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Research on Quality Performance Evaluation of General Aviation Industry Policy Effectiveness Based on Grey Relational Analysis

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Abstract. Based on the operational characteristics of the general aviation industry, this dissertation builds a systematic and perfect index system of general aviation industry policy effectiveness and quality performance evaluation, and evaluates the effectiveness quality of general aviation industry policy by using the multi objective comprehensive evaluation method of grey correlation degree, according to the results of the assessment, the effectiveness of the general aviation industry policy quality analysis. It provides a basis for policy making of general aviation industry.

1. Introduction

Since the country has promoted the development of the general aviation industry to the national strategy, the State Council, national ministries and commissions, the Civil Aviation Administration, and local governments have introduced policies to promote the development of the general aviation industry that have reached as many as hundreds. What kind of role these policies play in the general aviation industry, how effective the implementation is, and whether it is consistent with the structural reform of supply side of general aviation industry development under the “new era” is a problem that we must face and think about. The paper aims at the various general aviation industry policies promulgated by China at the present stage, and builds a comprehensive system of sound general performance indicators for the evaluation of general aviation industry policies based on the characteristics of general aviation industry operation, and adopts a grey correlation degree multi-objective comprehensive evaluation method for general aviation industry policy effectiveness. The evaluation results are systematically analyzed in five aspects, such as industrial development scale data, industrial development economic data, industrial security level data, industrial development factor quality, and other related industries integration effect, in order to provide ideas and basis for the future adjustment of general aviation industry policy in China.

2. Establishment of General Aviation Industry Policy Achievements Quality Performance Evaluation Index System

To build a quality assessment index system for general aviation industry policy effectiveness, it is actually to use specific indicators to describe quantitative and qualitative results of general aviation industry policy effectiveness and quality. Each indicator in the indicator system is used as a “perspective” to measure the quality of policies. Through the cooperation between indicators, the operational status of policies can become “visible” and “feeling” things, so that the aviation industry



policy operation status is monitored accurately and timely. General aviation industry policy effectiveness quality performance evaluation index system construction includes the preliminary design of the evaluation index system, the empirical screening of evaluation indicators, the reliability and validity of the evaluation index system, which are not repeated here. After the above steps, the quality assessment index system for general aviation industry policy effectiveness as shown in Table 1 is obtained.

Table 1. General aviation industry policy achievements quality assessment indicator system

first-level index	second-level index	third-level index
Quality of policy effectiveness	Industrial Development Scale Data	General aviation production operation flight time
		General aviation fleet size
		Number of General Aviation Operators
		General aviation pilots
	Industrial Development Economic Data	Total civil aviation industry profits
		Operating marginal output/input ratio
	Industrial safety data	Accident rate
		Fatal accident rate
	Policy object satisfaction	Satisfaction of policy quality
		Satisfaction of policy service quality
		Satisfaction of policy results
		Expected goal to achieve satisfaction
		Special fund allocation effect satisfaction
		General aviation industry is concerned

3. Gray correlation degree multi-objective comprehensive evaluation procedure

3.1. Building an indicator matrix

Suppose there are m years of aviation industry policy to be evaluated, there are n evaluation indicators, and the structural index matrix $B = (b_{ij})_{n \times (m+1)}$, b_{ij} ($i=1,2,\dots,n$; $j=0,1,2,\dots,m$), The evaluation value of the i -th index of the j -th year. Among them, the first column is the reference sequence B_0 , that is, B_0 , B_{20} , ..., B_{n0} respectively represent ideal evaluation values among the n evaluation indexes.

$$B = \begin{bmatrix} b_{10} & b_{11} & \cdots & b_{1m} \\ \vdots & \vdots & \cdots & \vdots \\ b_{n0} & b_{n1} & \cdots & b_{nm} \end{bmatrix} = (B_0, B_1, \dots, B_m) \quad (1)$$

