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# Analysis of Landscape Vitality of Historical and Cultural Blocks Based on AHP–Fuzzy Comprehensive Evaluation Method: A Case Study of Daopashi Street in Anqing City

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**Abstract** Historical and cultural blocks are witnesses of history and inheritors of culture. As one of the main spaces for outdoor interaction in historical and cultural blocks, the improvement of its vitality is of great significance for the improvement of residential environment and the better inheritance of history and culture. Taking Daopashi Street in Anqing City as an example, an evaluation model of landscape spatial vitality of historical and cultural blocks was constructed from three aspects of viewing function, store status and service facilities, and analytic hierarchy process was used to determine the index weight and vaguely evaluate the landscape spatial vitality of historical and cultural blocks. The results show that through the comparison of weight, architectural style (0.317), the practicability of service facilities (0.168) and plant landscape (0.165) had a significant impact on the landscape spatial vitality of historical and cultural blocks, and the landscape spatial vitality of historical and cultural blocks in Daopashi Street in Anqing City was at a good level.

**Keywords** Analytic hierarchy process, Fuzzy comprehensive evaluation method, Historical and cultural blocks, Landscape vitality
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Historical and cultural blocks refer to areas with a certain scale, where preserved cultural relics are particularly rich and historical buildings are concentrated, and people are able to experience the traditional pattern and historical style more completely and truly[1]. Historical and cultural blocks embody the history, style, and humanistic spirit of urban development, and can reflect the local cultural and ethnic characteristics. It is a unique business card and an important window of a city. The modernist urban planning triggered a drastic change in urban form and demolishing of the historical relics that were considered to be hindering development and not modern enough. Many historical and cultural blocks were destroyed in the development process, and replaced with steel and concrete jungles[2]. With the improvement of people's material living standards, the spiritual pursuit and emotional needs of citizens have become imminent. However, most cities have broken memories and mixed feelings of the times at present. As the main body of a city, residents find it difficult to find a complete urban memory and lack a sense of belonging[3]. Historical and cultural blocks become the habitat of people's hearts due to their unique sense of history and cultural atmosphere. Therefore, the research and evaluation of the spatial vitality of historical blocks and the correct handling of the relationship between economic and social development and the protection of historical and cultural heritage have become the consensus of people.

In recent years, Anqing City has carried out a systematic transformation of Daopashi Street, and has built a characteristic style of architecture and shops in line with the trend of the times on the street. Although the protection and transformation of historical and cultural blocks have become a hot trend, the research on their landscape space is still at a relatively shallow stage. Hence, scientific and objective evaluation of landscape spatial vitality is conducive to the improvement of the living environment and quality of life of residents around historical and cultural blocks, and further has a positive impact on the protection of historical and cultural blocks. In this paper, the opinions of experts were widely consulted during field research, and some instruments and equipment in the teaching laboratory were used, such as virtual simulation technology, high-precision rangefinder, illuminance meter, anemometer, sound level meter, etc. The landscape spatial vitality of Daopashi Street in Anqing City was quantitatively analyzed by combing analytic hierarchy process (AHP) and fuzzy comprehensive evaluation method. The aim is to combine subjective and objective methods to analyze people's satisfaction with Daopashi Street in Anqing City and find its problems and shortcomings[4], so as to provide some effective data for the transformation, development and protection of historical and cultural blocks (Fig.1−2).

## 1 Materials and methods

### 1.1 General situation of the study area

Located in the center of the ancient city of Anqing City, Dashiki traditional commercial block is named after the stone archway of "an inverted lion" built during the Longqing period of the Ming Dynasty (1567−1572). Here provincial and municipal cultural preservation units, such as the stone archway of "an inverted lion", Anqing Post Office, Xu Xilin Memorial Platform, as well as Dashiki traditional street space are preserved, and it is an important preservation place for the traditional style of the ancient city (Fig.3)[5].

