



Development of Wushu culture industry using internet of things technology: A case study of Anhui Province, China

Sile Wang^{a,*}, Yun Chen^{b,c}, Dong Liang^d, Liyan Zhang^e

^a College of Physical Education, Anqing Normal University, Anqing, 246000, China

^b College of Management and Entrepreneurship, Binary University, Puchong, 47100, Malaysia

^c Yuanshan Sports Training School Co., Ltd., Anqing, 246000, China

^d College of Physical Education, Weifang University, Weifang, 261061, China

^e School of Management, Changwon National University, Changwon, 51767, South Korea

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ABSTRACT

Objective: In recent years, as the modern economy rapidly advances, and urbanization continues to flourish, Anhui Province has emerged as a significant hub for Wushu, boasting a rich historical tradition in this martial art form. However, despite this heritage, Wushu often remains associated with traditional sports, and the growth of the Wushu cultural industry has not been as robust as desired. This paper seeks to harness the potential of the Internet of Things (IoT) and capitalize on the burgeoning trends within the cultural industry to foster the development of Chinese Wushu. The primary objective of this study is to explore strategies for advancing the Wushu cultural industry in Anhui Province, leveraging IoT technology. To achieve this goal, we employ a novel approach, combining SWOT (Strength, Weakness, Opportunity, Threat) analysis with Analytic Hierarchy Process (AHP), providing a quantitative assessment of the region's Wushu cultural industry development. This approach minimizes subjective bias and offers a sound theoretical foundation for industrial progress. Our research yields promising results, as we effectively integrate Wushu, culture, and tourism. This not only facilitates the dissemination and popularization of Wushu culture but also enhances the appeal of local tourism resources. Notably, the fifth World Wushu Championship experienced sustained popularity, and in 2014, Anhui Province successfully hosted the sixth edition of the event in Jiuhuashan, yielding a significant income of 170 million yuan. The development of the Wushu cultural industry in Anhui Province has exhibited positive growth trends and garnered considerable attention. This study underscores the importance of embracing IoT technology and aligning with broader cultural industry trends to nurture the development of Chinese Wushu. The implications of our research extend to the realms of tourism, culture, and sports, offering valuable insights into leveraging technology for the advancement of traditional practices. This study represents a novel exploration of the intersection between Wushu and IoT technology, with the potential to inform and inspire further research in this evolving field.

* Corresponding author.

E-mail address: wangsile@aqnu.edu.cn (S. Wang).

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1. Introduction

Wushu, a living body that gathers China's excellent traditional culture and condenses the changes of China's history, its survival characteristics and development and evolution have always been based on the trend under different historical backgrounds since ancient times [1]. It constantly enriches its own color, thus forming a unique cultural phenomenon. It clearly reflects the changes of human wisdom and lifestyle. Although Wushu has gradually reflected its own educational value, fitness value and economic value, the development of Wushu, an excellent traditional sport, is deeply limited at the moment of rapid urbanization. It has long been crowned with the embarrassing symbol of "transmission but not unification" [2]. It originates from its complicated theory, attack system and development and communication channels that do not conform to the process of the times. If this national treasure wants to develop and inherit in modern society, it must find a suitable breakthrough point and use high-tech promotion means to integrate into people's daily life.

As early as the pre-Qin period in the slave society, Chinese Wushu had a trend of leisure and entertainment. The entertainment function of Wushu was intertwined with primitive education and religion, and many projects with interest, appreciation, artistry, entertainment, game and performance began to appear in large numbers. Besides, the inheritance and development of traditional Chinese Wushu skills in the folk society were also promoted. It has a positive effect on the change of Chinese traditional Wushu to Chinese traditional Wushu, and constantly promotes its development. After the Opium War, ethnic and class contradictions deepened, and Chinese churches combined with traditional Chinese Wushu to become a reliable non-governmental organization in the period of resistance to aggression. However, the development of war greatly weakened the entertainment of traditional Chinese Wushu.

Looking back on the development of New China's Wushu is to explore the important events, representative figures and their impact on the development of new China's Wushu in each stage of Chinese social development. Wushu in the long historical development process, from the concept, function, value and many other aspects are constantly changing, the reason is closely related to the changes of the times, social progress and Wushu itself. It is always difficult to estimate the influence of these aspects in the previous studies on Wushu, and there is one-sidedness. The cross-border integration of Internet of things technology and Wushu culture is not only the actual need of Wushu development, but also the trend of the development of the times [3]. The Internet of things provides the best living environment and opportunities for the modern development of Wushu. It is an essential technical tool for the industrial development of Wushu. At a time when the pattern of cultural industry is obvious, Wushu should make rational use of its own advantages, reasonably integrate into the cultural industry, or learn from its experience and reasonably apply modern scientific and technological means to survive and break through, so as to form a pattern of "cultural guidance, Internet of things, Wushu singing". It realizes the transformation and upgrading of Wushu. By using Internet of things technology to realize the network development of Wushu, it carries forward Chinese Wushu culture. It re integrates the internal sect boxing system of Wushu, and deeply excavates the disappearing Kung Fu stunts and weapon culture. It creates a network sales platform for Wushu products, guides Wushu to take the road of modern industry, and realizes the cross-border integration of Internet of things and Wushu.

The innovations of this paper are as follows: (1) this paper introduces the relevant theoretical knowledge of Wushu culture and Internet of things technology in Anhui Province, and puts forward the SWOT-AHP quantitative analysis algorithm. It analyzes how the SWOT-AHP quantitative analysis algorithm has an impact on the evaluators of the development of Wushu cultural industry in Anhui Province. (2) This paper investigates and analyzes the development and industry of Wushu Culture in Anhui Province. Through the experiment, it can know that with the support of the Internet of things, the martial arts cultural industry in Anhui Province began to flourish.

1.1. Related works

Nowadays, Chinese Wushu culture spreads rapidly and widely. People in many parts of the world recognize and deeply love Chinese Wushu. Ma [4] found that investigating the process and effect of Wushu communication in different cultural environments can help provide more targeted communication strategies for Chinese Wushu. The case of the spread of Wushu in Sudan can show the combination of Wushu spirit and Arab culture from both macro and micro levels, and draw on the experience of Wushu entering the Arab people. He believed that the further dissemination of Wushu in Arab countries should be improved in such aspects as the formulation of strategies based on the comparison of communication environment, the extraction of symbols and connotation, the construction of teachers, the correct handling of the relationship between Wushu and cultural activities, and the solution of specific problems in different cultural environments according to local conditions. Samodra et al. [5] used a sample of 15 Daron Draja Wushu athletes, seven male and eight female. The results showed that 7 athletes accounted for 46 %, 1 athlete accounted for 7 %, 6 athletes accounted for 40 %, and 1 athlete accounted for 7 %. Ma and Wang [6] proposed to put forward a strategic proposition of coordinated promotion from four dimensions according to the actual situation of Wushu cultural brand construction in countries along the "the Belt and Road". In terms of construction concept, they are considered not only use the "the Belt and Road" platform to increase the efficiency of Wushu cultural brand construction, but also help the "culture first" of the "the Belt and Road" through brand construction; in terms of construction elements, they should find and optimize the fit of brand value, brand image, product price and extended products according to the characteristics, culture and customs of countries along the line; in the principle of construction, they should start from the demand side, attract more consumer groups by providing diversified products and characteristic products, and make them gradually recognized by the audience; in terms of construction guarantee, through top-level design, financial support, policy preference and full staff cooperation, Wushu cultural products are really "introduced" to countries along the line, and become a booster to continuously deepen the "the Belt and Road" initiative. Ciembroniewicz [7] found that Wushu are now practiced worldwide and take a wide range of forms, from traditional schools to combat systems or sports. They have been greatly modified and integrated into western

culture to become goods belonging to the entertainment industry. He raised the question whether traditional Wushu could still exist in a commercialized and globalized world. By comparing eight destination websites in Thailand and China, Deng [8] conceived AMLs as the creative appropriation, transmogrification and hybridisation of divergent images of masculinities circulated at different scales. This conceptualisation speaks to a cultural complexity framework that moves beyond the deterministic and unidirectional paradigm of self-Orientalism by highlighting the productive role of Asian destination ‘image-makers’ as both cultural remediators and improvisers occupying the intermediary position between the homogenising and heterogenising discourses of transnational masculinities. The main purpose of Gayathri and Anand [9] research was to clarify the concept of organizational culture, which is usually defined in different ways and has different application guidelines. The main objective is to study the organization’s work culture and how employees adapt to it. Data collection was completed through questionnaires and analyzed using different statistical tools to describe the relationship between various variables related to organizational culture perception. Although Wushu culture has always been loved by people, scholars’ cognition of Wushu culture still stays in the past. They only found the shortcomings of traditional Wushu culture and did not put forward innovative ideas, which is not conducive to the development of modern Wushu culture industry.

