Research on Standardized Model Method of Reutilization of Retired Aircraft Based on Big Data

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Abstract. Reuse of retired aircraft is an intuitive manifestation of the effective combined development of the aviation industry and the circular economy, which involves the conversion of passenger aircraft to cargo and aircraft dismantling. In the new era, it shows the characteristics of intensive development of technology and capital. According to the operation scale of China’s aircraft in recent years, with the improvement of scientific research and technology, the number of aircraft fleets is also growing continuously, and the corresponding number of retired aircraft is also increasing every year, which proves that the development of China’s retired aircraft reuse industry has a very broad prospect. Therefore, on the basis of understanding the current global trend of aircraft life-cycle training and utilization, this paper calculates the FA model based on the potential output value of the retired aircraft recycling industry based on the FA-SD model, analyzes the empirical analysis and prediction of the evaluation model of the retired aircraft recycling potential, and identifies the effective measures for future development.

1. Introduction
Retired aircraft reuse as a new era under the background of the aviation industry to implement strong measures of the development of the economic cycle, the corresponding industry development has in the primary stage, and facing the market competition is small, but since the business scale of lack of support of core technology, so the whole industry chain is not perfect, and difficult to guarantee the final benefits. Based on the operation of the European and American markets, it is found that the overall structure has basically reached stable saturation, and the business field has gradually shifted to the Asia-Pacific region, which has a positive guiding role for China’s retired aircraft reuse market. Therefore, the aviation industry should strengthen the exploration of the re-use of retired aircraft on the basis of guaranteeing its own operation quality, pay attention to the study of the output value of different types of aircraft, and then put forward effective re-use schemes according to relevant research models.[1-5]

2. Trend analysis of current global aircraft life-cycle training utilization
Aircraft life cycle refers to the whole process of a research aircraft from the initial stage of demonstration to the completion of its mission and retirement, which involves four aspects: development, procurement, service support and retirement processing. Nowadays, as the global air cargo market gradually shows a trend of sustainable development in the process of innovation and development, enterprises have begun to increase the demand for air cargo on the basis of controlling the delivery time and improving the storage capacity in order to meet the increasing demand for manufacturing exports. From the perspective of practical operation, air cargo has the advantages of efficiency and speed, so it accounts for 25% of the total global trade in cargo transportation, but the actual cargo volume only reaches 1% of the total global trade. According to the statistical study on the change trend of global air cargo volume in recent years, from 85 in 2016 to nearly 100 in 2018, with the increase of air cargo demand, the air transport industry has been further innovated and developed. Among them, B737 modified machines account for 36% of the total transportation volume, which is the largest in the market and the most mature in corresponding technology development. As shown in Representative 1, it is the optimal processing step for China's current retired aircraft. Figure 1 is a comparative analysis diagram of the actual passenger revenue and the profit after modification:

### Table 1. Optimal disposal process of decommissioned aircraft

| Age (years) | Disposal plan |
|-------------|---------------|
| 8-10        | Sell them     |
| 10-15       | Convert the goods |
| More than 15 years | Airplane dismantling |

![Diagram](image)

Fig. 1 Comparison results of passenger transport and improved income

3. Estimating FA model of potential output value of retired aircraft reuse industry based on FA-SD model

In order to improve the accuracy of actual measurement, commercial aircraft need to be divided into three types: first, wide-body aircraft; The second is narrow body machine; The third is regional aircraft. In order to facilitate the price disassembly calculation in the subsequent research, various types need to be classified in an orderly manner, as shown in Table 2 below:

### Table 2. Analysis of types of commercial airliners

| Type          | Classification |
|---------------|----------------|
| Jet           | 747-400sp      |
| Cargo         | 747-400sf      |

According to 400 passengers, the average round trip fare is 4500 RMB, and the one way fare is 2250 RMB, that is, 2250 RMB/400 passengers = 90000 RMB
Therefore, the profit of the largest passenger plane flying to the United States is 90000 RMB

The full load is calculated at 95 tons, and the average price per kilogram is calculated at 20 yuan, that is 95000 kg x 20 yuan = 1900000 yuan, the profit of a full load cargo plane flying to the United States is 1.9 million yuan
On the one hand, the predicted retired aircraft types should be statistically studied according to the classification form in the table below. Ti is used to represent the number of decommissioned aircraft of various types, where I = 1, 2 and 3 represent wide-body aircraft, narrow-body aircraft and regional aircraft.

