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Research on the High-Quality Development of China's Airport Economy Based on the Perspective of Industrial Integration—Taking Aviation Logistics Industry and Advanced Manufacturing Industry as Examples

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Abstract: During the '14th Five-Year Plan' period, China has entered the key period of high-quality development, relying on the airport to optimize the industrial layout and accelerating the development of industrial integration have gradually become a new growth point of the airport economy. Aviation logistics industry and advanced manufacturing industry support and promote each other. Based on statistical data of China's aviation logistics industry and advanced manufacturing industry from 2012 to 2022, this paper constructs the evaluation index system of the two industries, uses entropy value method to determine the index weights, and measures the integration and development level of China's aviation logistics industry and advanced manufacturing industry according to the coupling coordination degree model. The results show that: the integration development of China's aviation logistics industry and advanced manufacturing industry is in a good state, and it has achieved high-quality and coordinated integration effect. Finally, this paper puts forward the countermeasures and suggestions to promote the integration and development of China's aviation logistics industry and advanced manufacturing industry.

1. Introduction

China's '14th Five-Year Plan' proposes to accelerate the construction of a strong manufacturing country, and to promote the deep integration of advanced manufacturing industry and modern service industry; The integration of advanced manufacturing and modern service industries can comply with the new round of scientific and technological revolution and industrial upgrading, enhance the core competitiveness of the manufacturing industry, cultivate a modern industrial system, and then achieve high-quality development. This provides an important opportunity and development platform for the transformation and upgrading of China's manufacturing industry and the high-quality development of civil aviation, especially aviation logistics.

China has entered a new stage of building a new development pattern, and both the logistics industry and the manufacturing industry are facing higher requirements. Relying on airports around

the country has been empowered to use the ‘airport-manufacturing’ system as an important growth point for high-quality economic development. In the context of China's industrial structure upgrading and high-quality development, aviation logistics industry and advanced manufacturing industry support and promote each other. It can be seen that promoting the deep integration of these two industries has significant economic significance.

2. Review of related research literature

Manufacturing and logistics are both important industries that support China's economic development, and they are closely related in the way of production activities. With the development of science and technology, relationship between industries becomes increasingly close. How to deeply embed the logistics industry in the manufacturing industry has become the key content of scholars to explore the integration of the two industries[1]. Gao Zhijun, Su Yongming, Qian Xuying et al. (2023) demonstrated the integration effect of the logistics industry and the manufacturing industry based on the theory and practice of the relationship between the logistics industry and the manufacturing industry, and put forward the theory of the ‘three chains of synergy’ to promote the integration of China's logistics industry and manufacturing industry[2]; Wang Xiaolei, Wang Ling(2022) analyzed the integration mechanism of logistics industry and manufacturing industry and explored the industrial upgrading effect brought by integration development to the manufacturing industry[3]; Sinkovics R R, Kuivalainen O, Roath A S analyzed the creation of added value brought by industrial integration through the level of the value chain[4]; Gong Xue, Xia Yin, Jing Linbo (2022) analyzed the evolutionary trend of the integration development of logistics and manufacturing industries based on the coupled coordination model and panel data, and analyzed the influencing factors of the integration development of the two industries [5]; Gong Ruifeng analyzed the degree of closeness of the linkage development of the manufacturing industry and the logistics industry in Hunan Province by using the full-rights method and Grey Relational Analysis[6].

Under the above-said background, this study will focus on the development of deep integration between China's aviation logistics industry and advanced manufacturing industry. It will determine the degree of integration and development of China's aviation logistics industry and advanced manufacturing industry, summarize the connotation of integration and development, and put forward policy recommendations to promote the deep integration of the two industries. The conclusions of the study will help to solve the current dilemma faced by the development of China's aviation logistics industry, and are of great significance for enhancing the strength of China's air cargo, improving international competitiveness, promoting the high-quality development of China's economy, and realizing the strategy of a strong civil aviation country.

3. Quantitative analysis of the integration development level of aviation logistics industry and advanced manufacturing industry

3.1. Construction of Indicator System

Gong Xue, Li Yuanjing (2023) constructed the evaluation index system of the integrated development level of the two industries from the aspects of development efficiency, scale, structure and potential. They analyzed the relationship between integrated development of the two industries and the total factor productivity in the manufacturing industry[7]. Based on *Statistical Yearbook of China's High-Tech Industry* and *Statistical Bulletin on the Development of Civil Aviation Industry*, this paper uses the statistical data from 2012 to 2022 of which the statistical data of China's high-tech industry in 2017 is not disclosed for the time being. What’s more, the total export amount and proportion of the high-tech industry in 2022 is not disclosed for the time being. So it is

supplemented by the index smoothing prediction method. And from three aspects as shown in Table 1 and Table 2, this paper construct the evaluation index system for the development of the two industries, which is used for the analysis and research on the integrated development.

Table 1: Comprehensive evaluation system of Aviation Logistics Industry.

