural environment and realizes ecological functions such as lighting, ventilation and rainwater collection through atrium gardens and vertical greening. For example, the atrium ecological warehouse is designed for plant growth, and the natural ventilation system is utilized to reduce energy consumption. Fully practicing the concept of energy saving and low carbon, combining the building orientation, window-to-wall ratio and other parameters to optimize the building thermal environment and reduce energy consumption. At the same time, the low-carbon performance of the building is enhanced through green building materials and renewable energy technologies.

(3) Social value and living experience to promote the innovation of public interaction space. Vertical compounds are set up with public spaces integrating rest, communication, and viewing to form a multi-layer interactive sequence. For example, creating shared courtyards in office buildings promotes the exchange of people in different functional areas. It is also a remodeling of the urban cultural space. Through the design of the vertical courtyard, it breaks the limitation of the traditional living space and makes the high-rise building an “urban space” with social and cultural attributes. For example, it provides residents with facilities such as planting ponds to enhance the sense of belonging to the community.

II. A. 2) Modern campus building design

Education is the basis for a hundred years of planning. School is the implementation of education and training of talents place, school building should have the atmosphere of the times, spiritual style and humanistic connotation. With the development of the times, government departments at all levels and all walks of life are paying more and more attention to the cause of education, and the national investment in school construction is expanding, and the requirements for campus hardware construction are getting higher and higher. Accompanied by the rapid development of society, science and technology and the rapid update of human knowledge, people's understanding of the standards and values change, the functional role of the campus building and the demand for standards have also been diversified to the direction of development. Today, China's education reform is in full swing, grasp the pulse of education development, in the inheritance of the traditional style of the school on the basis of continuous innovation, to explore the creation of a campus building style with heavy cultural connotations and the times, in order to jointly promote the good development of the educational architectural design [14].

The architectural form of modern campus building design serves its intrinsic function. Reasonable arrangement of each functional partition is the basic premise of the design, and the construction of a quiet and rich cultural flavor of the teaching space is the fundamental purpose of the design. As the function of the campus building, the first to meet the students as the main body, the teacher as the leading teaching and learning and a variety of activities to communicate and exchange the material conditions of life. Secondly, to meet the living space needs of teachers and students, and thirdly, to ensure that the campus environment of humanistic attributes and artistic attributes, and enable teachers and students to be high-grade spiritual and cultural nutrition and subtle inculcation.

II. B. Design framework for the Security Assessment Center

II. B. 1) Xiongan Campus of NJTU

Beijing Jiaotong University Xiong'an Campus (hereinafter referred to as BJTU Xiong'an Campus), is located in the northern part of the fifth cluster of the start-up area and the beginning area of Xiong'an New Area in Hebei Province, covering an area of about 2,600 acres, and the dominant functions of the campus are all for the higher education and scientific research, and it is expected that the first phase of the construction is expected to be completed and put into use around 2026.

On May 19, 2022, Beijing Jiaotong University (BJTU) held a kick-off meeting for the master planning and design of the Xiong'an Campus, and the planning and construction of the Xiong'an Campus kicked off.In October 2022, BJTU announced the master planning scheme for the Xiong'an Campus, and the winning scheme was designed by the Architectural Design and Research Institute of Tsinghua University (ADRI-THU).In September 2023, the land site of the Campus was nailed down and positioned. In the same month, Beijing Jiaotong University, University of Science and Technology Beijing, Beijing Forestry University, and China University of Geosciences (Beijing), the first four universities to be relocated to Xiongan New Area, jointly initiated the establishment of the Xiongan University Collaborative Innovation Alliance.2023 In November 2023, the first batch of relocated Xiongan campuses of universities belonging to the ministries and commissions in Beijing centrally held a mobilization meeting in Xiongan New Area, which marked that Beijing Jiaotong University and the other four universities started the construction of their Xiongan campuses. In July 2024, the construction of the Xiong'an campus of Beijing Jiaotong University was advancing in an orderly manner. As of February 27, 2025, the Xiong'an campus of Beijing Jiaotong University is under full construction in a tight schedule.

The construction of BJTU Xiong'an Campus will significantly enhance the conditions for BJTU's operation and lay a solid foundation for the university to realize leapfrog development at a higher starting point. At the same time, BJTU will provide high-level education, science and technology talent support for the high-standard and high-quality construction and development of Xiong'an New Area. The commencement of the construction of BJTU Xiong'an Campus is an important achievement of implementing the decision-making and deployment of the CPC Central Committee, promoting the synergistic development of Beijing-Tianjin-Hebei region, relieving the non-capital functions of Beijing, and constructing the Xiong'an New Area with high standard and high quality.

II. B. 2) Security Assessment Center structural system

In order to better realize the architectural design of the Xiongan Center of Beijiao University, this paper combines the concept of vertical “compound” and puts forward the architectural design framework of the Xiongan Center of Beijiao University, the specific structure of which is shown in Figure 1. In order to achieve good architectural effect, the structural arrangement should be as regular and simple as possible on the basis of combining the functional arrangement of the building. Under the premise of meeting the structural safety, after the comparison of the economic indexes of each project, and taking into account the construction period and other influencing factors, this project adopts the concrete frame-core structure system. According to the role of each lateral force-resisting structural member in the horizontal load resistance, the core as the first line of defense to bear the main structure seismic, and the outer frame as the second line of defense, through the detailed calculation and analysis of the selection and performance design, a reasonable distribution of the stiffness, strength and lateral load ratio between the two, so as to form an effective and unified multiple line of defense system.

This design is an architectural design for the An Assessment Center of Xiongan Campus of Beijiao University, aiming to create rich spatial experiences and reasonable functional transitions through sliding and connecting between floors in order to stimulate the vitality of innovation and entrepreneurship of users. The site is adjacent to the South Campus Gate in the east and connected to the main road in the south, which is not only an important node of the internal spatial layout of the campus, but also a key window to show the image of Xiongan Campus to the outside world, and is an important interface connecting the city and the campus, assuming an important responsibility of showing the campus style and the city's image. The design starts from the perspective of low carbon system, through the interspersing and staggering of different functions and different openness blocks, it forms the space experience of interlacing reality and emptiness, and takes into account the spatial flexibility and sense of intimacy.

