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Research on Green Development Evaluation of Civil Aviation Airports in China based on SWOT-AHP Analysis

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Abstract

Aiming at the problem of green development of civil aviation airports in China, this paper makes a qualitative analysis of their development strategy by using SWOT analysis method, then constructs a judgment matrix for influencing factors by using AHP analysis method, calculates the weight, and finally carries out consistency test. On this basis, the strategic quadrilateral is obtained by coordinate method. It is concluded that under the existing airspace conditions, the green development of China's civil aviation airports should focus on the growth strategy (SO). Select the optimization strategy, then make a strategic positioning and strategic choice for the green development of China's civil aviation airports, and finally give the strategic implementation countermeasures. Therefore, the research of this paper can promote the green development of civil aviation airports in China to a certain extent.

Keywords

Civil Aviation; Airport; Green Development; SWOT Model; Analytic Hierarchy Process.

1. The Introduction

Entering the 14th Five-Year Plan and the second Centenary Goal, China's civil aviation has embarked on a new journey of high-quality development and building itself into a strong civil aviation country in various fields [1].In September 2020, General Secretary Kohei presented his views on " Carbon dioxide emissions will peak by 2030, and efforts will be made to achieve carbon neutrality by 2060 " at the General debate of the Seventy-fifth session of the United Nations General Assembly[2]. As an important infrastructure of air transportation system, airport is not only an important node in air transportation network and an important infrastructure for regional economic development, but also the growth point of urban and regional economy and the pillar of diversified society [3].The basic concept and goal of the development of civil aviation airports in China are to build green development of civil aviation airports in China, improve service guarantee ability, promote new technological progress and energy saving and emission reduction. Therefore, establishing a comprehensive, effective and feasible evaluation system of civil aviation airport can provide decision-making and reference basis for the green development scheme of civil aviation airport in China. However, the advantage of green development of civil aviation airport has not been fully displayed, can not meet the needs of rapid economic development of our country. This article uses SWOT theory to construct the green development of Chinese civil aviation airport in four dimensions: internal strengths, internal weaknesses, external opportunities and external challenges and 14 indicators. The analytic hierarchy process (AHP) is used to determine the weight of each index; Finally, based on the results of AHP-SWOT analysis, the strategic quadrilateral is constructed, the optimization strategy is selected, and the corresponding suggestions are put forward.

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2. SWOT Analysis of Green Development of Civil Aviation Airport in China

2.1 Green Development of Foreign Airports

As of December 2019, Chicago O 'Hare International Airport and Chicago Midway International Airport have used the Sustainable Airport Handbook to rate 127 projects, including air traffic control towers, airport runways, and more, during the design and construction phase of green airports. In continental Europe, the Paris Regional Urban Planning and Development Authority launched the "Sustainable Airport Region" initiative in 2015 and published the "Guide for Decision-Makers in the Field of Sustainable Airports" in 2018. [4] In 2014, the Airport Operators Association of the UK presented the achievements of Heathrow Airport and Manchester Airport in limiting carbon emissions and reducing noise in Sustainable Airports: Improving the Environmental Impact of the Global Gateway of the UK, and made carbon emission reduction plans for 2030 and 2050 [5]. The research on sustainable development of airports abroad mainly involves economy, environment and resources.

2.2 Green Development of Chinese Civil Aviation Airport

In 2020, CAAC issued the Action Outline for Promoting the Construction of Type IV Airports (2020-2035) (hereinafter referred to as the Outline). In the chapter on Green airports in the Outline, China defined green airports as "airports that achieve resource intensive conservation, low-carbon operation and environmental friendly in the whole life cycle" [4]. Meanwhile, in 2020, China formally put forward the ambitious goal of reaching a peak in carbon dioxide emissions before 2030 and striving to achieve carbon neutrality by 2060. Civil aviation airports in our country should seize the opportunity, analyze its characteristics, advantages and disadvantages in detail, and realize the benchmark airport to lead the development of world airports, which will provide important support for the construction of civil aviation power in all aspects.