Daopashi Street is relatively rich in spatial shape and structure, and the shops in the commercial section are orderly, which makes the street section compact. The multi-level space is highlighted between food streets and antique streets through the boundary of corridors. The street corner is flexible and changeable, and the shape is lively. The planning of the whole street is complete and reasonable, and it is not crowded, which leads to a strong and lively commercial atmosphere. The roods on the whole street is paved with stone slabs, and have smooth and flat surface. Besides, they are

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not easy to collapse, and have long service life. There is less accumulated dust in rainy days, and they have small noise, fast traffic, and easy maintenance. The laying of stone slabs creates a sense of historical time, and puts people in it. At the same time, the roads have a certain change in gradient, which brings fun to pedestrians. The roads paving with ancient charm attract the masses to come here, which affects the spatial vitality of the street to a certain extent.

### 1.2 Research methods

Analytic hierarchy process (AHP) is a relatively scientific and comprehensive method, and it is highly logical, systematic and scientific. The basic principle is to first list the factors that affect the occurrence of events, and then sort them according to the correlation between various factors and the occurrence of events, so as to obtain a set of data containing the sequence and provide data support for decision-making. This principle is called the sequencing principle[6]. This method is concise, practical and systematic, and it is convenient to select the best candidate. When the analytic hierarchy process is used to study any problem, it is necessary to conduct specific analysis of specific problems in practical application, reasonably delineate the importance degree, and conduct strict modeling and analysis in combination with the investigation situation, so as to draw objective research conclusions[7].

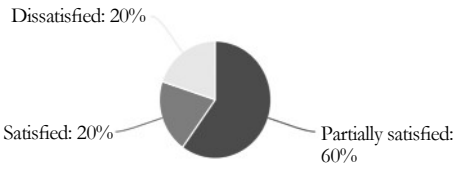


**Fig.1 Citizens' satisfaction with Daopashi Street**

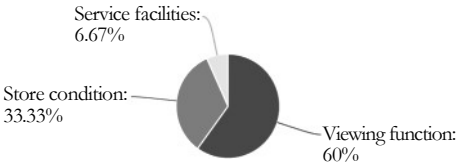


**Fig.2 Which part of Daopashi Street are the citizens more satisfactory with**

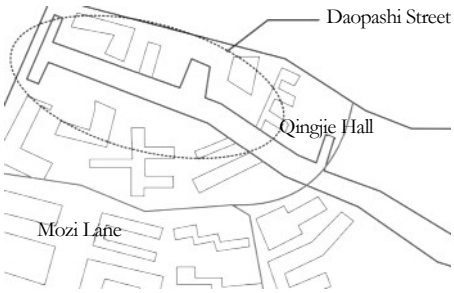


**Fig.3 Plan of Daopashi Street**

Fuzzy comprehensive evaluation method, a comprehensive evaluation method based on fuzzy mathematics, is used to study the uncertainty in mathematics and evaluate systematic factors. This method, on the basis of comprehensive consideration of various indexes and factors of evaluation objects, carries out quantitative processing of various indexes, determines the values of comprehensive evaluation indexes according to the weight of different evaluation indexes, and obtain results by comparison[8]. There are many related factors in this study, so the combination of analytic hierarchy process and comprehensive fuzzy evaluation is conducive to obtaining more accurate data and reasonable results.

## 2 Evaluation model of landscape spatial vitality in historical and cultural blocks based on AHP-fuzzy comprehensive evaluation

### 2.1 Evaluation process of landscape space vitality in historical and cultural blocks

The evaluation process of landscape space vitality in historical and cultural blocks based on AHP-fuzzy comprehensive evaluation method is as follows. Firstly, evaluation indexes were selected to build the landscape spatial vitality evaluation model of historical and cultural blocks, and then AHP method was adopted to calculate the weight of indexes. Then, based on questionnaire survey, fuzzy comprehensive evaluation method was used to determine the membership matrix of evaluation indexes[9], and the landscape spatial vitality of historical and cultural blocks was comprehensively evaluated (Fig.4).