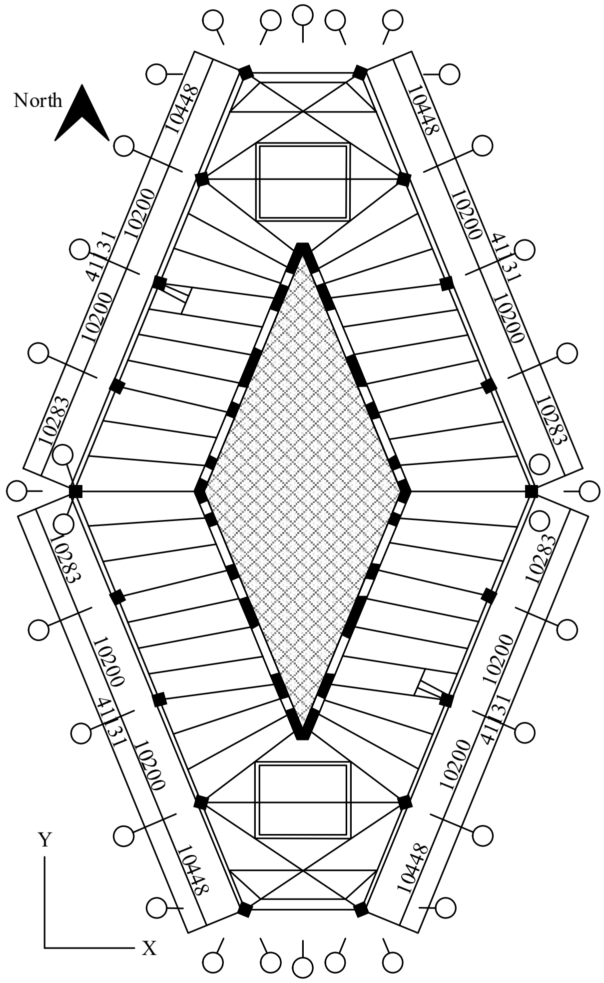


Figure 1: The structural system of the Safety Assessment center

III. Evaluation of the design of the An Assessment Center on the Xiongan Campus of NJTU

With the continuous improvement of social and economic level, people's quality of life is also getting higher and higher, and in the process of carrying out campus planning and design of colleges and universities, it is also necessary to promote the construction of a harmonious campus, to create a more comfortable learning environment for teachers and students. In this process, through the implementation of the green building concept, can strengthen environmental protection at the same time, realize the effective allocation of resources, play the effect of energy saving, for the development of teaching work to lay a good foundation.

III. A. Construction of evaluation index system

III. A. 1) Evaluation index system construction process

Based on the previously proposed framework for the architectural design of the An Assessment Center of Xiongan Campus of Beijiao University, in order to illustrate the feasibility of the design, this paper aims to establish an evaluation index system to carry out a comprehensive evaluation of it. Taking the path of unification of problem and goal orientation, the construction process of establishing the evaluation index system is shown in Figure 2, which mainly includes six steps: problem analysis, goal setting, element refinement, system construction, verification and optimization, and process design.

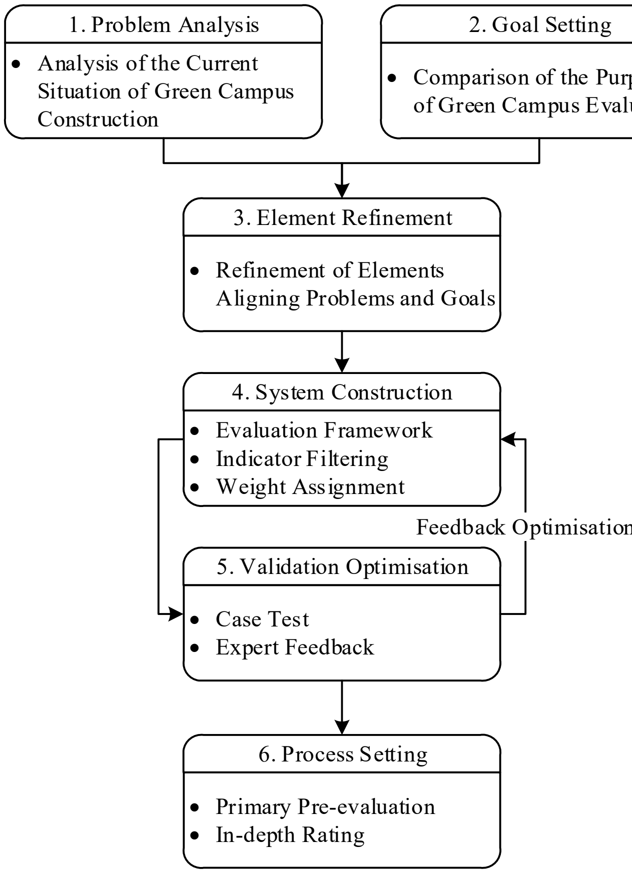


Figure 2: The construction process of the evaluation index system

(1) Problem analysis. Based on the problem-oriented analysis of the current situation of the construction of the Xiongan campus of Beijiao University, in-depth cases of representative colleges and universities in the Beijing-Tianjin-Hebei region, through research, literature, expert opinion collection and other sources of data comparison, to outline and summarize the current situation of the construction of the Beijing-Tianjin-Hebei universities and safety assessment center and the main problems.

(2) Goal setting. Based on the goal orientation, analyze the characteristics of typical campus evaluation systems, and compare horizontally their main evaluation purposes and applicable stages, basic settings, weights and contents. In this way, we locate the development stage and main purpose of the evaluation system for the design of the Xiongan Campus Safety Evaluation Center of Beijiao University, and select the elements that can be drawn on to provide a basis for the construction of the evaluation system.