2.3 Analysis of Evaluation Index System of Civil Aviation Airport Development in China

Civil aviation transportation has characteristics of high speed, high efficiency, safety and comfort, and as an important part of civil aviation transportation system, it plays an important role in promoting the rapid development of Chinese civil aviation transportation system. Therefore, the reasonable, efficient and feasible evaluation method can promote the rapid development of civil aviation airport in China. Based on the concept of sustainable development, Shen Ruina and Fan Chongjun studied and designed the environmental assessment standard and index system of civil aviation airport [6]. Wang Mengli, Nie Runtu and Zhang Zhaoning comprehensively evaluated the operation efficiency of airport control system by data envelopment analysis [7].Liu Hao, Li Yanjun, Cao Yuyuan and Yang Juzi used analytic hierarchy process to evaluate the airport operation efficiency [8].

2.4 SWOT Matrix of Green Development of Civil Aviation Airport in China

SWOT analysis was first put forward in the 1970s. At that time, it could only measure the number of factors in the pros and cons, and would not guide enterprises to make any strategic decisions. In 1971, Andrews put forward the concept of SWOT analysis for the first time in his book The Concept of Enterprise Strategy, which is to analyze the enterprise itself and the external environment under certain market competition conditions. In SWOT analysis, SWOT refers to strengths, weaknesses, opportunities and threats. On this basis, the internal resources and external conditions of the enterprise should be organically integrated to make full use of their own advantages to seize opportunities and minimize disadvantages and threats, so as to guide the enterprise to formulate effective decision-making strategies. [9-10]. The theoretical model adopted is shown in Table 1.

Therefore, this article establishes its development matrix according to the green development demand of our civil aviation airport. The SWOT model is evaluated in four aspects, and its advantages are determined as follows: national policy support, large potential market demand, gradually sound industrial chain development and green development opportunity. Its disadvantages are as follows: the cooperative development mechanism is not perfect, the infrastructure construction lags behind, the layout of civil aviation industry is not complete, and the operation and management of civil

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aviation airports are weak. Its development opportunities include: double carbon development demand, industry development demand, passenger consumption demand. The main threats include: underdevelopment of potential, competition from other means of transport, environmental pollution impact.

Table 1. theoretical model

	Strengths	Weaknesses
Opportunities	S-O Growth oriented strategy	W-O Torsion type strategy
	Rely on internal strengths	Take advantage of external opportunities
	Take advantage of external opportunities	Internal Disadvantage of Customer service
Threats	S-T Strategy of diversification	W-T Strategy of defense
	Rely on internal strengths	Reduce internal disadvantages
	Avoiding external threats	Avoiding external threats

3. The Application of Analytic Hierarchy Process in SWOT analysis

The Analytic Hierarchy Process (AHP) is a systematic analysis method proposed by the famous American operations research scholar T.L.Saaty in the mid-1970s [11].He pointed out that analytic hierarchy process (AHP) is a systematic and hierarchical analysis method for research objects, which has the characteristics of combining qualitative analysis with quantitative analysis. The application steps of analytic hierarchy process in SWOT analysis are as follows:

Step 1: Conduct a SWOT analysis.

Step 2: Build the model and calculate.

Step 3: Pairwise comparison of SWOT elements and SWOT groups to establish a judgment matrix. In this paper, the AHP method is set up with six different judgment levels, which are equally important, slightly important, important, strong important, strong important and extremely important, as shown in Table 2.

Table 2. Index range of values

A is no less important than B	a:b=1
A is slightly more important than B	a:b=1.0~1.5
A is more important than B	a:b=1.5~2.0
A is important than B (slightly)	a:b=2.0~4.0
A is important than B (normally)	a:b=4.0~6.0
A is important than B (strongly)	a:b>6

If groups A and B have the same grade as groups B and C, it can be concluded that groups A and C have the same grade nature. However, if the comparison grade of a to B and B to C is known, it can be deduced that the comparison grade of a to C is transitive. After the experts judge the importance of the research object, the following comparative judgment matrix will be generated:

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$$B = (b_{ij})_{n\times n} = \begin{bmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{n1} & \cdots & b_{nn} \end{bmatrix}$$

Where, B_i is the evaluation target factor of the current layer, and b_{ij} is the importance degree of B_i relative to B_{ij}.