With the rapid development of modern information technology industry, the Internet of Things technology has been widely used. With these skill estimates, people simulate the contest as an actual fight using Markov chains, rather than predicting a binary outcome. Holmes et al. [10] compared the model’s accuracy to that of the bookmakers using their historical odds and show that the model can be used as the basis of a successful betting strategy. Sisavath and Yu [11] found that in today’s world, family security is becoming more and more necessary as the possibility of invasion increases. His design took “the Internet of Things is close to life, easy to use” as the design concept, and built a smart home system based on the Internet of Things. Portilla et al. [12] examined the potential of large-area electronics technology in the development of sustainable, wirelessly powered Internet of Things sensor nodes. He provided a system-level analysis of wirelessly powered sensor nodes, identifying the constraints faced by such devices and highlighting promising architectures and design approaches. A large number of medical institutions have confirmed the potential value of this system in the treatment of chronic diseases and provided useful feedback. With the development of the Internet of Things, integrating the Internet of Things into the development of the Wushu cultural industry can effectively promote the timely dissemination and innovation of the Wushu cultural industry.

The weaknesses in the existing research on Wushu culture and its dissemination are notable. While scholars have recognized the importance of Wushu culture, many have remained entrenched in traditional perspectives, focusing primarily on identifying shortcomings rather than proposing innovative ideas for its development in the modern era. This limited vision hampers the advancement of the modern Wushu cultural industry. Moreover, there has been a lack of comprehensive exploration into the transformative potential of modern information technology, particularly the Internet of Things (IoT), in the context of Wushu culture. Existing research has not adequately addressed how IoT can be effectively harnessed to enhance the dissemination and innovation of Wushu culture. This gap in knowledge represents a significant weakness in previous studies.

To address these limitations, the current research aims to bridge the gap between traditional and modern perspectives on Wushu culture and leverage IoT technology as a catalyst for its development. By doing so, it seeks to provide a more comprehensive and forward-thinking approach to the promotion and evolution of Wushu culture in the contemporary world.

2. Research methods

2.1. SWOT elements in the development of Wushu culture industry in Anhui Province

SWOT analysis method is a scientific evaluation method to evaluate the development strategy of Wushu cultural industry and to measure the importance of various factors affecting the development of Wushu cultural industry. Through a comprehensive analysis of internal and external factors, it can formulate a better strategy for the development of the Wushu culture industry, and at the same time, it has a general reference significance for the development of tourism [13].

(1) Advantage Analysis of Development of Wushu Culture Industry in Anhui Province



Fig. 1. Children’s Wushu training in Anhui Province.

Rich Wushu resources: Anhui Province’s rich Wushu resources have laid the foundation for the development of the Wushu industry. First, Anhui Province has a far-reaching historical tradition of Wushu. Bozhou City and Zongyang County are well-known Wushu townships in China, which are the advantages of the development of Anhui Province’s Wushu industry. Secondly, it has local characteristics of the Wushu in Anhui province inheritance and promotion, but also has regional characteristics of the rich variety of fists [14].

Deep mass base: Anhui Province is a big traditional province practicing Wushu and has a deep mass base. It has many advantages such as great social influence, high participation of the masses, and large number of people practicing Wushu, which are incomparable with other sports. In 2015, Anhui Wushu Association was listed as the first pilot association for the materialization of provincial sports associations, which rely on social and sports resources. Under the leadership of the Provincial Sports Bureau, it independently organizes and carries out various activities and undertakes international, national, provincial and municipal competitions by relying on its own advantages in sports, technology and business. It has become a group organization that serves the masses, the government, the society and the members. The children’s Wushu training in Anhui Province is shown in Fig. 1.

As shown in Fig. 1, Wushu culture has a long history. Wushu is the representative of Chinese excellent traditional culture, which contains all the excellent features of Chinese traditional culture. It highlights the brave and stubborn spirit of the descendants of China. For a long time, though it has the function of sports, it mainly exists in society in the form of a skill and is popular in the army and the people. It creates personality in a cultural way and feeds the national spirit of Chinese children.

(2) Analysis of the disadvantage of the development of Anhui Wushu culture industry:

Its lack of clear market segmentation: In the Wushu cultural creative performance industry, the first step in the development of the industry, market segmentation is not very good. An industry-sized performance doesn’t end in just a few minutes. A few people in the

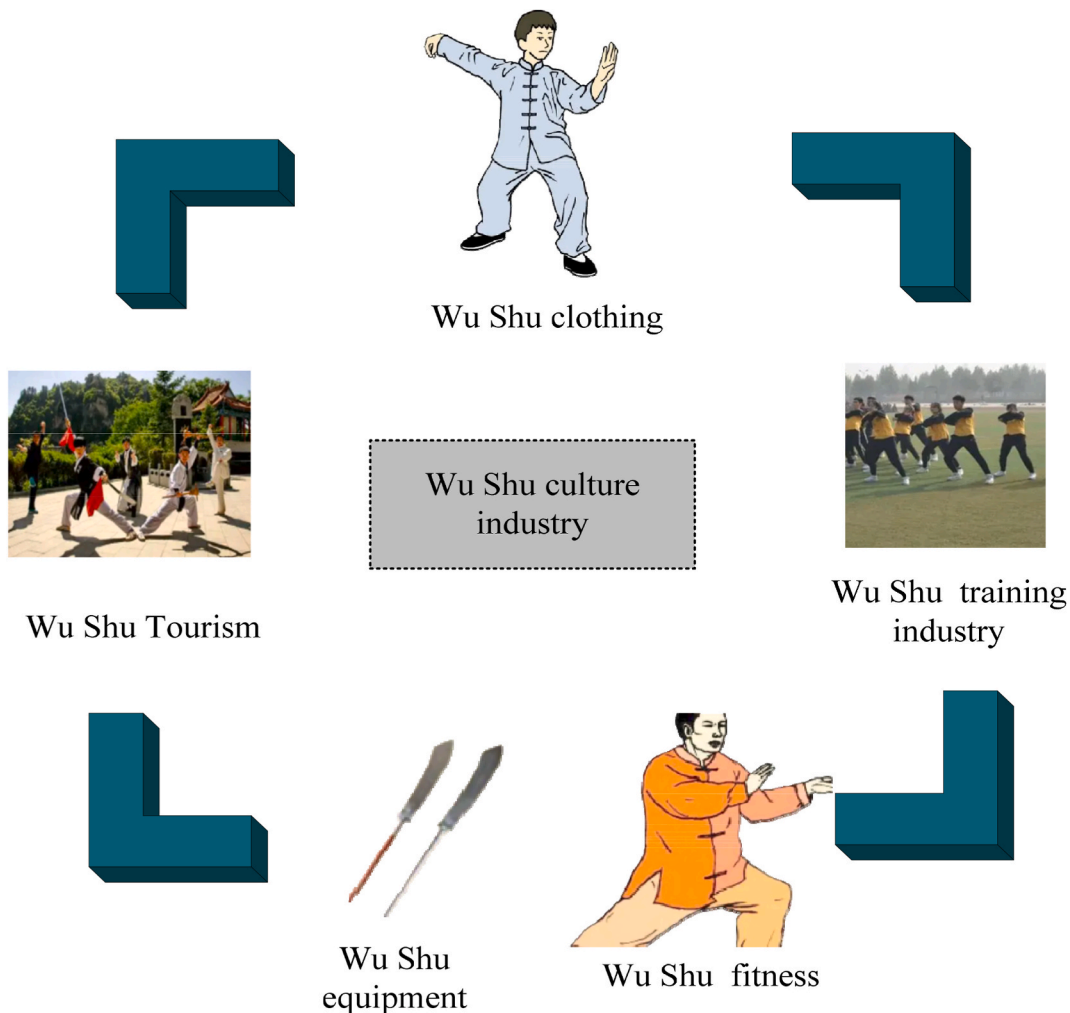


Fig. 2. Types of Wushu culture industry in Anhui province.

audience represent several types of enjoyment. Although it is not possible to divide the performance into countless forms of performance, there should be at least a division of audience groups. Today, however, people don't put much effort into this. Even though the martial arts performance really makes the audience see the blood boiling and spiritual, there are not many people who really impressed the audience.