(3) Refinement of elements. Based on the principle of unity of problem and goal orientation, analyze the problems and development trends of the design of the Beijing-Tianjin-Hebei campus safety assessment center, and on the basis of existing research and the experience of experts in related fields, analyze and refine the characteristics and elements of the evaluation system to provide guidance for the design of the evaluation system.

(4) System construction. Combined with the basic framework of the campus evaluation system, taking the design of the Xiongan Campus An Assessment Center of NJTU as an example, the evaluation framework of the design of the Xiongan Campus An Assessment Center of NJTU is proposed from the core functions, the main contents of the green campus and the rights and responsibilities of stakeholders, and the construction principle of the evaluation system is taken as the constraint to screen the specific evaluation contents, indicators and baselines.

(5) Validation and optimization. The evaluation verification combines theoretical research and empirical evidence through the combination of campus case study verification and expert feedback verification to verify the scientific and rationality of the evaluation system; and proposes specific optimization directions to provide complete and clear guidance for the evaluation of the design of the Xiongan Center of NJTU Xiongan Campus.

(6) Process setting. After the evaluation system design and validation are completed, based on the optimization suggestions, the two-level evaluation methods and processes of the system are constructed - “primary diagnosis” and “deepening rating”, and the grading of the two-level evaluation methods are systematically set up and described. The systematic setting and elaboration of the two levels of evaluation methods, graded application objects, laddering

process and typed results provide detailed instructions and support for the implementation of the evaluation, so as to provide a clear and convenient evaluation process for the design of different university safety evaluation centers.

III. A. 2) Evaluation indicators for the design of the security assessment center

Focusing on the core objectives of the design and construction of the safety assessment center of Xiongan Campus of Beijiao University, while considering the comprehensiveness and representativeness of its planning and design influencing factors as much as possible, and synthesizing the relevant knowledge about the comprehensive evaluation of the safety assessment center of universities in the existing related literatures and researches, this paper establishes the evaluation index system of the safety assessment center of Xiongan Campus of Beijiao University in the following aspects: spatial design, openness and integration, economic benefits and sustainability, and security and health, respectively. Evaluation index system of design. The content of the evaluation index system is shown in Table 1, which contains four primary indicators and 15 secondary indicators.

Table 1: The content of the evaluation index system

Criterion layer	Scheme layer	Code
Spatial Design	Functionality	SD1
	Flexibility	SD2
	research and teaching efficiency	SD3
Openness and Integration	Communication, interaction and public services	OI1
	Interdisciplinary cooperation promotion	OI2
	The integration of educational concepts and architectural design	OI3
	The harmonious integration of architecture and the environment	OI4
Economic Benefits and Sustainability	Construction scale	EB1
	Construction Site	EB2
	Engineering and process equipment	EB3
	Engineering construction standard	EB4
	Green technology and energy consumption design	EB5
Safety and Health	Building Safety Standards and Emergency Preparedness	SH1
	Indoor environmental quality and comfort	SH2
	Laboratory and facility safety	SH3

III. B. Fuzzy integrated evaluation model

III. B. 1) Entropy weighting method to solve indicator weights

The amount of information is the synthesis of all the information that needs to be queried to understand something about a location, and is measured in bits. When the random variable X takes a certain value, the logarithm of the derivative of its probability (p) $log\frac{1}{p}$ is the amount of information I, and the probability of the occurrence of a thing p determines the magnitude of its uncertainty, which also determines the size of the amount of information contained I. That is to say, the amount of information contained in things I and its probability of occurrence P negative correlation, large probability of events, less information; small probability of events, more information. Then:

$$I_i = log\frac{1}{p_i} = -logp_i \tag{1}$$

Information entropy: Information entropy refers to the expectation of the amount of information, assuming that X represents a source, then the information entropy can be expressed as:

$$H(X) = \sum_{i=1}^{n} p_i \times log\left(\frac{1}{p_i}\right) \tag{2}$$

Entropy value method is a multi-attribute decision-making method, the basic principle is based on the concept of information entropy, through the calculation of the information entropy of each indicator to determine the importance of each indicator in the decision-making, and then determine the weight of each indicator [15].

The operation steps are as follows:

Step1 Data standardization processing. For positive indicators can be expressed as:

$$X'_{ij} = \frac{x_{ij} - \min(x_{1j}, x_{2j}, \cdots, x_{nj})}{\max(x_{1j}, x_{2j}, \cdots, x_{nj}) - \min(x_{1j}, x_{2j}, \cdots, x_{nj})} + 1 \quad (3)$$
$$i = 1, 2, \cdots, n; j = 1, 2, \cdots, m$$

For negative indicators can be expressed as:

$$X'_{ij} = \frac{\max\left(X_{1j}, X_{2j}, \cdots, X_{nj}\right) - X_{ij}}{\max\left(X_{1j}, X_{2j}, \cdots, X_{nj}\right) - \min\left(X_{1j}, X_{2j}, \cdots, X_{nj}\right)} + 1 \quad (4)$$
$$i = 1, 2, \cdots, n; j = 1, 2, \cdots, m$$

For convenience, the non-negativized processed data is still noted as X_{ij}.

Step2 Based on the normalized data, calculate the weight of the i th evaluation object on the j th indicator. Then:

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \quad \left(j = 1, 2, \cdots m\right) \quad (5)$$

where P_{ij} denotes the weight of the j th indicator on the i th evaluation object.

Step3 Calculate the entropy value E_j of each indicator. That is:

$$E_j = -k * \sum_{i=1}^{n} P_{ij} \ln\left(P_{ij}\right) \quad (6)$$

where $k > 0$, $\ln$ is the natural logarithm, and $e_j \geq 0$. The constant k in Eq. is related to the number of samples m, generally let:

$$k = \frac{1}{lnm} \quad (7)$$

There are $0 \leq e \geq 1$.