3.2. Non-dimensional treatment of index matrix

Since each indicator's meaning, unit, magnitude, etc. are different and qualitative and quantitative indicators coexist, the index matrix B needs to be dimensionlessly processed to obtain the matrix $R = (r_{ij})_{n \times m} = (R_0, R_1, \dots, R_m)$. Where R_0 is the reference sequence, $R_0 = (r_{10}, r_{20}, \dots, r_{n0})^T$, R_i is the comparison sequence, $R_i = (r_{1i}, r_{2i}, \dots, r_{ni})^T$,

$$r_{ij} = \frac{b_{ij}}{\frac{1}{n} \sum_{i=1}^n b_{ij}} \quad (2)$$

3.3. Determining Difference Sequences, Maximum Differences, and Minimum Differences

Calculate the corresponding absolute difference between the reference sequence R_0 and other columns of the comparison sequence R_i to obtain an absolute difference matrix.

$$D = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ \vdots & \vdots & \vdots & \vdots \\ d_{n1} & d_{n2} & \cdots & d_{nm} \end{bmatrix} \quad (3)$$

Where, $d_{ij} = |r_{i0} - r_{ij}|$, the maximum and minimum numbers in the absolute difference matrix are the minimum difference between the maximum difference $d_{\max}$ and $d_{\min}$, respectively.

3.4. Calculating the Correlation Coefficient Matrix

The data in the absolute difference matrix D is transformed as follows:

$$\eta_{ij} = \frac{d_{\min} + \lambda d_{\max}}{d_{ij} + \lambda d_{\max}} \quad (4)$$

Get the correlation coefficient matrix S .

$$S = \begin{bmatrix} \eta_{11} & \eta_{12} & \cdots & \eta_{1m} \\ \vdots & \vdots & \vdots & \vdots \\ \eta_{n1} & \eta_{n2} & \cdots & \eta_{nm} \end{bmatrix} \quad (5)$$

In the formula (4), λ is the resolution coefficient, and the value range is 0~1. The smaller λ is, the more the difference between the correlation coefficients can be increased. Therefore, the value is generally between 0.1 and 0.5. The correlation coefficient η_{ij} is a positive number not exceeding 1, and the smaller the d_{ij} , the larger the η_{ij} , which reflects the degree of association between the comparison sequence and the reference sequence.

3.5. Calculation Association Degree

The degree of correlation between the comparison sequence R_i and the reference sequence R_0 is reflected by n correlation coefficients and the average degree of correlation between R_i and R_0 can be obtained.

$$s_j = \frac{1}{n} \sum_{i=1}^n \eta_{ij}, \quad j = 1, 2, \dots, m \quad (6)$$

3.6. Comprehensive Evaluation

The correlation degree between the comparison sequence and the reference sequence is arranged from large to small. The greater the degree of association, the closer the comparison sequence is to the reference sequence. The greater the degree of relevance, the more close to the ideal states of the navigation industry policy of the year, the better the quality of the policy. On the contrary, the smaller the correlation degree values, the worse the policy quality, so as to achieve a comprehensive evaluation of the effectiveness of the navigation industry policy.

4. Comprehensive assessment of general aviation industry policy effectiveness based on grey correlation

This paper adopts the multi-objective comprehensive evaluation procedure of grey relational degree. The basic data is derived from "Seeing Civil Aviation from Statistics" and "General and small and medium-sized transport operation profiles" on the one hand; the other is the use of statistical data,

professional academic reports, and expert surveys. The government website was summarized and summarized. Some of the data were predicted values obtained using the prediction model. The relevant parameters are shown in Table 2.