The target market is not clear: every update to a show of Wushu cultural creative performance would consume a certain amount of human and material resources, especially for smaller performances, lighting and dancing beauty, packaging and so on. Each update costs a lot of money, but many companies would choose a program to go all over the country or even the world and then design a new show, which saves time, effort and money. However, such target market deviation is one of the major problems that the Chinese Wushu cultural creative performance industry continues to solve.

There is no clear marketing strategy: The most popular experience marketing today advocates increasing consumer experience participation and involving consumers in marketing activities. From senses, thoughts to behaviors, emotions and other experiences, it really triggers the needs and desires of consumers. However, looking back at people's creative performance of martial arts culture, it can't find what can involve the audience. It makes the audience feel Chinese Wushu in many ways by various means, except for the visual viewing, as if there is nothing else.

The way of industrial development is obsolete: its main industry is creative performance of Wushu culture or performance to attract customers. Its main income channel is ticket sales, and few Wushu cultural performance industries have supplementary products. It does not follow the development of the times and change the way of development in time. Many industries of this traditional cultural attribute still proceed in a constant and ever-changing way. This does not conform to the law of the development of today's market. If the fittest survive through competition, they would be gradually eliminated if they do not adapt to the development of the times.

(3) Threat analysis of the development of Anhui Wushu culture industry:

The shortage of creative talents: The development of the Wushu cultural and creative culture industry needs the advice of relevant talents, while it just lacks such a professional group of creative talents. People need innovative Wushu culture to emerge one after another, and more creative cultural models are needed. For this reason, people should bring in a large number of creative professionals from outside China and recruit creative minds.

Since the entry of New China, with the stability of the country and the development of the economy, people's martial spirit has gradually lost, and Wushu seem to have lost its value instantly. Although the organizational structure, competition system and competition form of Wushu have been continuously improved, the purpose of Wushu is different, so it is always impossible to find the lost Wushu and to save the nearly disappearing fist schools. The whole socialization of the Internet of Things has accelerated the transmission of information, and the continuous popularity of virtual space has challenged the transmission of traditional Wushu.

The consumption form of Wushu is single: the traditional consumption form of Wushu is backward and single. The consumption forms of Wushu clothing and Wushu instruments and Wushu books are far from satisfying the industrialization forms of Wushu in the future, and the audience of clothing and instruments is very limited. The types of Wushu culture industry in Anhui Province are shown in Fig. 2.

As shown in Fig. 2, as a traditional culture, Wushu should be good at using the Internet of Things thinking to make traditional culture unconventional and to modernize traditional consumption. The modern consumption of Wushu can create the tourism consumption of Wushu sacred places, the consumption of Wushu movies and TV, the consumption of Wushu cultural performances, the consumption of outdoor expansion of Wushu and so on through the Internet of Things technology. It tries to introduce a modern consumption mode by drawing on the consumption experience of cultural products and retaining its traditional characteristics.



Fig. 3. The performance of children's Wushu in Anhui Province on the Spring Festival Evening.

(4) Opportunity Analysis of Development of Wushu Culture Industry in Anhui Province

The development of high and new technologies in the Internet of Things: science and technology, the age and creativity lead, promote and restrict each other. Science and technology have driven the pace of the times, and the times have also promoted the pace of scientific and technological updates. With the gradual advent of high and new technology, people’s level of appreciation has rapidly increased. It is difficult to call a work of creativity without adding scientific and technological content.

The performance of children’s Wushu in Anhui Province on the Spring Festival Evening is shown in Fig. 3.

As shown in Fig. 3, the development of cultural industries is based on serving the general direction of the country, carrying the important tasks of China’s economic development, cultural inheritance and national revival. It is the creator of modern material society and human spiritual civilization. The continuous improvement of economic, political, cultural and entertainment functions has gradually become the value standard to measure social development, filling the shortage of the country in the cultural industry. Policy support: During the 14th Five-Year Plan period, Anhui Province further accelerated the development of sports industry and issued a series of policies and regulations. It supports the municipalities and counties in Anhui Province to plan and construct major sports industry projects such as sports eco-parks, sports-featured towns and sports-tourism complexes, relying on local resources. It actively introduces major sports events from outside China and sets up a promotion platform for exchanges and cooperation between sports and enterprises. It continues to promote the integration and development of sports and health, sports and tourism, sports and culture industries.

2.2. Combination of SWOT qualitative and hierarchical (AHP)

At present, only SWOT qualitative analysis method is used in China’s actual work. It only explains and analyses the inherent advantages and disadvantages of the development of Wushu culture industry, as well as the external opportunities and threats, but it can’t quantify their importance. It is necessary to weigh and subdivide the internal and external factors that affect the development of scenic spots by using SWOT-AHP quantitative analysis method [15].

Analytic hierarchy process (AHP) can solve complex multi-objective problems. In the process of analysis, it first needs to use the experience of decision-makers to evaluate the relative importance of whether each goal can be achieved. Then, through mathematical checking calculation, the relative weight of each standard of each solution is reasonably calculated. It uses the weight to determine the order of advantages and disadvantages of each scheme [16].

It determines the factor domain for evaluating the development of Wushu cultural industry, and the evaluation index domain is formula 1:

$$q = \{q_1, \dots, q_n\} \tag{1}$$

It determines the comment level domain. The level set is that each level can correspond to a fuzzy subset, which is formula 2:

$$p = \{p_1, \dots, p_n\} \tag{2}$$

The fuzzy relation matrix is established to determine the membership degree of the evaluated object to the hierarchical fuzzy subset from the perspective of single factor, and then the fuzzy relation matrix is obtained as formula 3:

$$G = \begin{bmatrix} G_1 & q_1 \\ G_2 & q_n \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{bmatrix} \tag{3}$$

The element in row i and column j of matrix G represents the membership of a certain evaluated object to the fuzzy subset of p_n level from the perspective of factor q_1 .

In fuzzy comprehensive evaluation, the weight vector of evaluation factors is determined as formula 4:

$$A = (a_1, \dots, a_t) \tag{4}$$

in this paper, the analytic hierarchy process is used to determine the relative importance order between evaluation indexes, which is normalized to formula 5 before synthesis:

$$\sum_{i=1}^n a_i = 1, (a_i \geq 0, i = 1, 2, \dots, n) \tag{5}$$

The fuzzy comprehensive evaluation result vector of each evaluated object is obtained by synthesizing a and g of each evaluated object with an appropriate operator, which is formula 6:

$$A \times G = (a_1, a_2, \dots, a_t) \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \dots & \dots & \dots & \dots \\ r_{p1} & r_{p2} & \dots & r_{pm} \end{bmatrix} = (b_1, b_2, \dots, b_m) = B \tag{6}$$

b_1 is obtained by the j-th column operation of A and R, which represents the membership degree of the evaluated object to the a_t fuzzy subset as a whole.

Additive evaluation: it is mainly to add and sum the scores of each evaluation index, and express the evaluation results according to the total score, as shown in formula 7:

$$S = \sum_{i=1}^n S_i \tag{7}$$

However, additive evaluation is only suitable for projects with simple relationship between evaluation indicators.