Step4 Calculate the coefficient of variation d_j for each indicator. That is:

$$d_j = 1 - E_j \quad (8)$$

The coefficient of variation reflects the information validity of each indicator, and the larger the coefficient of variation, the greater the difference in the distribution of the indicator among the evaluation objects and the greater the contribution to the evaluation results.

Step5 Calculate the indicator weights, i.e:

$$W_j = \frac{g_j}{\sum_{j=1}^{m} g_j} \quad , j = 1, 2 \cdots m \quad (9)$$

where W_j denotes the weight of the j th indicator, and the sum of the weights is 1.

III. B. 2) Steps of fuzzy integrated evaluation

Fuzzy Comprehensive Evaluation Principle (FCE) is based on fuzzy mathematical transformations, and through the fuzzy comprehensive evaluation method, the qualitative indexes are transformed into quantitative analysis, which clarifies the degree of influence and the grade of each factor on the overall evaluation, and has the characteristics of systematic and clear results. For the evaluation index system designed by the Security Evaluation Center of Xiongan Campus of Beijiao University, there are factors that are difficult to be accurately quantified by numbers, and this paper adopts the fuzzy comprehensive evaluation method to carry out assessment and analysis [16]. The steps of the fuzzy comprehensive evaluation method are as follows:

(1) Firstly, it is necessary to determine all the factors involved in the evaluation, which constitute the evaluation factor set, which is usually denoted as $C = \{c_1, c_2, \ldots, c_n\}$, where c_i stands for the i th evaluation factor.

(2) Establish the value domain set $V = \{v_1, v_2, \ldots, v_m\}$, and classify the indicators according to the difference of risk level. Where m is the number of dividing levels.

(3) Determine the single-factor evaluation matrix $R_i = [r_{ij}]_{n_i \times m}$.

(4) Establish the weights based on the expert scores C The weight set of $P = \{p_1, p_2, \ldots, p_s\}$, and C_i The weight set of C_i is $P_i = \{p_{i1}, p_{i2}, \ldots, p_{in}\}$.

(5) From the one-factor evaluation matrix R_i of C_i and the set of weights P_i on C_i, we get the first level of integrated decision vector:

$$Q_i = P_i \circ R_i = [q_{i1}, q_{i2}, \ldots, q_{im}] \tag{10}$$

where "$\circ$" is the fuzzy relational synthesis operator.

Taking each C_i as an element and Q_i as its one-factor evaluation, the evaluation matrix R is:

$$R = (C_1 \ldots C_s) \tag{11}$$

The second level of synthesized decision vector $Q_i = P_i \circ R_i = [q_{i1}, q_{i2}, \ldots, q_{im}]$ is computed to obtain the second level. B is used as the basis for judgment, and the composite score is calculated based on the formula:

$$S = B * V \tag{12}$$

III. C. Evaluation of the design of the Security Assessment Center

III. C. 1) Establishment of evaluation indicator weights

Based on the evaluation index system of the security assessment center design of Xiongan Campus of Beijiao University established in this paper, a number of experts in the field of security assessment center design were selected to issue questionnaires, a total of 30 questionnaires were issued, 30 were effectively recovered, and the data were sorted and counted. Combined with the entropy weight method of indicator weight calculation steps, the weight distribution of the evaluation indicators of the design of the safety assessment center of Xiong'an Campus of Beijiao University is obtained as shown in Table 2.

Table 2: Evaluation index weight distribution

Criterion layer	Scheme layer	Absolute weight	Relative weight
Spatial Design (0.2318)	Functionality	0.3521	0.0816
	Flexibility	0.2527	0.0586
	research and teaching efficiency	0.3952	0.0916
Openness and Integration (0.2741)	Communication, interaction and public services	0.2831	0.0776
	Interdisciplinary cooperation promotion	0.2158	0.0592
	The integration of educational concepts and architectural design	0.2532	0.0694
	The harmonious integration of architecture and the environment	0.2479	0.0679
Economic Benefits and Sustainability (0.2837)	Construction scale	0.1814	0.0515
	Construction Site	0.2051	0.0582
	Engineering and process equipment	0.2042	0.0579
	Engineering construction standard	0.1876	0.0532
	Green technology and energy consumption design	0.2217	0.0629
Safety and Health (0.2104)	Building Safety Standards and Emergency Preparedness	0.3074	0.0647
	Indoor environmental quality and comfort	0.3328	0.0700
	Laboratory and facility safety	0.3598	0.0757

As can be seen from the table, under the guideline layer indicators, the design of the Xiongan Campus An Assessment Center of Beijiao University mainly focuses on the economic benefits and sustainable development (EB), and the weight of its indicators has reached 28.37%. This fully lives the fact that the design of the Xiongan Campus Security Assessment Center of NJTU needs to start from economic benefits and sustainability to better ensure that the building of the Center is in line with the modern campus architectural design concept as well as the vertical compound concept. In addition, the weight share of Openness and Integration (OI) is in the second place (27.41%), and the security assessment center building is related to the content of the relevant security assessment, and its architectural design needs to realize openness and interdisciplinary cooperation with diverse integration and interaction, in order to lay the foundation for promoting the benefits of security assessment on the Xiong'an Campus of NJTU. The weight values of space design (SD) and safety and health (SH) are 0.2318 and 0.2104, respectively. Improving the architectural space design and safety and health of the safety assessment center on the basis of taking into account economic benefits and sustainability, openness and integration can help to further enhance the functionality of the design of the center, and to improve the quality of the indoor environment and comfort. Under the program level indicators, research and teaching efficiency (SD3), functionality (SD1), communication and interaction and public service (OI1), laboratory and facility safety (SH31), and indoor environmental quality and comfort (SH2), which are in the top five in terms of weight share, have weight values of 0.0916, 0.0816, 0.0776, and 0.0757, respectively, 0.0700.The purpose of the design of the Security Assessment Center is to further enhance the security assessment capacity to guarantee the smooth implementation of scientific research and teaching, and the diversification of its functions can promote the Security Assessment Center to carry out diversified communication and interactive activities and provide more comprehensive public services. Therefore, in the architectural design of the security assessment center of Xiong'an Campus of Beijiao University, it is necessary to further optimize the indicators with relatively large weight values, so as to promote the feasibility and applicability of the design of the security assessment center.