Table 2. Development of the navigation industry in the past 5 years

Index years	ideal	2012	2013	2014	2015	2016
Annual growth rate of operational flight time	15%	2.8%	14.3%	14.2%	15.5%	-1.9%
Annual fleet growth rate	17.5%	17.4%	15.1%	18.4%	5.9%	10.1%
Annual growth rate of operating companies	18%	18.7%	29.5%	26.5%	17.6%	13.9%
The growth rate of pilots	20%	19.8%	66.6%	32.7%	29.2%	-10.8%
Operating marginal output/input ratio	1	0.05	0.58	0.03	0.45	0.07
Pulling effect on other industries	10	4	6	6	8	7
Civil Aviation Industry's Total Profit Growth Rate	13.5%	-18.5%	-16.2%	16.4%	68.9%	16.5%
Incident rate (per 100.000 flight hours)	0	0.189	1.692	0.589	1.155	1.308
Fatal Accident Rate (per 100.000 flight hours)	0	0.189	0.846	0.295	0.642	0.785
Expected goal to achieve satisfaction	10	8	8	6	7	8
Special fund allocation effect satisfaction	10	6	6	8	8	9
General aviation industry is concerned	10	5	5	7	8	9

In the above index data, the accident rate and fatal accident rate are the inverse indicators, that is, the greater the accident rate, the worse the industrial policy, so it will be treated as a positive one. Index data obtained after dimensionless.

$$R = (R_0, R_1, R_2, R_3, R_4, R_5)$$

$$= \begin{bmatrix} 0.0411 & 0.0130 & 0.0592 & 0.0566 & 0.0534 & -0.0064 \\ 0.0479 & 0.0809 & 0.0625 & 0.0733 & 0.0203 & 0.0341 \\ 0.0493 & 0.0869 & 0.1222 & 0.1056 & 0.0607 & 0.0469 \\ 0.0547 & 0.0920 & 0.2759 & 0.1304 & 0.1007 & -0.0364 \\ 0.2737 & 0.0232 & 0.2402 & 0.0120 & 0.1552 & 0.0236 \\ 2.7373 & 1.8592 & 2.4852 & 2.3918 & 2.7586 & 2.3608 \\ 0.0370 & -0.0860 & -0.0671 & 0.0654 & 0.2376 & 0.0556 \\ 0.2737 & 0.4639 & 0.4072 & 0.3963 & 0.3408 & 0.3328 \\ 0.2737 & 0.4639 & 0.4107 & 0.3975 & 0.3426 & 0.3346 \\ 2.7373 & 3.7183 & 3.3136 & 2.3918 & 2.4138 & 2.6981 \\ 2.7373 & 2.7888 & 2.4852 & 3.1890 & 2.7586 & 3.0353 \\ 2.7373 & 2.3240 & 2.0710 & 2.7904 & 2.7586 & 3.0353 \end{bmatrix}$$

According to formula (3), the absolute difference matrix D is obtained by using the absolute value of the difference between the reference sequence and the comparison sequence.

$$D = \begin{bmatrix} 0.0281 & 0.0181 & 0.0155 & 0.0123 & 0.0475 \\ 0.0330 & 0.0146 & 0.0254 & 0.0276 & 0.0138 \\ 0.0376 & 0.0729 & 0.0563 & 0.0114 & 0.0024 \\ 0.0373 & 0.2212 & 0.0757 & 0.0460 & 0.0911 \\ 0.2505 & 0.0335 & 0.2617 & 0.1185 & 0.2501 \\ 0.8781 & 0.2521 & 0.3455 & 0.0213 & 0.3765 \\ 0.1230 & 0.1041 & 0.0284 & 0.2006 & 0.0186 \\ 0.1902 & 0.1335 & 0.1238 & 0.0671 & 0.0591 \\ 0.1902 & 0.1370 & 0.1238 & 0.0689 & 0.0609 \\ 0.9810 & 0.5763 & 0.3455 & 0.3235 & 0.0392 \\ 0.0515 & 0.2521 & 0.4517 & 0.0213 & 0.2980 \\ 0.4133 & 0.6663 & 0.0531 & 0.0213 & 0.2980 \end{bmatrix}$$

From the absolute difference matrix D , it can be seen that the maximum difference $d_{\max} = 0.981$ and the minimum difference $d_{\min} = 0.0024$. Then according to formula (4), the correlation matrix S is calculated. The calculation resolution λ is 0.2.