### 2.2 Construction and index weight of evaluation index system of landscape spatial vitality in historical and cultural districts

Through literature review, field investigation and expert consultation, 11 representative evaluation indexes were selected to construct the evaluation index system of landscape spatial vitality of historical and cultural blocks, including the target layer (landscape spatial vitality evaluation of historical and cultural blocks), the criterion layer (viewing function, shop condition, and service facilities) and the index layer. Questionnaires were issued to students majoring in landscape architecture to determine the importance of each index and form a judgment matrix. In order to compare the influence of each factor in the index layer on the criterion layer, the weight of each element was obtained by pairwise comparison of the factors in the layer. In this paper, the relative importance of each factor at the same level was judged by the 1–9 scale method (Table 1). The evaluation system of landscape spatial vitality of historical and cultural blocks and the weight of corresponding indexes are shown in Fig.5.

### 2.3 Evaluation model of landscape spacial vitality of historical and cultural blocks

Step 1: index weight vector and fuzzy evaluation index set was established; target layer index set was set : $U = \{A_1, A_2, A_3\}$; criterion layer index set was set: $A_1 = \{B_1, B_2, B_3, B_4, B_5\}$, $A_2 = \{B_6, B_7, B_8\}$, $A_3 = \{B_9, B_{10}, B_{11}\}$.

Step 2: the rating level was determined. The evaluation index set was divided into five levels, namely evaluation set $V = \{V_1, V_2, V_3, V_4, V_5\}$, and the grade vector of the evaluation set is as follows: C = (100, 80, 60, 40, 20). The corresponding score, evaluation level and evaluation language of the evaluation set are shown in Table 2.

Step 3: the membership degree of evaluation indexess was determined. Landscape architecture students and experts were invited to evaluate the evaluation indexes of Daopashi Street in Anqing City according to the evaluation

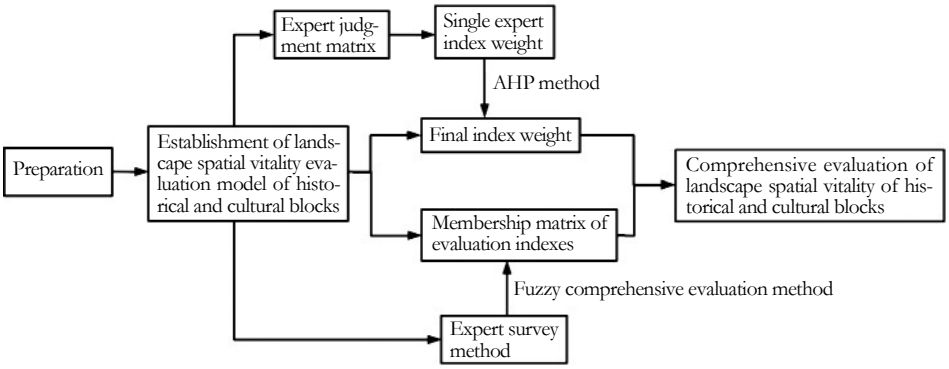


**Fig.4 Evaluation process of landscape vitality of historical and cultural blocks**

level. The membership degree of the evaluation indexes was calculated according to the formula of membership degree $H = m/n$. In the formula, $H$ represents the membership degree of the indexes, and m represents the frequency of the indexes belonging to a certain evaluation level, while n represents the number of evaluators. In this study, 15 experts and students in related fields were invited to evaluate the 11 indexes and obtain the membership degree of the corresponding indexes. The vector composed of membership degree is the fuzzy evaluation vector of each index in the index layer, such as $B_1$ = (0.20, 0.53, 0.13, 0.13, 0).