III. C. 2) Fuzzy integrated evaluation analysis

Based on the evaluation index system of the design of the An Assessment Center of Xiongan Campus of Beijiao University established in the previous paper, this paper replaces the set of evaluation factors into two levels. Based on the evaluation standards of the existing related literature, this paper divides the evaluation results of the design of the An Assessment Center of Xiongan Campus of Beijiao University into five levels, i.e., V={very poor, poor, average, good, very good}, whose corresponding scores range from 1 to 5 points.

For the data related to the indicator level, this paper mainly collects them through questionnaires. 300 questionnaires were randomly distributed, and teachers and students were invited to score the design of the An Assessment Center of Xiongan Campus of Beijiao University according to the evaluation criteria of the qualitative indicators, to collect the intuitive feelings of the campus users, and finally 284 valid questionnaires were recovered, with a recovery rate of 94.67%. Statistics on the number of times of each evaluation level of each indicator, where the proportion of the number of times of the evaluation level to the number of people who effectively filled in the questionnaire can be derived from the degree of affiliation of the indicator.

The evaluation of the design of the Xiongan Campus Security Assessment Center of Beijiao University is a multi-level index system, and a multi-level fuzzy comprehensive evaluation should be carried out to arrive at the final evaluation results.

(1) First-level fuzzy comprehensive evaluation

Taking the evaluation calculation process of space design (SD) as an example, it mainly contains three indicators of functionality (SD1), flexibility (SD2), scientific research and teaching efficiency (SD3), combined with the affiliation degree obtained from the questionnaire, the fuzzy matrix of space design (SD) is obtained as:

$$R_{SD}=\begin{bmatrix}0.021 & 0.105 & 0.342 & 0.458 & 0.074\\ 0.049 & 0.121 & 0.339 & 0.413 & 0.078\\ 0.013 & 0.046 & 0.127 & 0.643 & 0.171\end{bmatrix} \tag{13}$$

Combined with the weight distribution of each indicator given in the previous section, the absolute weights of SD1~SD3 on SD are 0.3521, 0.2527, 0.3952, respectively, and combined with the formula of the fuzzy comprehensive evaluation results, the vector of fuzzy comprehensive evaluation results of spatial design (SD) is obtained as:

$$\begin{aligned}B_{SD}&=W_{SD}\circ R_{SD}\\ &=[0.3521 \quad 0.2527 \quad 0.3952]\begin{bmatrix}0.021 & 0.105 & 0.342 & 0.458 & 0.074\\ 0.049 & 0.121 & 0.339 & 0.413 & 0.078\\ 0.013 & 0.046 & 0.127 & 0.643 & 0.171\end{bmatrix}\\ &=[0.0249 \quad 0.0857 \quad 0.2563 \quad 0.5197 \quad 0.1133]\end{aligned} \tag{14}$$

This is then combined with the formula for the fuzzy composite evaluation score:

$$\begin{aligned}S_{SD}&=B_{SD}\circ V\\ &=[0.0249 \quad 0.0857 \quad 0.2563 \quad 0.5197 \quad 0.1133]\circ\begin{bmatrix}1\\2\\3\\4\\5\end{bmatrix}\\ &=0.0249*1+0.0857*2+0.2563*3+0.5197*4+0.1133*5\\ &\approx 3.611\end{aligned} \tag{15}$$

According to the above steps, the fuzzy comprehensive evaluation result vector and comprehensive evaluation value of all guideline level indicators can be calculated in the same way to form a first-level fuzzy comprehensive evaluation, and the specific results are shown in Table 3.

From the table, it can be seen that the comprehensive evaluation values of functionality (SD1), flexibility (SD2), scientific research and teaching efficiency (SD3), communication, interaction and public service (OI1), harmonious integration of building and environment (OI4), and construction site selection (EB2) are higher, and their comprehensive evaluation values are all more than 3.52 points, which overall achieves a better level. The remaining nine indicators, however, have an average level of comprehensive evaluation, with the lowest comprehensive rating of 1.403 points for Interdisciplinary Collaboration Facilitation (OI2), which is close to a very poor level.

Table 3: First-level fuzzy comprehensive evaluation result

Criterion layer	Code	Fuzzy comprehensive evaluation result vector					Evaluation value
		Very bad	Poor	General	Better	Very good	
Spatial Design	SD1	0.0249	0.0857	0.2563	0.5197	0.1133	3.611
	SD2	0.0291	0.1013	0.3251	0.4536	0.1015	3.529
	SD3	0.0035	0.2934	0.3881	0.4261	0.0238	3.578
Openness and Integration	OI1	0.0048	0.1251	0.7724	0.2743	0.0216	3.777
	OI2	0.0231	0.0643	0.2831	0.0815	0.0151	1.403
	OI3	0.1024	0.0851	0.2235	0.5134	0.0124	3.059
	OI4	0.0513	0.2573	0.4375	0.4284	0.1469	4.327
Economic Benefits and Sustainability	EB1	0.0948	0.1694	0.3458	0.1857	0.2568	3.498
	EB2	0.0765	0.3124	0.3627	0.4206	0.0264	3.604
	EB3	0.0421	0.2151	0.3418	0.0815	0.0216	1.932
	EB4	0.0713	0.2582	0.5045	0.1293	0.0128	2.682
	EB5	0.0618	0.1733	0.4537	0.2854	0.0134	2.978
Safety and Health	SH1	0.0624	0.3127	0.4038	0.2361	0.0079	2.883
	SH2	0.0743	0.1735	0.3892	0.3199	0.0361	3.049
	SH3	0.1095	0.2411	0.3563	0.2581	0.0457	2.922