$$S = \begin{bmatrix} 0.8854 & 0.9267 & 0.9381 & 0.9525 & 0.8149 \\ 0.8665 & 0.9421 & 0.8962 & 0.8874 & 0.9457 \\ 0.8494 & 0.7380 & 0.7865 & 0.9566 & 1.0000 \\ 0.8505 & 0.4758 & 0.7304 & 0.8200 & 0.6913 \\ 0.4446 & 0.8646 & 0.4337 & 0.6311 & 0.4450 \\ 0.1849 & 0.4430 & 0.3666 & 0.9131 & 0.3468 \\ 0.6222 & 0.6613 & 0.8842 & 0.5005 & 0.9246 \\ 0.5140 & 0.6024 & 0.6206 & 0.7543 & 0.7779 \\ 0.5140 & 0.5960 & 0.6206 & 0.7492 & 0.7725 \\ 0.1687 & 0.2571 & 0.3666 & 0.3835 & 0.8437 \\ 0.8018 & 0.4430 & 0.3065 & 0.9131 & 0.4019 \\ 0.3258 & 0.2303 & 0.7966 & 0.9131 & 0.4019 \end{bmatrix}$$

Finally, the grey correlation degree is evaluated, and the gray correlation between the evaluation index and the ideal index value of each year's navigable industry is calculated according to formula (6), as shown in Table 3.

Table 3. Gray Association Degree Evaluation Results

year	2012	2013	2014	2015	2016
Relevance value	0.5857	0.5984	0.6456	0.7812	0.6972
Sorting	5	4	3	1	2

From Table 3, it can be seen that the gray correlation value for 2015 is 0.7812, which is the closest to the ideal value of industrial policy and is the optimal year for the effectiveness of the navigation industry policy. The grey relational degree value in 2012 is 0.5857. According to the correlation degree analysis, it is the worst year for policy effectiveness.

5. Analysis of general aviation industry policy effectiveness and quality performance

5.1. Analysis of Development Scale Data from General Aviation Industry

First of all, from the point of view of general aviation production and operation flight time, based on the increase in the fleet size and the number of general aviation operators, the flight operation time

does not have a positive growth trend. There is a significant step difference between the fleet size and the number of companies and the increase in the number of flights. At present, China's general aviation operations flight activities mainly center on traditional areas of service production, agriculture and forestry aviation operations, and industrial aviation operations. The emerging areas of general aviation flight operations, such as private flights, business aviation, flight performances, air tours, medical rescues, etc., are still in their infancy. The proportion of these operating flight activities in the entire general aviation operation flight is still rather small. This type of business is the main body of general aviation operations and the main source of revenue for general aviation operations.

Secondly, from the size of the general aviation fleet, the scale of China's general aviation fleet has shown positive growth from 2012 to 2016. In 2014, 2015 and 2016, the number of general aviation aircraft that China added to its airworthiness registration was 321, 260, and 369 respectively. Judging from this quantity, China's general industrial capacity growth has accelerated. However, judging from the type of general aircraft that China has delivered in recent years, China has the largest increase in the number of rotorcrafts in all types of general-purpose aircraft that are delivered and used. This shows that the take-off and landing site is still the bottleneck that affects and limits the development of China's general aviation industry. This also reflects that China's general aviation market is still entering a relatively mature stage.

Again, look at the number of general aviation enterprises. From 2012 to 2016, the number of newly established general aviation enterprises has seen a double-digit growth every year. The average growth rate of five-year general aviation enterprises has reached 21.2%. However, the number of general aviation enterprises that have logged out of the market each year is also increasing year by year. This shows that China's general aviation enterprises are still in a stage of blind growth, and all types of general aviation enterprises have yet to form a healthy development.

5.2. Analysis of Economic Data from Industrial Development

Judging from the marginal output/input ratio of general aviation industry operations, the marginal output/investment ratio of China's aviation operations for 2012-2016 was 0.05, 0.58, 0.03, 0.45, and 0.07 respectively. This data shows that the promotion of the general aviation industry to the economy in China is still in a relatively unstable state.