Step 4: Calculate the weight coefficient of each influencing factor and check the consistency.

(1) Calculate the weight coefficient

Let's multiply our judgment matrix B by rows:

$$\overrightarrow{W_i} = \prod_{i=1}^{n} b_{ij}\ (i = 1,2,\cdots,n) \tag{1}$$

Where, N is the order of the matrix.

Multiply by rows to the n power:

$$\overrightarrow{W_i} = \sqrt[n]{\prod_{i=1}^{n} b_{ij}}\ (i = 1,2,\cdots,n) \tag{2}$$

Normalization was performed:

$$\overrightarrow{W_i} = \frac{\overrightarrow{W_i}}{\sum_{j-1}^{n} \overrightarrow{W_i}} (j = 1,2,\cdots,n) \tag{3}$$

You get the final weight vector:

$$W = (W_1, W_2, \cdots, W_n)^T \tag{4}$$

Where, W_i is the weight value of the desired index.

Conduct a consistency check. After the weight vector is calculated, the consistency test of the judgment matrix is needed to ensure the rationality and accuracy of the weight value obtained.

(2) Find the maximum eigenroot of the judgment matrix λ_{max}

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{(BW)_i}{W_i} \tag{5}$$

Where, n is the order of the matrix, and W_i is the weight value of the index to obtain the maximum characteristic root of the judgment matrix

(3) In the formula of the consistency evaluation index, n is the order of the matrix, and W_i is the weight value of the index to obtain the maximum characteristic root of the judgment matrix $C.I.$

$$C.I. = \frac{\lambda_{max} - n}{n-1} \tag{6}$$

(4) Calculate consistency ratio

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$$\mathrm{C.R.} = \frac{\mathrm{C.I.}}{R.I.} \tag{7}$$

Where, R.I. is the average random consistency index

If the value of C.R. is less than 10%, it can be considered that the comparative judgment matrix has good consistency, and the conclusion drawn by analytic hierarchy process has certain rationality and correctness, that is to say, the decision-maker's thinking at all levels is consistent. If the calculated C.R. value is greater than 10%, the judgment matrix needs to be readjust. The average random consistency index is shown in Table 3, and R.I. is the average random consistency index.

Table 3. The mean random consistency index $R.I.$

The matrix order	1	2	3	4	5	6	7	8	9
$R.I.$	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.46

Step 5: Make a comprehensive analysis of the calculation results, find out the most critical factors affecting the research object, as the basis for decision-making; At the same time, the strategy is analyzed to find the optimal solution.

4. Instance Analysis

Using SWOT analysis method and analytic hierarchy process, the green development of civil aviation airport in China is analyzed.

4.1 SWOT Analysis

Table 4. SWOT Analysis of green development of civil aviation airport in China

advantage (S)	disadvantage (W)
National policy support (S_1) Large potential market demand (S_2) The industrial chain has been gradually improved (S_3) Green development Opportunity (S_4)	The mechanism of coordinated development is not sound (W_1) Infrastructure construction lags behind (W_2) The industrial layout is incomplete (W_3) Airport operation management is weak (W_4)
opportunity (O)	threat (T)
Double carbon development needs (O_1) Industry development needs (O_2) Passenger consumption demand (O_3)	Not enough potential (T_1) Competition from other means of transportation (T_2) Impact of environmental pollution (T_3)

4.2 Build the Model and Calculate

According to Table 4 of the SWOT analysis of green development of civil aviation airport in China, the hierarchy model of key elements selection is constructed, and the AHP method is used to calculate.

(1) Through questionnaire survey and evaluation by several experts, each factor in the group is assigned according to the importance degree, and the judgment matrix B between the criterion layer and the target layer is obtained, as shown in Table 5. Table 6-9 shows the judgment matrix of each criterion layer.