Continuous product evaluation: multiply the scores of each evaluation index and express the evaluation results according to the product, as shown in formula 8:

$$S = \prod_{i=1}^n S_i * S_j \tag{8}$$

This method requires a particularly close relationship between the evaluation indicators. If there is a deviation in the score of one of the indicators, it would affect the overall situation and deny the whole evaluation result. The weighted evaluation represents the evaluation result according to the final summation result, as shown in formula 9:

$$S = \prod_{i=1}^n w_i S_i, \sum_i w_i = 1, 0 \leq w_i \leq 1 \tag{9}$$

It carries out data standardization according to the formula:

$$A'_{ij} = \frac{a_j - a_{\min}}{a_{\max} - a_{\min}} \tag{10}$$

$$A'_{ij} = \frac{a_{\max} - a_j}{a_{\max} - a_{\min}} \tag{11}$$

a_j represents the j -th index, a_{\max} represents the maximum value of the j -th index, a_{\min} represents the minimum value of the j -th index, and A'_{ij} represents the standardized value.

2.3. Fuzzy comprehensive evaluation of Wushu Cultural industry development

The evaluation index factor set refers to the set composed of various factors affecting the development risk of Wushu cultural industry. It is expressed as $U = \{u_1, u_2, \dots, u_m\}$, where $v_m (m = 1, 2, \dots, n)$ is the evaluation index in the evaluation index system, i refers to different influencing factors, and M refers to the number of evaluation indexes. In view of the more or less fuzziness of such risk influencing factors, when creating the factor set, it should consider whether the selected factors can describe the overall picture of the evaluation objectives from multiple angles and fields. The evaluation index of this paper is the influencing factors under the index level [17].

In the development of Wushu cultural industry, because different risk factors have different degrees of impact on the whole investment project, the evaluation level of Wushu cultural industry development risk is divided into five grades, that is, formula 12:

$$V = \{v_1, v_2, \dots, v_5\} \tag{12}$$

v_1 Indicates high risk; v_2 indicates high risk; v_3 indicates average risk; v_4 indicates low risk and v_5 indicates low risk. Since all elements in V are written descriptions, they can't be quantified in the study. Therefore, V can be quantified and the risk level of Wushu cultural industry development can be determined by the interval to which the score belongs. The corresponding relationship between risk score range and risk evaluation level is shown in Table 1:

As shown in Table 1: when using fuzzy comprehensive evaluation for risk assessment, it needs to consider two sets. The first is the set of evaluation factors and the second is the set of evaluation index comments, which have corresponding fuzzy relations. The core of the fuzzy comprehensive evaluation method is to obtain the fuzzy relationship between the evaluation factor set U and the evaluation index comment set V , and select the appropriate synthesis algorithm [18].

When implementing the multi factor comprehensive evaluation process, the role of each factor in the evaluation grade should be considered. With the help of expert scoring or statistical method, formula 13 can be obtained:

$$A = \frac{a_1}{u_1} + \frac{a_2}{u_2} + \dots + \frac{a_m}{u_m} \tag{13}$$

Fuzzy comprehensive evaluation method is a method to obtain the fuzzy transformation of image B by using fuzzy relation R when

Table 1
Corresponding relationship between risk score range and risk evaluation level.

V	Score interval	Evaluation level
v_1	0.9–1	very risky
v_2	0.7–0.9	high risk
v_3	0.5–0.7	general risk
v_4	0.3–0.5	lower risk
v_5	0.3 or less	low risk

the original image A is known. The expression of its operation is $B = A \bullet R$, and R is a corresponding fuzzy subset on the evaluation level universe V, which is formula 14:

$$B = \frac{b_1}{v_1} + \frac{b_2}{v_2} + \dots + \frac{b_n}{v_n} \tag{14}$$

V is the membership degree of the evaluation object corresponding to the evaluation grade v_n . The simple change of the above formula is expressed as the comprehensive evaluation matrix, and the comprehensive evaluation matrix is normalized to become the judgment matrix, which is formula 15:

$$p_j = \frac{b_j}{\sum_{j=1}^n b_j} (j = 1, 2, 3, \dots, n) \tag{15}$$

when $p_s = \max\{p_j\}$, the evaluation grade corresponding to p_s is the evaluation grade that should be determined by comprehensive evaluation.

Firstly, the advantages, disadvantages, opportunities and threats of the development of Wushu culture industry in Anhui Province are analyzed. The AHP analysis and evaluation index system is shown in Fig. 5.

As shown in Fig. 4: for the evaluation layer group, four aspects are mainly considered (internal advantage S, internal disadvantage W, external opportunity O and external threat T). After the tourism planning expert group scores with the fuzzy comprehensive evaluation method, it obtains the primary index matrix [19].

In order to verify the scientific rationality of the calculation results and reduce the artificial subjective deviation, the above weight vector is obtained as formula 16:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \frac{(BW)_i}{W_i} \tag{16}$$

n in the formula is the number of levels of the judgment matrix, W_i is the value of their weight coefficient, and the calculation process of random consistency test is shown in Fig. 5:

As shown in Fig. 5, the weight calculation of the first level indicators and the second level indicators of the above Wushu cultural industry only represents the importance of this layer of elements to the previous layer of elements, and it is also the actual desired result. It is the relative importance of all indicators to the overall goal. Therefore, it must further calculate the weight of the total.

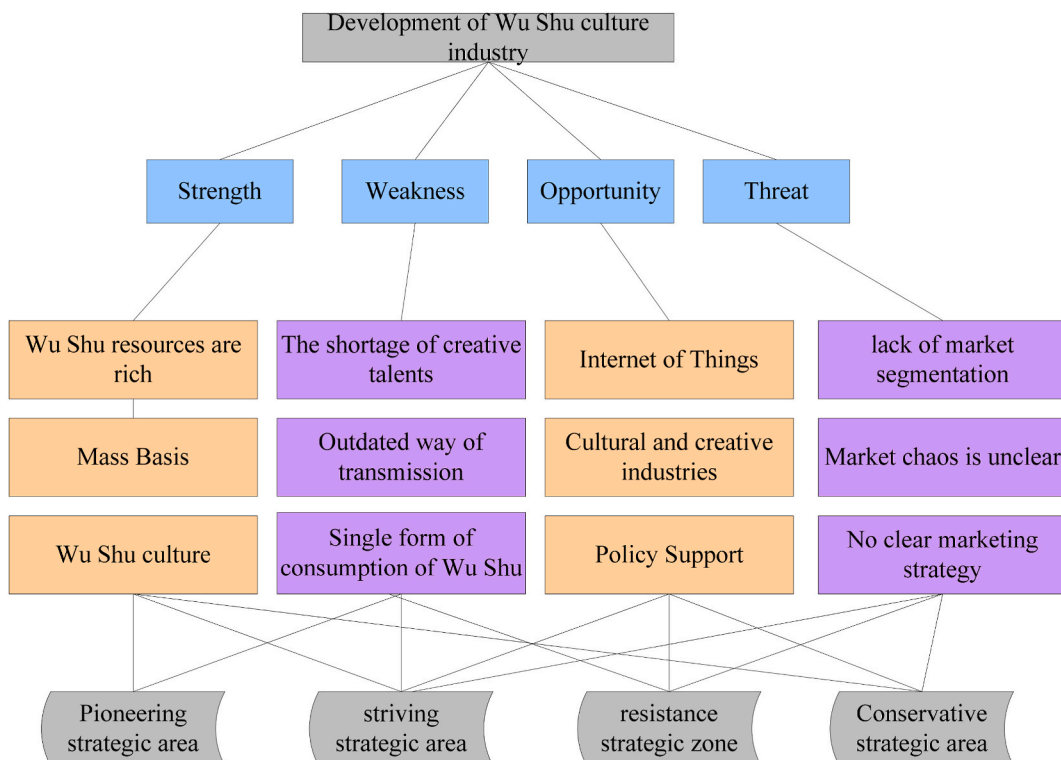


Fig. 4. Evaluation index system of Wushu cultural industry development in Anhui Province.