(2) Second-level fuzzy comprehensive evaluation

The second-level fuzzy comprehensive evaluation is the comprehensive evaluation of the target level, the evaluation process and the first-level fuzzy comprehensive evaluation calculation method is the same, according to the relevant data in Table 3 to establish the fuzzy evaluation matrix is as follows:

$$R_A = \begin{bmatrix} 0.0218 & 0.2041 & 0.5164 & 0.3078 & 0.0537 \\ 0.0234 & 0.1057 & 0.3149 & 0.4263 & 0.1854 \\ 0.0857 & 0.2911 & 0.4876 & 0.5196 & 0.1149 \\ 0.1021 & 0.2568 & 0.3524 & 0.4081 & 0.0972 \end{bmatrix} \tag{16}$$

Combined with the absolute weight values of the four indicators of the guideline layer given in the previous section, the fuzzy comprehensive evaluation vector of the design of the An Assessment Center of the Xiongan Campus of Beijiao University is obtained as:

$$\begin{aligned} B_A &= W_A \circ R_A \\ &= [0.2318 \quad 0.2741 \quad 0.2837 \quad 0.2104] \begin{bmatrix} 0.0218 & 0.2041 & 0.5164 & 0.3078 & 0.0537 \\ 0.0234 & 0.1057 & 0.3149 & 0.4263 & 0.1854 \\ 0.0857 & 0.2911 & 0.4876 & 0.5196 & 0.1149 \\ 0.1021 & 0.2568 & 0.3524 & 0.4081 & 0.0972 \end{bmatrix} \\ &= [0.0572 \quad 0.2129 \quad 0.4185 \quad 0.4214 \quad 0.1163] \end{aligned} \tag{17}$$

This is then combined with the formula for the fuzzy composite evaluation score:

$$\begin{aligned} S_A &= B_A \circ V \\ &= [0.0572 \quad 0.2129 \quad 0.4185 \quad 0.4214 \quad 0.1163] \circ \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{bmatrix} \\ &= 0.0572*1 + 0.2129*2 + 0.4185*3 + 0.4214*4 + 0.1163*5 \\ &\approx 4.006 \end{aligned} \tag{18}$$

The calculation shows that the comprehensive evaluation score of the design of the security assessment center design of Xiongan Campus of Beijiao University is 4.006, which is at the level of better grade. This indicates that the design of the Security Assessment Center of Xiongan Campus of Beijiao University, which combines the concept of vertical compound and modern campus architectural design, is more in line with the needs of teachers and students, and can significantly enhance the benefits of security assessment.

IV. Factors affecting the design of the An Assessment Center on the Xiongan Campus of NJCU

As the representative material culture carrier of college campus, college campus building carries the role of providing specific space area and displaying the image of the school, which is the material wealth combining construction engineering technology and campus humanities and arts. This paper constructs the architectural design framework of Xiong'an Campus Safety Assessment Center of Beijiao University by relying on the vertical compound and modern campus architectural design concepts, and analyzes the feasibility of the design scheme through fuzzy comprehensive evaluation. In order to further explore the relevant factors affecting the design of the An Assessment Center on the Xiongan Campus of Beijiao University, this chapter introduces multi-source linear regression for quantitative analysis of the data.

IV. A. Security Assessment Center design influences

IV. A. 1) Analysis of influencing factors

The practical embodiment of any architectural design and the influencing factors, methodological principles and target requirements are all considered in an integrated manner, and all three play a constraining role, while at the same time, they are the key to innovation in combination with the context and environment of the times. As a landmark building of Beijing Jiaotong University campus education building, the Xiongan Campus Security Assessment Center of Beijiang Jiaotong University cannot be separated from the influencing factors of social development. Therefore, to study the design of the Xiong'an Campus An Assessment Center of Beijing Jiaotong University, it is necessary to grasp the influencing factors at the macro level, meso level and micro level as a whole, which are mainly divided into the geographical environment, campus planning, site conditions, and the needs of teachers and students, and at the meso and micro levels, the geographical environment can be divided into the geographical climate and geographical humanities, the campus planning can be divided into the campus area and the scale of the campus, the site conditions can be divided into the topography and landscape resources, and the site conditions can be divided into the topography and landscape resources. Campus planning can be divided into campus area and campus scale, site conditions can be divided into topography and landscape resources, and teachers' and students' needs can be divided into functional needs and activity needs.

Based on the above analysis, this paper establishes a questionnaire from the four dimensions of regional environment, campus planning, site conditions and teachers' and students' needs, and adopts on-site distribution, a total of 500 questionnaires were distributed, excluding invalid and duplicated questionnaires, a total of 472 valid questionnaires were obtained, and the effective rate of questionnaires recovery was 94.4%. The questionnaire data will be collected and organized, in order to lay a reliable data foundation for the later analysis of the degree of influence of different factors on the design of the Xiongan Center of Beijiaotong University Xiongan Campus.

IV. A. 2) Selection of research variables

In order to better analyze the factors influencing the design of the An Assessment Center on the Xiongan Campus of Beijiao University, this paper chooses the comprehensive score of the design of the An Assessment Center on the Xiongan Campus of Beijiao University (SACS) as an explanatory variable, and its value is quantified by the fuzzy comprehensive evaluation results of the previous paper.

For the factors related to the design of the An Assessment Center on the Xiongan Campus of NJTU, combining the qualitative analysis of the previous paper with the related research literature, this paper mainly chooses the regional environment (RE), campus planning (CP), site conditions (VC) and faculty and student needs (TS) as the explanatory variables, and the data of each variable are obtained through the questionnaire.