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Table 5. The Judgement Matrix and Its Weight of Criterion Layer to Target Layer

	B_1	B_2	B_3	B_4	weight
B_1	1	1/2	1	3	0.2395
B_2	2	1	2	4	0.4328
B_3	1	1/2	1	3	0.2395
B_4	1/3	1/4	1/3	1	0.0883

λ_{max}=3.0758, C. I.=0.0253, R. I.=0.09, C. R.=0.0281<0.1, The matrix can be judged to satisfy the consistency.

Table 6. The judgment matrix and equivalent weighting of advantage

S	B_1	B_2	B_3	B_4	weight
S_1	1	5	7	3	0.584
S_2	1/5	1	3	2	0.1909
S_3	1/7	1/3	1	1/4	0.0603
S_4	1/3	1/2	4	1	0.1648

λ_{max}=4.2091, C. I.=0.0697, R. I.=0.90, C. R.=0.0774<0.1,The matrix can be judged to satisfy the consistency.

Table 7. The judgment matrix and equivalent weighting of Weaknesses

W	B_1	B_2	B_3	B_4	weight
W_1	1	1/2	2	3	0.2856
W_2	2	1	2	4	0.434
W_3	1/2	1/2	1	2	0.1825
W_4	1/3	1/4	1/2	1	0.098

λ_{max}=4.0458, C. I.=0.0153, R. I.=0.90, C. R.=0.017<0.1,The matrix can be judged to satisfy the consistency.

Table 8. The judgment matrix and equivalent weighting of Opportunities

O	B_1	B_2	B_3	weight
O_1	1	2	4	0.5584
O_2	1/2	1	3	0.3196
O_3	1/4	1/3	1	0.122

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λ_{max}=3.0182, C. I.=0.0091, R. I.=0.58, C. R.=0.0157<0.1,The matrix can be judged to satisfy the consistency.

Table 9. The judgment matrix and equivalent weighting of Threats

T	B_1	B_2	B_3	weight
T_1	1	1/5	1/4	0.0955
T_2	5	1	5/2	0.6014
T_3	4	2/5	1	0.3482

λ_{max}=3.0667, C. I.=0.0334, R. I.=0.58, C. R.=0.0576<0.1,The matrix can be judged to satisfy the consistency.

4.3 Hierarchical Total Order

The results of each single ranking are used for hierarchical total ranking, and the relative plotted evaluation weights of each evaluation index can be obtained. The ranking results are shown in Table 10.

Table 10. Sort results

criterion layer	B_1	B_2	B_3	B_4	The weight of each index relative to the total target
	0.2395	0.4328	0.2395	0.0883	
S_1	0.584				0.1399
S_2	0.1909				0.0457
S_3	0.0603				0.0144
S_4	0.1648				0.0395
W_1		0.2856			0.1236
W_2		0.434			0.1878
W_3		0.1825			0.0790
W_4		0.098			0.0424
O_1			0.5584		0.1337
O_2			0.3196		0.0765
O_3			0.122		0.0292
T_1				0.0955	0.0084
T_2				0.6014	0.0531
T_3				0.3482	0.0307

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4.4 SWOT Strategic Choice

According to Table 10, the maximum weight in the total ranking is selected, that is, the maximum weight is marked in the SWOT analysis chart respectively, and the quadrilateral is connected in order, as shown in Figure 1.

According to Table 10, the maximum weight in the total ranking is selected, namely S_1= 0.1399, W_2= 0.1878, O_1= 0.1337, T_2= 0.0531, and the maximum weight is marked in the SWOT analysis chart respectively, and the quadricle is connected in order, as shown in Figure 1.