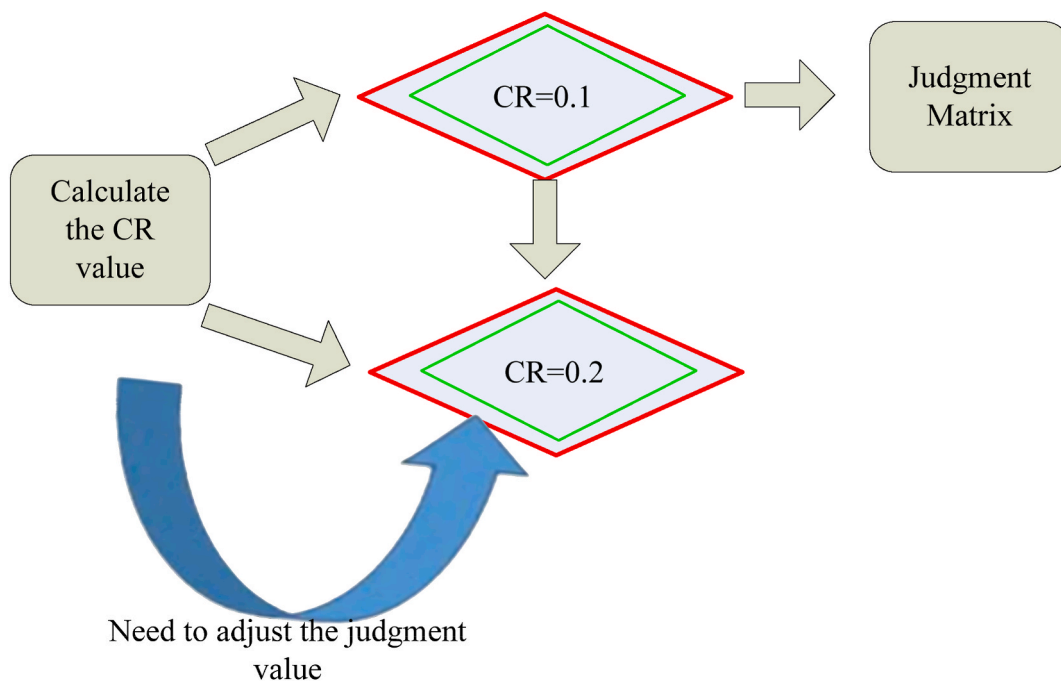


Fig. 5. Process chart of random consistency test.

The value of “combination weight” is determined according to the AHP method, and the expert score is performed. The use of each element and the corresponding performance are taken as - 4, - 3, - 2, - 1, 0, 1, 2, 3 and 4 respectively. Here, advantages and opportunities are given positive values, while disadvantages and threats are given negative values. The greater the absolute value, the greater the performance. The evaluation of internal and external factors in the development of Wushu cultural industry in Anhui Province is shown in Table 2 and Table 3.

As shown in Tables 2 and 3: it calculates the weighted score of each element in the table and multiplies the weighted value of that element by the score. The total score of internal and external factors is obtained by adding the weighted scores of all elements under this item.

According to the qualitative analysis of SWOT elements, the Delphi method obtains the basic evaluation value required for the quantitative analysis of SWOT elements. It uses swot-ahp quantitative analysis method and 4-quadrant coordinate method to obtain:

The total strength of advantage is formula 17:

$$S_a = \sum_{n_s} \frac{S_i}{n_s} = 2.1683 \tag{17}$$

The total strength of disadvantage is formula 18:

$$W_a = \sum_{n_w} \frac{W_i}{n_w} = -0.3908 \tag{18}$$

The total opportunity strength is formula 19:

Table 2

Evaluation matrix of internal factors in the development of Wushu cultural industry in Anhui Province.

Internal factors	Weights	Score	Weighted score
Advantage(S)	0.5522	0	2.1683
Wushu Resources	0.1067	4	0.4268
Mass Basis	0.405	4	1.62
profound culture	0.0405	3	0.1215
Disadvantage(W)	0.1067	0	-0.3908
Market is not clear	0.0515	-4	-0.2061
The goal is not clear	0.0069	-3	-0.0208
weak marketing strategy	0.0291	-4	-0.0872
Outdated way of development	0.0192	0	-0.0766

Table 3
Evaluation matrix of external factors in the development of Wushu cultural industry in Anhui Province.

External factors	Weights	Score	Weighted score
Chance (O)	0.2838	0	0.9355
Technology development	0.0635	4	0.254
Industrial Development	0.0203	4	0.0812
Policy Support	0.2001	3	0.6003
Threat (T)	0.0573	0	-0.1859
Talent shortage	0.3308	-3	-0.1096
Poor transmission	0.0140	-4	-0.0558
Less consumption	0.0068	-3	-0.0204

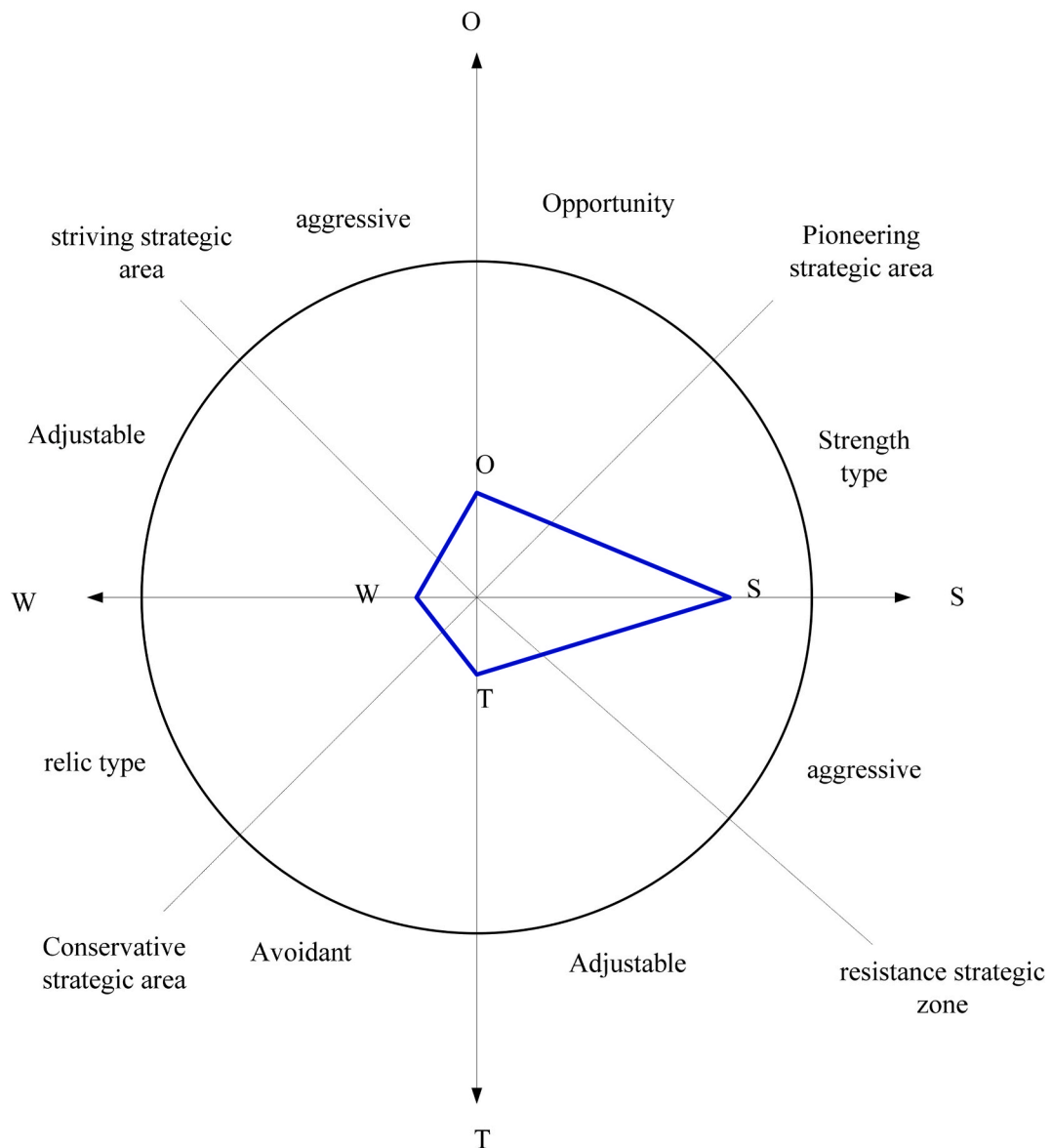


Fig. 6. SWOT strategic interval selection chart of Wushu cultural industry development in Anhui Province.

$$O_a = \sum \frac{O_i}{n_o} = 0.9355 \tag{19}$$

The total threat intensity is formula 20:

$$T_a = \sum \frac{T_i}{n_t} = -0.1859 \tag{20}$$

A four-dimensional coordinate system is established with the four variables of advantage (S), disadvantage (W), opportunity (O) and threat (T) as the semi axis, which can draw a quadrilateral diagram of project development strategy. This quadrilateral diagram is the final result produced by the interaction of four elements: S, W, O and T, as shown in Fig. 6.