The fuzzy evaluation score of each index in the index layer was calculated according to its formula $M_n = B_n \times B_T$, where $M_n$ is the fuzzy evaluation score of each index in the index layer; $B_n$ is the fuzzy evaluation vector of each index in the index layer; n = 1, 2, …, 11; T represents transpose. For example, the fuzzy evaluation score of plant landscape $B_1$ is $M_1 = B_1 \times B^T = 0.20 \times 100 + 0.53 \times 80 + 0.13 \times 60 + 0.13 \times 40 + 0 \times 20 = 75.4$.

According to Table 1, the evaluation level of plant landscape of Daopashi Street in Anqing City was level 4. The fuzzy evaluation table of index layer of landscape spatial vitality of historical and cultural blocks was established (Table 3).

Step 4: the index weight and membership matrix were determined. For instance, the index set in the criterion layer $A_2 = \{B_6, B_7, B_8\}$ contains three indexes, namely $B_6$, $B_7$ and $B_8$. The weight vector of each index can be obtained from Fig.5 as follows: $W_2$ = (0.011, 0.067, 0.028), and the membership matrix can be obtained from Table 2 as follows:

$$A_2 = \begin{bmatrix} 0.07 & 0.20 & 0.33 & 0.27 & 0.33 \\ 0.03 & 0.33 & 0.20 & 0.13 & 0 \\ 0.27 & 0.47 & 0.13 & 0.13 & 0 \end{bmatrix}$$

That of the other indexes were calculated according to the above method.

## 3 Evaluation results and analysis of landscape spatial vitality of Daopashi Street in Anqing City

### 3.1 Fuzzy evaluation of criterion layer

On the basis of the fuzzy matrix operation rule $A_n = W_n \times R_n$, the fuzzy evaluation vector of index set in the criterion layer was calculated, where $A_n$ is the fuzzy evaluation vector of the nth index set in the criterion layer; $W_n$ is the weight vector of the nth index set in the criterion layer; $R_n$ (n = 1, 2, 3) is the corresponding membership matrix. For the index set $A_2 = \{B_6, B_7, B_8\}$ in the criterion layer, the matrix of membership degree $R_2$ was obtained. Thus, the fuzzy evaluation vector of the nth index set in the criterion layer was obtained as follows: $A_2 = W_2 \times R_2$=(0.215, 0.384, 0.191, 0.168, 0.091).

According to the formula of fuzzy evaluation score $K_n = A_n \times C^T$, the fuzzy evaluation score of each index in the criterion layer was calculated. In the formula, $A_n$ is the fuzzy evaluation vector of each index in the criterion layer, and n = 1, 2, 3. For example, the fuzzy evaluation score of shop condition $A_2$ is $K_5 = A_5 \times C^T = 0.215 \times 100 + 0.384 \times 80 + 0.191 \times 60 + 0.168 \times 40 + 0.091 \times 20 = 72.2$.

Seen from Table 1, the evaluation level of shop condition of Daopashi Street in Anqing City was level 4. That of the other indexes were calculated according to the above method, and the fuzzy evaluation table of the criterion layer was obtained (Table 4).

### 3.2 Fuzzy evaluation of target layer

The membership degree matrix of the index set in the target layer was calculated according to the fuzzy matrix operation rule $Z = W \times R$, where Z is the fuzzy evaluation vector of index set Z in the target layer; W is the weight vector of index set in the target layer, namely W = (0.633, 0.106, 0.261); R is the fuzzy evaluation membership matrix of the target layer. The fuzzy evaluation vector of the target layer was obtained: $Z = W \times R$ = (0.352 8, 0.327 8, 0.174 8, 0.119 0, 0.030 3).