	Primary Indicators	Secondary Indicators
Comprehensive Evaluation System of Aviation Logistics Industry	Operational scale	Scale of operation Number of freighters
		Ratio of cargo aircraft to transport fleet
		Number of airports above cargo and mail scale
		Number of all-cargo carriers
	Development potential	Freight and mail transport volume
		Freight and mail turnover
		Freight and mail throughput
	Development benefits	Civil Aviation Cargo Revenue
		Freight and mail transport revenue level

Table 2: Comprehensive Evaluation System of Advanced Manufacturing Industry.

	Primary Indicators	Secondary Indicators
Comprehensive Evaluation System for Advanced Manufacturing Industry	Operational scale	Number of enterprises
		Average number of employees
		Number of enterprises with R&D institutions
		Number of R&D institutions
		Number of staff
	Development potential	Number of Product Development Projects
		Expenditure on Product Development
		Institutional Expenditure
		Number of Patent Applications
		Number of effective invention patents
	Development benefits	Operating Revenue
		Product Sales Revenue
		Total Profit
		Total Exports
		Export proportion

3.2. Coupling Coordination Degree Model

This model is used to describe the mutual influence between different systems, interaction, integration degree model, the use of entropy value method to calculate the indicator weights of different variables, the level of quantitative calculation of the two industries coupling degree, coordination index, coupling coordination degree.

(1)Let X be the comprehensive value of aviation logistics industry system, then X_{ij} is the jth

variable of the ith index in aviation logistics industry system(i=1,2,...,m;j=1,2,...,n).Let Y be the comprehensive value of advanced manufacturing industry system. Firstly, standardize the data:

$$\begin{cases} X_{ij}^{*} = \frac{X_{ij} - minX_{ij}}{maxX_{ij} - minX_{ij}} (X\ as\ positive\ data) \\ X_{ij}^{*} = \frac{maxX_{ij} - X_{ij}}{maxX_{ij} - minX_{ij}} (X\ as\ negative\ data) \end{cases} \quad (1)$$

$$\begin{cases} Y_{ij}^{*} = \frac{Y_{ij} - minY_{ij}}{maxY_{ij} - minY_{ij}} (Y\ as\ positive\ data) \\ Y_{ij}^{*} = \frac{maxY_{ij} - Y_{ij}}{maxY_{ij} - minY_{ij}} (Y\ as\ negative\ data) \end{cases} \quad (2)$$

(2)The weight of the ith evaluation object of aviation logistics industry and advanced manufacturing industry about the jth index:

$$p_{ij} = \frac{X_{ij}^{*}}{\sum_{j=1}^{n} X_{ij}^{*}} \quad (3)$$

$$q_{ij} = \frac{Y_{ij}^{*}}{\sum_{j=1}^{n} Y_{ij}^{*}} \quad (4)$$

(3)The entropy value of the jth indicator of aviation logistics industry and advanced manufacturing industry:

$$e_{1j} = -\frac{1}{ln\, n} \sum_{i=1}^{n} p_{ij}\, ln\, p_{ij} \quad (5)$$

$$e_{2j} = -\frac{1}{ln\, n} \sum_{i=1}^{n} q_{ij}\, ln\, q_{ij} \quad (6)$$

(4)The weights of the jth indicator in the aviation logistics industry system and advanced manufacturing sub-system:

$$d_j = 1 - e_j \quad (7)$$

$$w_j = \frac{d_j}{\sum_{j}^{m} d_j} \quad (8)$$

$$v_j = \frac{d_j}{\sum_{j}^{m} d_j} \quad (9)$$

(5)The value of the comprehensive evaluation index of the aviation logistics industry and advanced manufacturing industry is:

$$X = \sum_{j=1}^{m} w_j \times p_{ij} \quad (10)$$

$$Y = \sum_{j=1}^{m} v_j \times q_{ij} \quad (11)$$

(6)D is the degree of coupling coordination, T is the comprehensive coordination index reflecting the integration effect between the two industries, α and β represent the importance of the aviation logistics industry and advanced manufacturing industry and satisfy the degree of α + β = 1.

$$C = 2 \times \sqrt[2]{\frac{X \cdot Y}{(X+Y)^2}} \quad (12)$$

$$T = \alpha X + \beta Y \quad (13)$$

$$D = \sqrt{C \times T} \quad (14)$$

According to the classification of China's industry categories and the background of social development, taking into account the different degrees of importance for the entire economic system, we take $\alpha = 0.4$ represents the weight of aviation logistics industry, $\beta=0.6$ represents the weight of advanced manufacturing industry. Given that Cao Yunchun, Zhang Yazhuo (2022) using the coupling coordination degree model to measure the coupling degree and coordination degree method between the aviation logistics industry and the industrial transfer acceptance[8], the coupling coordination degree is divided into 10 grades in order, as shown in Table 3. The higher coupling coordination degree, the better integration effect is.

Table 3: Fusion Coordination Degree Levels and Discrimination criteria.

Coordination level	Coordination Degree D	Coordination level	Coordination Degree D
Extremely out of Tune	(0,0.1]	Barely Coordinated	(0.5,0.6]
Severe Disordered	(0.1,0.2]	Elementary Coordination	(0.6,0.7]
Moderately Disordered	(0.2,0.3]	Intermediate Coordination	(0.7,0.8]
Mildly Disordered	(0.3,0.4]	Good Coordination	(0.8,0.9]
On the verge of Disorder	(0.4,0.5]	Perfect Coordination	(0.9,1]

According to the formula (1)-(14), this paper adopts the coupling degree of coordination model to measure and analyze the integration and development of the relationship between the two industries, the results are shown in Table 4.