As shown in Fig. 6: Based on the results of SWOT element analysis and quantitative analysis, Anhui Wushu cultural industry should be based on its rich Wushu resources. It fully excavates the spiritual culture of Wushu and firmly grasps the opportunity of the great development of Wushu cultural tourism industry. Taking meeting the pursuit of physical and mental health of modern people as the starting point, it develops martial arts products that closely follow the trend.

- 1) Industry scale expansion: Anhui Huangshan Wushu competition with the theme of “to the friends of the Wushu, sword Huangshan”, attracted a total of 245 teams from 55 countries and regions in the world, a total of 2865 athletes to participate in the event scale is unprecedented and grand (the data is from the official website of the 5th World Traditional Martial Arts Festival).
- 2) Abundant resources

The Chinese Wushu industry has rich resources, including cultural resources, human resources, product resources, technical resources and so on. Especially rich talent resources, since the founding of the People’s Republic of China, the diversified development path of Wushu talents has cultivated many Wushu talents. According to incomplete statistics, at present, there are tens of thousands of Chinese folk fighters, hundreds of senior Wushu coaches, nearly 500 people who have won the title of senior Wushu segment, and thousands of high-level Wushu athletes. There are more than 200 international and national referees.

In addition, there are many Wushu tourist attractions in China, such as Songshan Shaolin Temple in Henan Province, Cangzhou in Hebei Province, Wudang Mountain in Hubei Province, Emei Mountain in Sichuan Province, Liangshan in Shandong Province, and South Shaolin in Fujian Province.

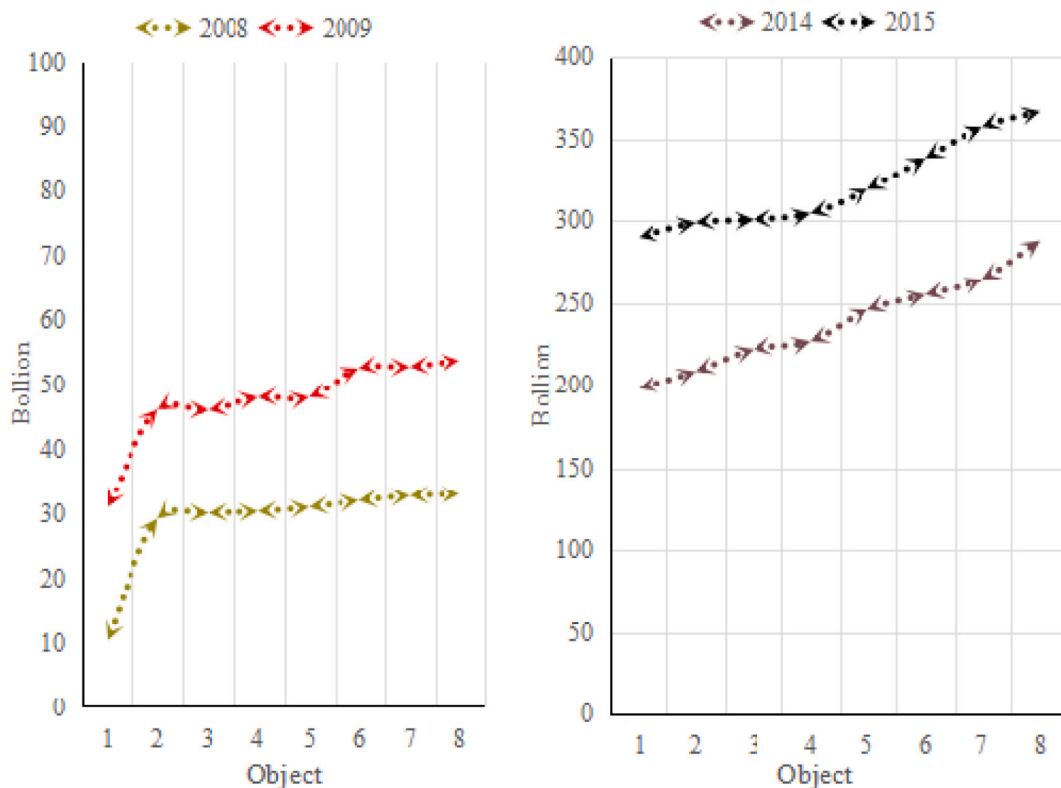


Fig. 7. Comparison chart of Wushu development trend in recent years.

3. Result and discussion

3.1. Economic development of Wushu cultural industry

The development of Wushu is the basis for the survival and development of Wushu Industry. After the founding of the people’s Republic of China, Wushu in Anhui Province developed rapidly, the number of people practicing Wushu increased rapidly, the enthusiasm for practicing martial arts was high, and the development of martial arts reached a peak [20].

This paper uses the methods of literature, field investigation, mathematical statistics, logical analysis research methods to study the origin, current situation and influencing factors of the development of Wushu industry in Anhui province, and on this basis, preliminarily outlines the development planning of Wushu industry in Anhui province. This paper refers to the economic situation of Anhui province and the market value of Wushu related industries, the audience group led by the future industrialization, media interest, enterprise attention and other information and paper monographs, and puts forward the ideas and views of martial arts industrialization in Anhui province combined with relevant content.

According to the actual situation, questionnaire survey is carried out in two ways, namely, on-site questionnaire distribution and questionnaire distribution with the help of others. The on-site questionnaire was collected by collecting questionnaires on site during winter and summer holidays. The questionnaire can be sent to the local students by mail, so that the students can complete the distribution and recycling of the questionnaire at the relevant morning training site.

Bozhou Wushu in Northern Anhui has a certain influence on regional Wushu in China. The comparison chart of Wushu development trend in recent years is shown in Fig. 7 (the following data is from the official website of the 5th World Traditional Martial Arts Festival).

As shown in Fig. 7: nearly 100 million people in China take Wushu as a means of exercise, and Wushu has become the largest sport in the field of traditional Chinese sports. At the same time, Wushu is widely spread all over the world. The cultural connotation and value function of Wushu are loved by people all over the world. In 2008, the total output value of the sports industry was 3.288 billion yuan, which increased to 36.619 billion yuan in 2015, with an average annual growth rate of more than 30 %.

The vigorous development of Wushu has promoted the development of Wushu Industry, especially the introduction of relevant policies of sports industry, which has greatly stimulated the development of Wushu Industry [21]. In recent years, Anhui Province has actively explored the development of sports industry, and the scale of sports industry has been expanding, as shown in Fig. 8.

As shown in Fig. 8: the development of Wushu Industry in Anhui Province actively explores various forms and methods, expands the scale of Wushu Industry and cultivates new economic growth points of Wushu industry. In the process of investigation, people are generally optimistic that Wushu industry would have a good development.