In addition, in order to effectively control the influence of exogenous variables on the research results, this paper chooses construction input (CIN), economic level (ECO), number of teachers (TEA) and number of students (STU) as control variables, whose data are mainly obtained through the information disclosure platform of Beijiao University.

IV. A. 3) Research modeling

Quantile regression models can be built by estimating the quantile of the dependent variable from the independent variable under different conditions [17]. Quantile by giving different proportions of quantile values (0<1), different quantile functions can be obtained and the vector regression equation can be written as:

$$\min_{\beta} \sum_{i:y_i \geq x_i'\beta} \phi | y_i - x_i'\beta | + \sum_{i:y_i < x_i'\beta} (1-\phi) | y_i - x_i'\beta | \tag{19}$$

where $\rho\phi(\varepsilon)$ is the calibration function, defined as:

$$\begin{cases} \rho\phi(\varepsilon) = \varphi\varepsilon, \ if \ \varepsilon \geq 0 \\ \rho\phi(\varepsilon) = (\phi - 1) \ \varepsilon, \ if \ \varepsilon < 0 \end{cases} \tag{20}$$

Given a value of ϕ, one can find a set of $\hat{\beta}_\phi$ for β_ϕ as the estimated solution. And we can write the quantile regression equation for ϕ as:

$$y_i = x_i'\beta_\phi + u_i, \vartheta_\phi(y_i | x_i) = x_i'\beta_\phi \tag{21}$$

where $\vartheta_\phi(y_i | x_i)$ denotes the ϕ quantile mean equation of y_i under the condition that the regression vector is x_i.

Based on the above analysis, combining the selected explanatory variables and explanatory variables, the quantile regression model is established as:

$$SACS_{i,\phi} = a_\phi + b_{i,\phi}RE_{i,\phi} + c_{i,\phi}CP_{i,\phi} + d_{i,\phi}VC_{i,\phi} + e_{i,\phi}TS_{i,\phi} + f_{i,\phi}\sum Control_{i,\phi} + \varepsilon_{i,\phi} \tag{22}$$

where $SACS_{i,\phi}$ is the composite evaluation of the design at the ϕ quartile, $RE_{i,\phi}, CP_{i,\phi}, VC_{i,\phi}, TS_{i,\phi}$ is the individual explanatory variables, $Control_{i,\phi}$ are the control variables, $b_{i,\phi} \sim f_{i,\phi}$ are the regression coefficients of each variable, a_ϕ is a constant term, and $\varepsilon_{i,\phi}$ is a randomized disturbance term.

IV. B. Regression Analysis of Security Assessment Center Design

IV. B. 1) Benchmark regression results

Based on the data obtained from the questionnaire, the baseline regression results of the linear regression model combined with the linear regression model to analyze the factors influencing the design of the Security Assessment Center on the Xiongan Campus of Beijiao University are shown in Table 4. As can be seen from the table, among the four factors listed as influencing the design of the safety assessment center of Xiongan Campus of NJTU, the geographical environment (RE) has a relatively large degree of influence, and its unstandardized regression coefficient reaches 1.038, i.e., for every 1 percentage point change in the geographical environment, the design of the safety assessment center of Xiongan Campus of NJTU will improve by 1.038 percentage points, which exhibits a significant positive influence at the 1% level. And campus planning (CP), site conditions (VC), and student and faculty needs (TS) all significantly and positively affect the design of the An Assessment Center on the Xiongan Campus of NJTU at the 1% level. Therefore, it is necessary to fully integrate the geographical environment of NJTU Xiongan Campus, comply with the campus planning and site conditions, and fully satisfy the needs of students and faculty, so as to build a reasonable building for the safety assessment center of NJTU Xiongan Campus.

Table 4: Benchmark regression result

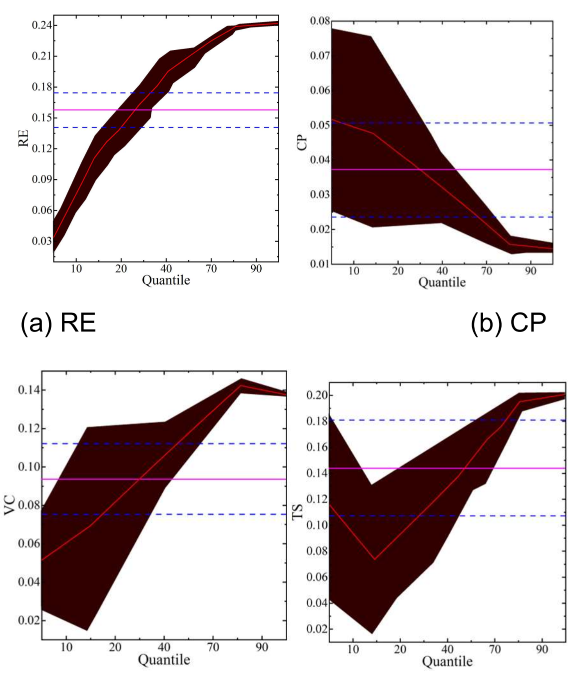
Model	Non-standardized coefficient		Standardized coefficient	t	P
	B	Sd Err			
(Con_)	5.742	0.451	-	9.874	0.000
RE	1.038	0.128	0.224	3.992	0.002
CP	0.672	0.135	0.057	5.168	0.000
VC	0.394	0.142	0.113	7.342	0.003
TS	0.815	0.139	0.205	6.053	0.001

IV. B. 2) Quantile regression analysis

In order to further analyze the dynamic trends under different influencing factors, this paper chooses five quartiles, such as 10%, 20%, 40%, 70% and 90%, and combines them with the quartile regression model established in the previous section as a means of exploring the trend of regression coefficients for each influencing factor. Figure 3 shows the dynamic trends of different influencing factors of the bye-year conversation, in which Figures 3(a) to (d) show the dynamic trends of the geographical environment (RE), campus planning (CP), venue conditions (VC) and student and faculty demand (TS), respectively. The curves in the figure indicate the changes in the corresponding regression coefficients of the influential factors at different quartile levels, the dark areas indicate the 95% confidence intervals of the regression coefficients, the horizontal straight lines in the middle indicate the regression coefficients of the influential factors in the mean regression model, and the areas between the upper and lower horizontal straight lines are the 95% confidence intervals of the regression coefficients of the explanatory variables in the mean regression model.