Table 4: The integration and development relationship between aviation logistics industry and advanced manufacturing industry.

Year	Coupling Degree C	Coordination Index T	Coupling Coordination Degree D	Coordination Level
2012	0.814270776	0.084715008	0.262642257	Moderately Disordered
2013	0.993972129	0.104988434	0.323041139	Mildly Disordered
2014	0.99951831	0.106109119	0.325665484	Mildly Disordered
2015	0.993193319	0.19849337	0.444007082	On the verge of Disorder
2016	0.986912358	0.21864302	0.464522871	On the verge of Disorder
2018	0.997940482	0.406179915	0.636665831	Elementary Coordination
2019	0.999710867	0.473389203	0.687933376	Elementary Coordination
2020	0.999898969	0.641410425	0.800840573	Good Coordination
2021	0.99999277	0.881379331	0.938814656	Perfect Coordination
2022	0.99433296	0.888770719	0.940071284	Perfect Coordination

Table 4 shows that the coupling degree between China's aviation logistics industry and advanced

manufacturing industry shows the fluctuation trend of ‘rising-declining-rising-smooth’, and the coupling degree was the lowest in 2012, which is related to the general environment of the continuous downturn of the air cargo market. On the international front, the growth rate of import and export trade slowed down in 2011, the global air logistics volume dropped by 0.7% year-on-year. On the domestic front, since 2011, factors such as weak transportation demand, mismatch between supply and demand in the freight market had seriously affected the profitability of China's aviation logistics. However, the duration of the downturn is not too long, with the implementation of aviation logistics ‘integration’ reform, China’s aviation logistics enterprises’ business direction gradually turns to consumers and integration of resources, which greatly alleviate the continuing downturn in the air cargo market depression. From 2015 to 2016, China's domestic express delivery business emerged and improved. Road and railway transport constantly impacted the air cargo market, making the linkage with the manufacturing industry weakened, and air logistics once again ushered in the challenge. Since 2019, under the background of high-quality development, China's manufacturing industry is rapidly transforming and upgrading to high precision, and the requirements for transport conditions are becoming more and more demanding. At the same time, the concept of development of aviation logistics has been gradually perfected and its interaction with other industries has been enhanced, the degree of coupling has risen again and remained relatively stable. Overall, the degree of integration and development of China's aviation logistics industry and advanced manufacturing industry is increasing and basically maintain stable coordination.

4. Countermeasures for the integration and development of aviation logistics industry and advanced manufacturing industry

4.1. Deepening long-term planning for integration and development

Based on the advantages and characteristics of air cargo transportation in the local area, the government conduct in-depth analysis of the capabilities and market demand of advanced manufacturing industry in the region, and then determine the positioning of air logistics industry and advanced manufacturing industry in the industrial chain, promoting integrated development. The government should choose a scientific and accurate integration mode, including cooperation in the upstream and downstream of the supply chain, resource sharing, information exchange. For Chinese government departments, it is necessary to strengthen the connection between enterprises in two fields, such as directly introducing aviation convenience conditions into the advanced manufacturing park through the planning near the airport, in order to enhance the aviation logistics support capability of advanced manufacturing industry.

4.2. Establishing a stable and controllable supply chain

It is necessary to enhance the international air cargo capacity and establish a stable and controllable supply chain. One is to strengthen institutional safeguards and optimize the international air logistics environment. According to demand, the government should support the establishment of off-site freight stations in areas with sufficient supply of advanced manufacturing products. The implementation of measures by updating security inspection equipment marks a significant step towards improving the efficiency of product inspection. The second is to build leading enterprises and enhance service capabilities. The policy of enhancing the embedding of advanced manufacturing in the aviation logistics industry has evidenced the effectiveness of cooperation between advanced manufacturing and service providers in improving the localization operation capabilities of customs clearance, overseas warehousing, and landing distribution. To

ensure that high value-added products can be smoothly and safely delivered to customer terminals, and providing efficient and agile one-stop services of "airport to airport" and "airport to factory".

4.3. Strengthen the guarantee of integrated development resources

Through policy support and sustained funding investment, the government should promote the deep integration of the two industries. One is to actively promote the formulation and improvement of policies that are conducive to the integration and development of the two industries, including support policies in taxation, land use, finance, etc., creating a favorable investment environment. Secondly, in terms of infrastructure, we need to accelerate the construction of international cargo airport hubs. Focusing on major airport clusters and 17 airport economic zones in China, we will strengthen the efficiency of air logistics resource allocation and create a global air logistics hub. Thirdly, it is necessary to encourage technological innovation and provide technical support for integrated development. By establishing research funds and supporting innovative projects, we aim to promote cross technology innovation between the two fields. The last one is to establish a talent cultivation system and attract more talents to participate in integrated development between the aviation logistics industry and advanced manufacturing industry.

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