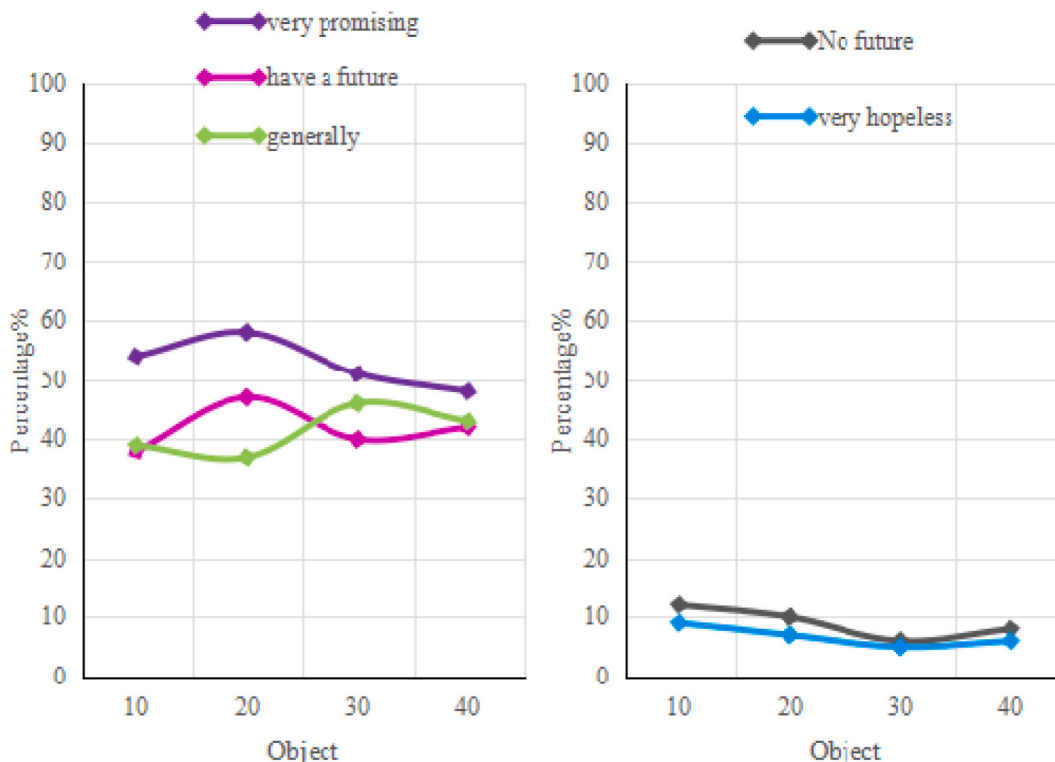


Fig. 8. Prospects of Wushu practitioners for the development of Wushu Industry in Anhui Province.

3.2. Investigation and Wushu fitness, entertainment and tourism

The Wushu fitness and entertainment industry, centered around the theme of “Wushu fitness,” offers fitness services through Wushu fitness counseling stations and other platforms. These services aim to promote physical fitness, enhance overall well-being, and provide mental relaxation [22]. As societal living standards continue to improve, there is a growing emphasis on both physical and mental health, making the pursuit of well-being a prevailing trend of our times.

Anhui Province has embraced the importance of national fitness and integrated it into the criteria for evaluating the establishment of provincial civilized cities. To understand the current landscape of the Wushu fitness and entertainment industry in Anhui Province, we conducted a comprehensive survey. A noteworthy aspect of this industry’s development is the proliferation of Wushu morning exercise points, reflecting its significant role in national fitness activities. Various establishments, including martial arts morning exercise points, counseling stations, and fitness clubs, have experienced substantial growth, as detailed in Table 4. This survey design provides valuable insights into the industry’s status and trends.

As in Table 4, that by 2016 Anhui Province had successfully established a remarkable 5800 Provincial National Fitness demonstration morning exercise points. To delve into this further, this study conducted observations at 59 national fitness morning exercise points located in Bozhou, Bengbu, Hefei, and Huangshan within Anhui Province. The selection process involved random sampling. The findings from this investigation uncovered compelling insights. Notably, the data indicated that the likelihood of individuals engaging in Wushu practice at the selected morning exercise points from Bozhou, Bengbu, and Huangshan stood at an impressive 100 %. Moreover, the overall probability of participating in Wushu practice at these national fitness morning exercise points reached an impressive 96.67 %.

These findings underscore the increasing significance of fitness programs among the populace in Anhui Province, as elucidated in Fig. 9. This research design allows us to grasp the evolving fitness landscape in the region effectively.

As shown in Fig. 9: This paper investigates the morning exercise points in communities, squares, parks and other places in four cities of Anhui Province. It is found that healthy Taijiquan and traditional Wushu are the first candidates for fitness projects, with a probability of 51.49 %. In addition, middle-aged and elderly people would first choose Taijiquan as a fitness method. Taijiquan is characterized by weak antagonism and less exercise. Most young people choose Sanda or traditional Wushu, which are popular among young people because of their strong antagonism and high intensity.

The development of Wushu cultural tourism:

Anhui Province boasts a wealth of renowned tourist attractions, including the picturesque Huangshan Mountain and the sacred Jiuhua Mountain. The province also enjoys a bountiful reserve of Wushu resources distributed across its nine distinct regions. This includes the northern, southern, and southeastern areas of the province, which collectively foster a fertile ground for industrial integration. This synergy has given rise to the “Wushu + tourism” initiative. As a means to bolster the local economy, provincial authorities have adeptly intertwined Wushu events with the abundant local tourism resources.

To delve into the economic impact of Wushu tourism in the region, this study embarked on a comprehensive analysis of the relevant income data from 2014 to 2019. The insights gleaned from this examination are visually depicted in Fig. 10. This research design skillfully incorporates sampling techniques to provide a robust understanding of the dynamics between Wushu and tourism in Anhui Province.

As shown in Fig. 10, the sixth World Wushu Championship was held in Jiuhua Mountain, Anhui Province in 2014, with a related income of 170 million yuan. It can be seen that Wushu tourism in Anhui Province is very popular and developing rapidly every year.

Wushu training industry is one of the important pillar industries of Wushu industry [23]. It can not only cultivate and expand the population of Wushu, but also directly create economic benefits. The Wushu training industry in Anhui Province is dominated by martial arts schools and other training institutions. Wushu training industry mainly includes all kinds of training including Sanda, routine and skill, mainly technical training. It trains all kinds of Wushu talents. The development of Wushu training industry is shown in Table 5.

Table 5 provides a comprehensive overview of the burgeoning landscape of Wushu organizations within Anhui Province. These organizations span a spectrum of entities, including Wushu schools, educational institutions, training classes, clubs, boxing clubs, and research associations. Notably, the proliferation of Wushu schools stands out, with the province boasting more than 437 officially registered Wushu schools as of 2019. This robust growth within the Wushu training industry has been instrumental in nurturing a cadre of talented individuals who contribute to the advancement of Wushu in Anhui Province.

Drawing from the findings of this investigation, it is evident that the Wushu industry in the province has cultivated a thriving market across various domains, encompassing Wushu fitness and entertainment, competitive performances, cultural tourism, Wushu training, Wushu supplies, and Wushu media. The concerted efforts in these sectors have yielded commendable results, setting the stage for further developments.

Table 4
Development of national fitness Wushu in Anhui Province.

city	National fitness morning exercise point	Wushu Program	Percentage%
Bozhou	10	10	100 %
Bengbu	7	7	100 %
Hefei	8	7	87.5 %
Huangshan	5	5	100 %