As can be seen from the figure, the confidence intervals of the regression coefficients of the influencing factors estimated using quantile regression show different degrees of change with the change of quantile, while wider confidence intervals imply that the standard deviation of the coefficient estimates becomes larger and the volatility of the coefficient estimates increases. The confidence intervals of the coefficient estimates corresponding to campus planning (CP) and student and faculty needs (TS) gradually change from wide to narrow as the quartiles increase, while the confidence intervals of the coefficient estimates for venue conditions (VC) are wider and then narrower, and the coefficient corresponding to the geographic environment (RE) has the smallest change in the confidence intervals. This result indicates that campus planning (CP), site conditions (VC), and faculty and student needs (TS) have significantly differentiated marginal contributions to the evaluation of the design of the An Assessment Center on the Xiongan Campus of NJTU. In addition, the regression coefficients of regional environment (RE) and campus planning (CP) are monotonic, indicating that the marginal contributions of regional environment (RE) and campus planning (CP) to the evaluation of the design of the Center at Xiongan Campus of NJTU are very different, while the regression coefficients of the faculty and student demand (TS) have the "interquartile crossover problem". Increasing different student and faculty needs (TS) may achieve similar effects.

Overall, the quantile regression coefficient estimates for campus planning (CP) intersected the 95% confidence interval of the mean regression coefficient at the 0-50% quantile points, while the quantile regression coefficients for geographic environment (RE), site conditions (VC), and student and faculty needs (TS) intersected the 95% confidence interval of the mean regression coefficients to a lesser extent, and this difference was particularly pronounced at the lower and higher quantiles. It is helpful to identify the key influencing factors of the design evaluation of the safety assessment center of the Xiong'an campus of Beijing Jiaotong University, so as to provide a more targeted reference for the formulation of the design plan of the safety assessment center of the Xiong'an campus of Beijing Jiaotong University, and indirectly confirm that the quantile regression model has advantages in comprehensively revealing the relationship between the influencing factors and the design of the safety assessment center of the Xiong'an campus of Beijing Jiaotong University.



(a) RE (b) CP

(c) VC (d) TS

Figure 3: The dynamic change trend graph of the regression coefficient

IV. C. Design Optimization Strategies for the Security Assessment Center

IV. C. 1) Overall Planning and Design Strategies

Based on the above research on the content and weight of the evaluation indexes of the design of the Xiongan Center of Beijiao University, as well as the analysis of the relevant influencing factors, the optimization strategy of the overall planning and design of the Xiongan Center of Beijiao University focuses on the overall layout of the building, how to adapt to the unique climatic conditions of the region in terms of the choice of orientation, and how to embody the regional characteristics of the architectural landscape design and campus cultural heritage.

(1) Rational layout of building space. When determining the scale of construction, it is necessary to refer to the “General Higher Education Schools Building Area Indicators” for different types and scales of building area, as well as the “General Higher Education Schools Stadium Facilities and Equipment Equipment Catalogue” and the upper urban planning and design, and at the same time, combine with the specific use of their own demand for strict control of the land area, to avoid excessive construction of excessive building scale, low utilization efficiency and other issues.

(2) The full use of underground space can effectively alleviate the ground land tension and improve land use efficiency. The planning prioritizes the selection of parking lots, equipment rooms, service rooms and other building functions with lower requirements for natural ventilation and lighting to be set up in the underground space, and the public supporting facilities permitted by the relevant norms can be set up in the space with ventilation and lighting conditions such as the suspended floor, semi-basement, and the perimeter of the lighting courtyard. The design can make use of terrain height difference, lighting courtyard, high window or lighting skylight to enhance the connection between underground space and ground, introduce natural lighting, organize effective natural ventilation and improve the quality of underground space.

(3) The building layout conforms to the topography and geomorphology, reduces earth filling and excavation, and makes full use of natural elements such as the original water body, mountains, forests and fields of the base to plan public space and ventilation corridors, which can minimize the damage to the ecological environment caused by the construction of the campus, and at the same time, it has a significant effect on mitigating the heat island effect of the campus and improving the thermal comfort.

IV. C. 2) Emphasize the quality of the built environment

Existing or renovated campuses are generally built earlier and are prone to outdated facilities or untimely equipment renewal. The quality of campus space use can be improved by optimizing the building's physical environment and infrastructure. For example, the development of underground space, the construction of green rainwater facilities, and the use of parking lots.

Green campus construction is a task that requires reasonable planning and long-term accumulation. At present, the construction goals of most campuses are still limited to saving campuses, with a single construction method and limited indicators for evaluating construction results. New campuses should be reasonably planned from the beginning to lay the foundation of campus construction. Later, as the campus develops, the facilities, equipment and environmental quality should be reasonably updated to realize the sustainable development of the school. Campus administrators should formulate appropriate construction strategies based on the climate and environment of the region in which the campus is located.

V. Conclusion

The construction of security assessment center of Xiongan campus of Beijiao University is an important campus building to meet the security assessment of universities, this paper relies on the concept of vertical compound and modern campus architectural design, constructs the architectural structure framework of the security assessment center of Xiongan campus of Beijiao University and analyzes its construction effect and influencing factors through fuzzy comprehensive evaluation and quantile regression. Based on the results of data calculation and analysis, the strategy of optimizing the design of the Center for Security Assessment in Xiongan Campus of Beijiao University is proposed, which needs to start from the overall planning and design, fully combining the concept of vertical “compound”, and paying attention to the quality of the building environment, and fully realizing the requirements of green building on the basis of guaranteeing the effectiveness of the building.

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