According to the fuzzy evaluation score calculation formula $M = Z \times C^T$, the comprehensive evaluation score of the landscape spatial vita-lity of Daopashi Street in Anqing City was calculated: $M = Z \times C^T = 0.352\,8 \times 100 + 0.327\,8 \times 80 + 0.174\,8 \times 60 + 0.119\,0 \times 40 + 0.030\,3 \times 20 = 77.36$, and the comprehensive evaluation

**Table 1 1–9 scale method**

| Scale | Meaning |
|---|---|
| 1 | Two factors are equally important |
| 3 | The former factor is slightly more important than the latter factor |
| 5 | The former factor is obviously more important than the latter factor |
| 7 | The former factor is very obviously more important than the latter factor |
| 9 | The former factor is extremely more important than the latter factor |

**Table 2 Corresponding score, evaluation level and evaluation language of the evaluation set[7]**

| Evaluation set | Evaluation score | Evaluation level | Evaluation language |
|---|---|---|---|
| $V_1$ | 100–90 | 5 | Excellent |
| $V_2$ | 89–70 | 4 | Good |
| $V_3$ | 69–50 | 3 | General |
| $V_4$ | 49–30 | 2 | Worse |
| $V_5$ | 29–0 | 1 | Bad |

**Table 3 Fuzzy evaluation of the index layer of landscape spatial vitality of Daopashi Street in Anqing City**

| Index | Membership degree | | | | | Score | Level |
|---|---|---|---|---|---|---|---|
| | Excellent | Good | General | Worse | Bad | | |
| Plant landscape $B_1$ | 0.20 | 0.53 | 0.13 | 0.13 | 0 | 75.4 | 4 |
| Architectural style $B_2$ | 0.60 | 0.20 | 0.13 | 0.07 | 0 | 86.6 | 4 |
| Lighting effect $B_3$ | 0.27 | 0.47 | 0.07 | 0.13 | 0.07 | 75.4 | 4 |
| Taste landscape $B_4$ | 0.13 | 0.20 | 0.40 | 0.20 | 0.07 | 62.4 | 3 |
| Road paving $B_5$ | 0.20 | 0.33 | 0.33 | 0.13 | 0 | 71.4 | 4 |
| Store density $B_6$ | 0.07 | 0.20 | 0.33 | 0.27 | 0.33 | 60.2 | 3 |
| Hygiene $B_7$ | 0.33 | 0.33 | 0.20 | 0.13 | 0 | 76.6 | 4 |
| Decoration degree $B_8$ | 0.27 | 0.47 | 0.13 | 0.13 | 0 | 77.6 | 4 |
| Stayability $B_9$ | 0.47 | 0.20 | 0.20 | 0.07 | 0.07 | 79.2 | 4 |
| Signature $B_{10}$ | 0.20 | 0.33 | 0.27 | 0.13 | 0.07 | 69.2 | 4 |
| Practicality $B_{11}$ | 0.33 | 0.27 | 0.20 | 0.20 | 0 | 74.6 | 4 |

**Table 4 Fuzzy evaluation of the criterion layer of landscape spatial vitality of Daopashi Street in Anqing City**

| Index | Membership degree | | | | | Score | Level |
|---|---|---|---|---|---|---|---|
| | Excellent | Good | General | Worse | Bad | | |
| Viewing function $A_1$ | 0.411 8 | 0.329 4 | 0.143 9 | 0.101 6 | 0.011 4 | 80.46 | 4 |
| Store condition $A_2$ | 0.218 5 | 0.389 4 | 0.190 8 | 0.169 1 | 0.092 1 | 72.20 | 4 |
| Service facilities $A_3$ | 0.261 8 | 0.300 9 | 0.244 6 | 0.141 8 | 0.051 9 | 71.64 | 4 |

score was between 70 and 89, that is, it was good.

### 3.3 Evaluation results and analysis

The fuzzy evaluation scores of various indexes in the criterion layer is as follows: viewing function > shop condition > service facilities, showing that the viewing function of Daopashi Street in Anqing City can effectively improve the landscape space vitality. Judging from the weight of the criterion layer to the target layer, the weight of viewing function was 0.633. Therefore, historical and cultural blocks should be further optimized from the perspective of improving viewing value. From the fuzzy evaluation score of the index layer, the score of architectural style was the highest (86.6), and the score of store density was the lowest (60.2), indicating that the architectural style of historical and cultural blocks was more attractive, and can improve the landscape spatial vitality. It is worth noting that the score of taste landscape was low (62.4), and the global weight of taste landscape was 0.022. If the quality of taste landscape can be effectively improved, the landscape spatial vitality of historical and cultural blocks can be enhanced.