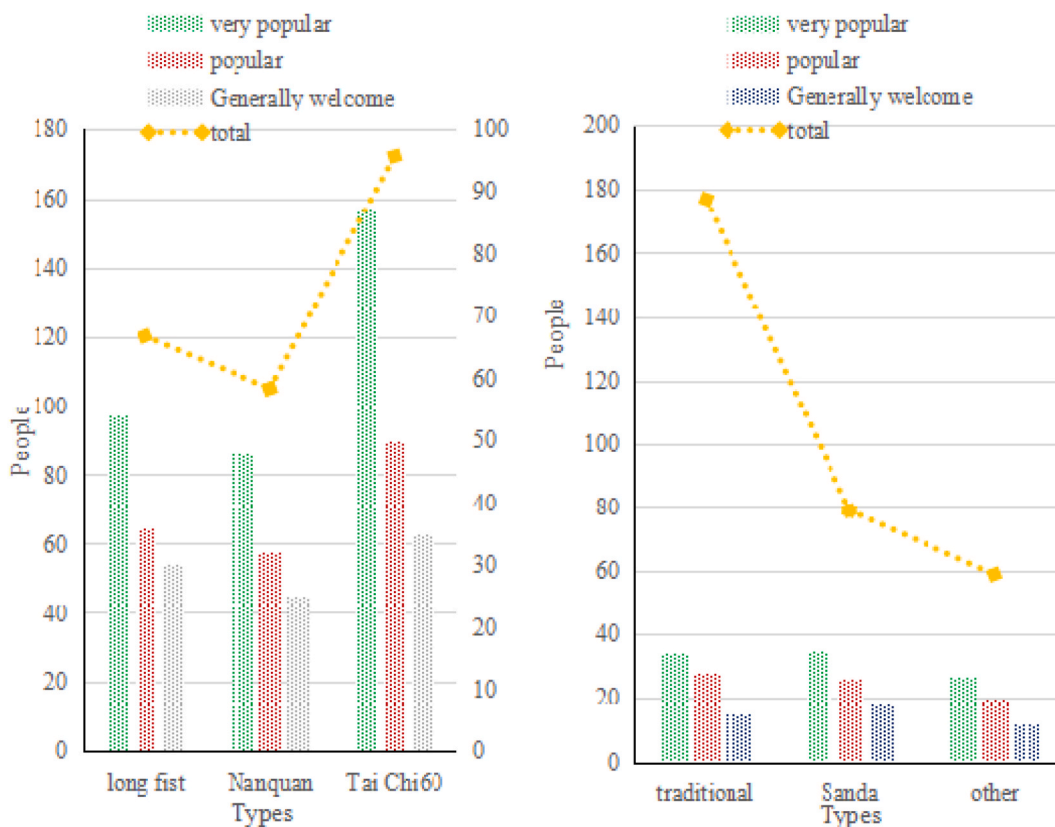


Fig. 9. Selection of fitness items in national fitness morning exercise points in Anhui Province.

In summation, the practice of martial arts in Anhui Province enjoys a broad and enthusiastic following, underscoring its substantial market potential and mass appeal. It possesses the prerequisites to emerge as a pivotal player in the realm of sports industrialization. However, it is important to acknowledge that many grassroots Wushu managers and practitioners maintain a somewhat narrow perspective regarding Wushu industrialization. The industry faces a shortage of adept management and skilled professionals. Additionally, conservative management philosophies and a lack of data-driven strategic decision-making have hindered the pace of industrialization. The study leveraged robust data collection techniques and advanced data analysis methods to discern these key insights. In light of current favorable national policies and the unique advantages of martial arts, there exists an opportunity to harness this potential fully. By advocating for the promotion and popularization of Wushu, the industry can steer the course towards a fashion-forward, consumer-guided Wushu culture. This proactive approach aims to foster the healthy evolution of the Wushu industry, aligning with the national PPP project and embracing an integrated economic paradigm reflective of the new era's ideology.

4. Conclusion

As the bearer of China's profound history and culture, Wushu should be a part of the development of China's cultural undertakings. In view of the rapid and mature development of cultural industry, Wushu should reasonably learn from its development experience. It breaks the confinement of the traditional development model and cultivates its own industrial integration attribute. Through the combination of tradition and modernity, it contributes to the rapid development of the country. Due to its rich Wushu resources and long Wushu history, Anhui Province has more and more research on the development of Wushu cultural industry. However, with the development of the Internet of things, the development of traditional Wushu cultural industry can't keep up with the pace of the times. Therefore, based on the Internet of things technology, this paper put forward the combination of SWOT qualitative analysis and analytic hierarchy process (AHP). It makes a reasonable evaluation on the development of Wushu cultural industry in Anhui Province. The results show that the development of Wushu cultural industry in Anhui Province meets people's needs. In the experimental part, the development of Wushu cultural industry in Anhui Province is investigated. This paper found that Wushu cultural industry in Anhui Province can be developed into Wushu fitness and cultural tourism. It is also conducive to driving the economic development of Anhui Province and introduces a pioneering blend of theoretical insights from Wushu culture and Internet of Things (IoT) technology within the context of Anhui province. It introduces the SWOT-AHP quantitative analysis algorithm, shedding light on its profound impact on evaluators assessing the development of the Wushu culture industry in Anhui province. Additionally, the study thoroughly investigates and dissects the evolving landscape of the Wushu culture industry in this region, revealing promising growth facilitated by IoT support.

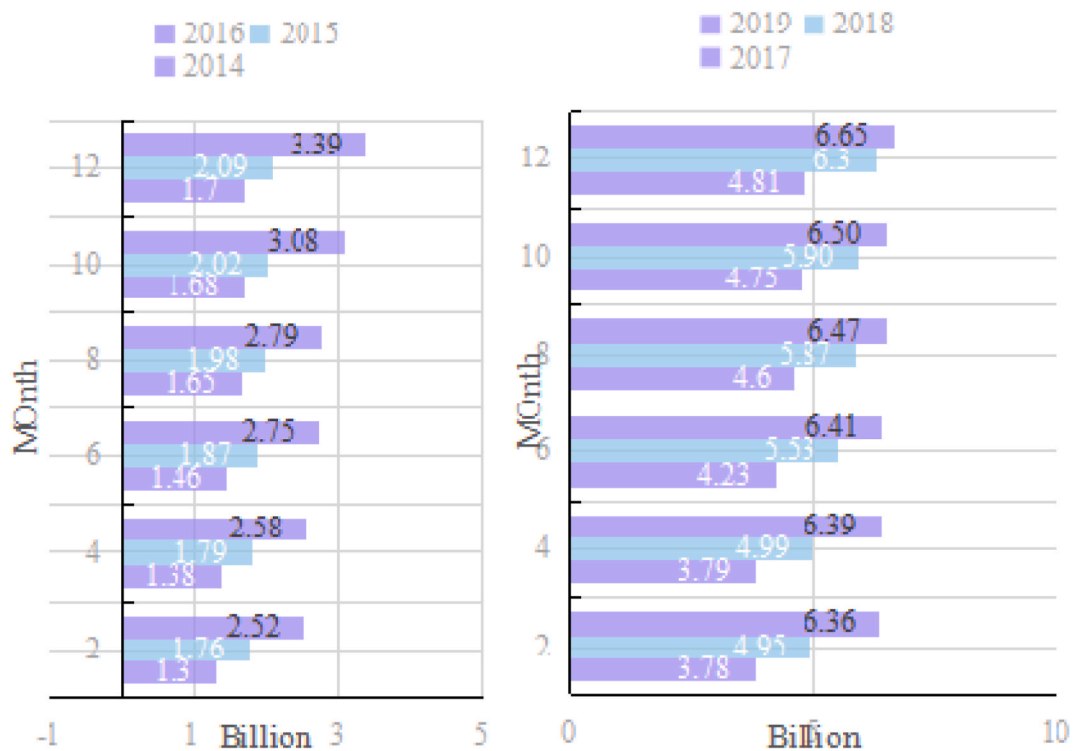


Fig. 10. Related income of Wushu tourism in Anhui Province from 2014 to 2019.

Table 5
Development of Wushu training industry in Anhui Province.

Year	Wushu hall	Training course	Club	Boxing club
2016	267	187	265	121
2017	308	207	269	135
2018	365	231	278	165
2019	437	246	284	189

However, it’s important to acknowledge the limitations of this research. While it explores the influence of Wushu culture, it does not delve deeper into its broader role within the social and economic industry chain. Furthermore, opportunities for synergizing Wushu with other industries and enhancing the overall Wushu industrial ecosystem remain unexplored. In the future, this paper aims to delve into the marketing landscape of Anhui’s Wushu industry and strategically optimize its positioning and development to fully harness its potential.

Data availability statement

The data that support the research findings are available on request.

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CRedit authorship contribution statement

Sile Wang: Writing – review & editing, Writing – original draft, Data curation. **Yun Chen:** Writing – review & editing, Investigation, Data curation. **Dong Liang:** Resources, Investigation, Data curation. **Liyan Zhang:** Writing – review & editing, Investigation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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