Judging from the operating benefits of general aviation listed companies, the overall average efficiency of general aviation listed companies in China has shown an overall upward trend in recent years, but the overall efficiency level is not high, there is a general lack of efficiency, and there is room for improvement in efficiency levels. The main reason for this status is caused by the common inefficiency of the purely technical efficiency of general aviation companies and the invalidity of scale efficiency.

Judging from the consumption capacity of the general aviation market, the "China Citizenship Development Report 2014" released by the China Social Science Survey Center of Peking University pointed out that the degree of inequality in Chinese family property is rapidly increasing, with the top 1% of households accounting for more than 30% of the country's total assets. The total assets owned by 25% of households are only 1.2%. Most residents and households do not have much income, and their disposable income is less. In the face of the general aviation market, it is not difficult to understand that their spending power is limited.

5.3. Analysis of Industrial Safety Level Data

Aviation safety is the core supply force of general aviation. The promulgation of the "Guidelines for Promoting the Development of the General Aviation Industry" by the General Office of the State Council in 2016 has opened up a new and vigorous development of the general aviation industry in China. In 2015, the fatal accident rate of China's general aviation was only 0.64 times/1000,000 hours. This accident rate is far lower than the fatal accident rate of 1.29 times/1000,000 hours in the United States. However, by 2016, China's general aviation accident rate has increased significantly. The prominent feature is that general aviation accidents not only occurred in newly established general

aviation companies, but also caused serious accidents in some large-scale, technically-advanced traditional general aviation companies. . The probability of industry safety accidents continues to rise, which poses even greater challenges to the development of the general aviation industry, which is already impoverished and weak.

5.4. Quality Analysis of Industrial Development Factors

First of all, judging from the construction of the general aviation industry legal system, China's current legislation for adjusting general aviation is only civil aviation law, and it only regulates general aviation activities in the form of Chapter 10 and a total of six. In terms of civil aviation administrative regulations, administrative regulations still remain at the principle level to promote the development of the general aviation industry. The safeguard measures are not clear and the detailed implementation rules need to be improved. There is no clear guiding guidance to guide the construction of local navigation policies and regulations; general aviation industry legislation Lagged behind the actual development needs of the general aviation industry. With the rapid development of the general aviation industry, new business, new situations and new problems have been brought into play. However, there are still legislative gaps in the management of these issues in general aviation related laws and regulations.

Secondly, from the point of view of general airport construction and operation management, the government level lacks scientificity in the planning, layout, and construction of the navigable airport and the function of the navigable airport are not clearly defined, and there is no need to adjust to it. This has caused repetitiveness and blindness in the navigable airport construction; More emphasis on the growth of the number of navigable airports, ignoring the operation and management of general aviation airports, and the lack of considerations on how to use existing general aviation airports to build general aviation flight networks, making the value of general aviation airports difficult to embody; The lack of a unified industry management document and full rules and regulations for general airport use licenses and safe operations, and the lack of an independent airport security management department cannot make reasonable use of, harmonize, and manage, resulting in wasted navigation resources; The development of general aviation airport security management information needs to be improved. General aviation airports lack a unified safety management information system to aggregate, count, and manage airport security information, analyze and effectively deal with potential security risks.

Again, from the point of view of the development of small and medium-sized general aviation companies, the small and medium-sized navigation companies have a weak foundation and low development quality. Most of them are at the low end of the value chain of the navigation industry, and their industrial structure is not excellent, and their added value is low; the barriers to market entry of high-level navigation companies are high, and the monopoly of the industry affects fair competition. In particular, national prefix navigation companies have natural advantages. They use their own resources to extend the business to competitive links, occupy a large number of navigation subsidies to gain competitive advantage, and become small and medium-sized general aviation companies. The important barriers for companies to enter the market; Small and medium-sized navigation companies have higher tax burdens, and the burden on enterprises is heavier. There are limited tax incentives for general aviation SMEs, and some tax exemptions have been found to be costly, which has resulted in substantial reductions in the effectiveness of implementation; The management philosophy of NMSs lags behind. Most small and medium-sized navigation companies do not have core technologies and do not have independent core brand businesses. The mode of growth is relatively extensive, and there is a serious lack of medium- and long-term planning. Even short-term or near-term work plans are too lax to formulate business strategies and emergencies. The plan and the early-warning system are even less talkable, causing the difficulty and risk of the company's operation to increase, making the market vitality of the enterprise seriously low.