## 4 Suggestions

(1) When visiting historical and cultural districts, environmental perception is obviously multi-sensory and not limited to vision. However, from studies on outdoor environments, it is found that vision is of great significance[10]. For visitors to historical buildings or cultural relics buildings, the buildings themselves and the facades with special architectural styles can trigger the emotions of tourists[11], and the aesthetic quality of buildings, the quality of works of art, and the composition of cultural heritage buildings also provide emotional experience for tourists[12]. The richness of viewing should be improved, and the architectural style should be consistent with the cultural atmosphere of historical and cultural streets as far as possible. At the same time, certain innovation can better enhance the spatial vitality of landscape. Right plants should be planted to blend in with buildings and complement the atmosphere. Lighting effect is added at night to accentuate the character of the surrounding landscape. The historical heritage of cultural blocks should be preserved, and the presentation of the context cannot be superficial.

(2) Rich and diversified business form is the basic indicator reflecting the prosperity of blocks[13]. Shops should retain their own characteristics and be combined with diversity, which is conducive to the protection and sustainable development of individual shops and historic districts, and can enhance the theme image and attractiveness of old streets, so as to better meet the consumption needs of tourists. On old streets, stores with the experiential consumption function with old street culture should be actively invested[14], which can not only increase the characteristics of stores, but also further promote the culture of old streets. Meanwhile, it is necessary to strengthen supervision, conduct efficient management, and pay attention to hygiene.

(3) The practicality of service facilities should be improved, and equipment with low utilization rate should be reduced. The stayability of the relevant site is an important criterion to measure landscape spatial vitality, and the construction of this site should be paid attention to. The basic service facilities of the blocks should be improved, and pavilions in line with the cultural atmosphere of the blocks are set as a resting place. Health service facilities should be improved to ensure the cleanliness of streets. A special historical and cultural exhibition area is set up to combine historical and cultural inheritance with modern business. The aesthetics of service facilities should be paid attention to, and service facilities and the cultural atmosphere of the blocks should be integrated. It is necessary to improve the supervision system of service facilities, and timely repair and update the basic service facilities, which is conducive to improving the service quality and vitality of the blocks.