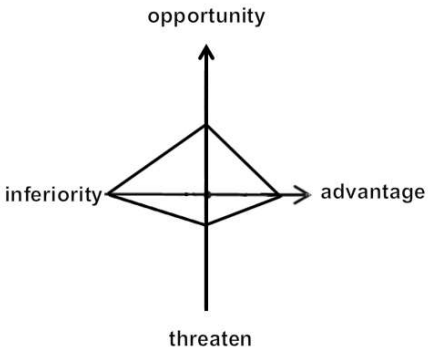

Figure 1. The SWOT analysis of green navigation development in western China

Calculation shows that $\mathrm{P(X,Y)} = (-0.0120, 0.0202)$ falls in the first quadrant. Therefore, our green development of civil aviation airport chooses the SO growth strategy. It is important to promote the green development of civil aviation airport to grasp and implement the corresponding strategies accurately in different circumstances, rely on internal advantages and play external opportunities.

5. Conclusion

In this paper, the SWOT-AHP analysis method is used to comprehensively evaluate the green development of civil aviation airport in China. Based on the above analysis, corresponding countermeasures and suggestions are given.

5.1 To Improve the Top-level Design of Green Airports and Strengthen Long-term Planning

With the civil aviation administration of strengthen the guidance of civil transport airport master plan "as an opportunity, in accordance with the" overall planning and coordinated development ", "security as the base, efficiency first", "people-oriented, green development", the basic principle of "innovation drive, wisdom leads", according to economic development and industrial structure of regional characteristics, We will optimize the planning and layout of civil aviation airports and surrounding Spaces in a unified manner, laying the foundation for airport construction to take the lead in realizing the goal of becoming a transportation power.

5.2 Build a Good Green Airport System Engineering, Expand the Industrial Chain

With the economic globalization and market integration, the role of civil aviation airport is becoming more and more obvious, and its function also radiates to the related industries related to aviation, and forms a huge industrial chain with it. Centering on the aviation industry chain, vigorously layout aviation R&D and manufacturing, air transportation, aviation maintenance, aviation training, aviation logistics and other related industries; Under the background of national implementation of "carbon emissions, carbon neutralization", our country has rich solar energy, wind energy and other resources, suitable for the development of new energy aircraft, realize green development of aviation, gradually realize zero carbon emissions. At the same time, it will promote the coupled development of aviation industry and regional economy, break the limitations of aviation industry, take the road of

characteristic civil aviation development, and promote the development of tourism, logistics, finance and other related industries.

5.3 Do a Good Job of Multi-dimensional Talents to Participate in the Operation of Green Airport, and Create an Engine Highland

The airport is an important part of the transportation system. In the long run, we should promote the construction of civil aviation talents engineering, and increase the training of professionals in flight, aircraft management, air traffic control and so on. It is necessary to encourage qualified colleges AND educational institutions not directly under CAAC to open relevant majors and train civil aviation professionals. At the same time, an open and effective CIVIL aviation personnel training, introduction, use, evaluation and incentive mechanism should be established, and a preferential policy should be adopted for the salary and treatment of professional and technical personnel in civil aviation administrative institutions, so as to stabilize the civil aviation professional personnel team. The implementation of collaborative development strategy of civil aviation airport is conducive to the globalization effect of resource element allocation. According to the present stage of economic development, resources and environmental constraints and social development level, we should give full play to comparative advantages of civil aviation airports, and do more to strengthen civil aviation industry, promote relevant industries into global industrial chain and industrial division system, attract multi-dimensional talents to participate in green airport operation, and build engine heights. Do a good job of multi-dimensional talents to participate in the operation of green airport, and create an engine highland.

5.4 We Will Achieve Synergistic Connectivity and Enhance the Development of Innovative Institutions and Mechanisms

To "building big hub, the development of industry, to extend the chain and realize the integration" as the goal, combining with the characteristics of China's civil aviation airport, improve the network coverage, constantly strengthen the "air + + inter-city high-speed railway + + metro" multimodal transport integrated transport hub, enlarge civil aviation airport cluster advantages, realize the complementary advantages, mutual benefit and win-win progress and coordinated development between the airport. At the same time, taking a new road of development driven by system and innovation and creating a good market atmosphere and system guarantee for the aviation industry can mobilize all forces to truly integrate into the synergy strategy and effectively improve the overall competitiveness of civil aviation airports in China.

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