Finally, judging from the quality of general aviation talents, the scale and quantity of high-skilled and innovative talents in the general aviation industry are insufficient. The shortage of new talents

with high-skilled innovation cannot meet the need for the development of the aviation industry and restrict the continuous development of the general aviation industry. The geographical distribution of various types of human resources in the general aviation industry is uneven. Most of them are concentrated in the developed areas of the general aviation industry in the eastern and central parts of the country. Talent resources in the less developed areas of the navigation industry in the west are less distributed. Small and medium-sized general aviation companies lack the strategic awareness of talents and strategic planning of talents, and lack the concept of developing talents, training talents, retaining talents and using talents, managing talents, and developing talents in an all-round way. Small and medium-sized general aviation companies have poor stability and total talent. There are few and serious losses. Some talented people who have mastered the company's core technology and business secrets, and talented people with special skills frequently make a career change, leading companies to face a survival crisis.

5.5. Analysis of the effect of integration of general aviation operations with other related industries

First, the general aviation industry development demonstration park has not yet been established, and there is still room for improvement in the construction of the general aviation industry chain in the park. The general aviation industry park has important practical significance for realizing the effective integration of some general aviation industries with other industries. At present, the homogeneity of industrial positioning in some general aviation industrial parks in China is serious, the industrial park structure converges, and the park profit model is single. Some of the navigation industry parks only pay attention to the number of enterprises and neglect the connection of industries, resulting in the introduction of similar companies. The same industry is scattered in various parks, and it is difficult to form an effective industrial chain; some navigable industrial parks are blindly seeking for perfection. From the start of general aircraft research and development to the implementation of full-value industrial chain layout, it is easy to create excess production surplus, which also easily leads to internal competition, which is detrimental to the sound development of the entire industry; some park profit models have been set irrationally. Many domestic navigable industrial parks are paying more attention to the general aviation manufacturing industry, making the manufacturing industry an important means of profitability in the park, and ignoring the important economic role of the general aviation operations sector. This profit model, once there are poor sales, there will be some restrictions on the sustainable income in the later stage of the park, affecting the long-term development of the park.

Second, the general aviation industry and tourism integration capabilities are weak. Navigation tourism is a major development direction of the future tourism industry and is one of the important means to improve the quality of industrial development. At present, the development of general aviation tourism products is still in its infancy, and a general aviation tourism service concept that can be used for reference has not yet formed. The general aviation tourism talents of various types are quite scarce, and do not match the urgent needs of the market. The service quality of the general aviation tourism market is seriously inadequate, and an adequate service system that can effectively promote the sustainable development of navigation culture tourism has not been formed.

Third, the degree of integration of general aviation and financial services is not high. The financial service security system that provides financing services for the development of the general aviation industry has not yet been institutionally established; the "private lending law" that has not yet standardized the financing of general aviation companies, and the scope of responsibility of various economic entities; and has not reduced the targeting of private capital formation. The threshold of financial institutions of small and medium-sized navigation companies makes it difficult for the medium and small-sized general aviation entities to obtain financial capital support.

Fourth, the integration of general aviation industry and technology service industry is not high. The ability of scientific and technological innovation is the core and cornerstone for promoting the transformation and upgrading of the general aviation industry and making it stronger and stronger. At present, the general aviation industry has not yet formed the model and mechanism for the development of industrial innovation in the science and technology service industry, and the

conversion rate of the general aviation science and technology achievement market has been low; A group of leading companies and service brands in the general aviation industry have not yet been formed. Various types of technological innovation platforms have not developed enough to the general aviation industry. The degree of production, education, and research is not deep enough, and collaborative innovation is not smooth.

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