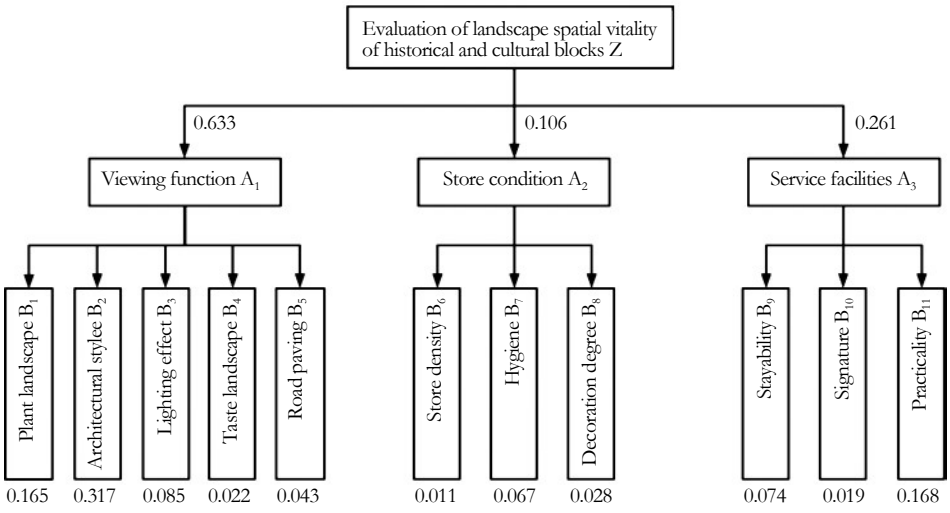


**Fig.5 Weight of evaluation indexes of landscape spatial vitality of historical and cultural blocks**

## 5 Conclusions

In the modern era with the emergence of fast food culture, historical and cultural blocks are the living embodiment of traditional culture, and the vitality of landscape space is an important indicator of the activity of historical and cultural blocks. In this paper, based on AHP method and fuzzy comprehensive evaluation method, the weight of various factors affecting the landscape spatial vitality of historical cultural blocks was analyzed, hoping to contribute to the effective preservation of culture in historical cultural blocks and the improvement of landscape spatial vitality. At the same time, how to maintain or improve the landscape spatial vitality of historical and cultural blocks in other aspects still needs to be further explored.

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culture, and launched two explosive stage performances "Chu Music" and "Qu Yuan". Through the exquisite integration of high-tech means and traditional Chinese cultural stories, it highlights the distinctive characteristics of Chu culture and shows the unique charm of Chu culture, and tells the audience the style of Chu State and the charm of Chu people continuously and pleasantly. The large-scale live performance of "Qu Yuan" is based on *Li Sao*, *Nine Songs*, *Tian Wen* and other masterpieces created by Qu Yuan as a representative figure. Qu Yuan's tortuous life experience depicted in the work is selected as the main material for the performance. On this basis, the show also perfectly combines the international top entertainment technology with real performances to create a dreamlike and "poetic" world full of Li Sao fantasy. At the same time, ink painting style and dynamic special effects animation are innovatively used to interpret the great patriotic poet Qu Yuan's life wonderfully. As another unique experience project of Jingzhou Fantawild, Chu Music is a highly integrated creation of culture and technology, combining Chu Ci, Chu Dance, Chu Music and Chime Bells unearthed in Chu, and performing Chu music and dance, Chu architecture and Chu customs through "real people + high − tech" to write a rich Chu cultural legendary movement. Moreover, the theme features of float parade, Jingchu culture exhibition, etc., will be held regularly, making tourists have an in-depth understanding of Jingchu culture, and meeting the needs and expectations of tourists for the theme park.

### 5.3 Landscape sketch

The landscape sketches in the park are also full of Jingchu cultural elements. For example, chime bells, war drums, figures of the Three Kingdoms period can be seen everywhere in the park, and pavilions, terraces and towers are also modeled after Chu architecture. Special flower bed shape is designed with flowers and shrubs according to the design of Chu culture totem, and Chu cultural symbols are caved on seats, decorative lighting, trash cans and other infrastructure. The historical and cultural changes of Chu State are written through the landscape wall and stone relief carving, showing the ups and downs of the history of Chu State. In addition, the whole Fantawild Park adopts Jingchu special food, such as Wuhan hot dry noodles, Gong'an guokui, Jingzhou rice noodles, etc. Meantime, there are special meals launched according to the development of Jingzhou City.

## 6 Conclusions

Jingchu culture is an important part of Chinese traditional culture, and contains rich and colorful cultural elements, such as historical stories, poems, folk customs, totem symbols, etc. It is crucial to carry forward and inherit the history and culture by studying the application and development of Jingchu culture. As a carrier for the dissemination of history and culture, the theme park can display Jingchu cultural elements in multiple dimensions and angles, innovate various ways of cultural inheritance and carry out diversified applications, so as to display Jingchu cultural elements more vividly and provide tourists with an immersive experience. It not only embodies the cultural tradition of Jingchu, but also meets the pursuit of modern tourists, so that tourists can better understand and feel the profound and long historical and cultural connotation of Jingchu region while enjoying leisure and entertainment. Nowadays, with the development of science and technology, there are more and more ways to apply the elements of Jingchu culture to different fields. Research on the application of Jingchu cultural elements in theme park is of great significance to the future, which will not only promote the development of theme park industry, but also provide a reference for other types of parks.

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