On the other hand, the prediction results of SD sub-model of modified cargo volume should be studied scientifically and processed effectively. Through the understanding of the current domestic and foreign aircraft passenger cargo market development situation, the Boeing series of aircraft modification technology is more and more skilled, and the actual cost is also falling. Taking the construction of passenger cargo conversion base of Guangzhou Airbus as an example, Airbus series A320, A321 and A330 are all equipped with relatively perfect modification technology, so the appropriate priorities in practical operation are as follows: B737 > B747 > B757 > B767 > B777 > A320 > A321 > A330

More suitable refitted airliners were found from the forecast results of retired aircraft, and according to the above principles and the data results of refitted airliners, the appropriate number of refitted airliners was selected and represented by KI. For example, three B737s, five B747s and three B747s were retired this year. Assuming that the predicted number of modified cargo aircraft is four, then the final screening result will be three B737s and one B747, and the corresponding types are respectively K1 and K2. All the other planes are being dismantled.[6-8]

According to the hypothesis analysis of the model shown in Figure 2 below, in addition to the transformation to a third party country or refit into a cargo plane after the aircraft is retired, other soybean milk will enter the aircraft dismantling market in China, and the corresponding dismantling amount NI calculation formula is:

![Analysis model based on FA-SD](image)

**Fig. 2** Analysis model based on FA-SD
where \( I = 1,2,3 \) represents the three types of aircraft studied in this paper. \( N_i \) represents the dismantled number of class \( I \) aircraft, \( T_i \) represents the retired number of class \( I \) aircraft, \( K_i \) represents the number of class \( I \) aircraft converted into cargo aircraft, and \( \beta_i \) represents the rate of class \( I \) aircraft transferred to foreign countries.

However, the calculation formula for the actual total potential output value of aircraft

\[
S = \frac{S_1 + S_2}{(1+r)^T},
\]

is where \( S \) represents the potential total output value, \( S_1 \) represents the potential total output value of replacing passenger goods, \( S_2 \) represents the total output value after dismantling the aircraft, \( R \) represents the discount rate (mainly calculated according to the current social benchmark discount rate of 8%), and \( T \) represents the year.

All aircraft refits were screened using the predicted refitted cargo volume. Combined with the obtained refit quantity, substitute it into the calculation formula of potential output value of replacing passenger goods, and the following can be obtained:

\[
S = \sum_{i=1}^{3} K_i \cdot P_i
\]

Where, \( K_i \) represents the number of modified Class \( I \) aircraft, and \( P_i \) represents the average price of modified Class \( I \) cargo aircraft.

The following formula is used to calculate the potential output value of aircraft dismantling industry, where \( N_i \) represents the dismantled number of class \( I \) aircraft, \( U_i \) represents the average price of class \( I \) aircraft, and \( N_i \) represents the number of engine of class \( I \) aircraft, and \( N_1 = 4, N_2, 3 = 2 \); The comprehensive calculation formula of potential gross output value is as follows:

\[
S_2 = \sum_{i=1}^{3} \{N_i \cdot (u_i + n_i + v_i)\}
\]

\[
S = \sum_{i=1}^{3} \{K_i \cdot P_i + N_i \cdot (u_i + n_i \cdot v_i)\}
\]

(3)

4. Empirical analysis and prediction of the re-use potential evaluation model of retired aircraft

4.1. Empirical analysis

On the one hand, the SD model of modified cargo volume is verified. After the construction of the corresponding research model, it is necessary to use the past accumulated data for in-depth discussion. Combined with the model validation analysis of the air cargo turnover system, it can be seen that the maximum error between the simulation value and the actual value is not more than 4.09%, which is very close to the actual value, thus proving that the research and design model in this paper is very effective. From the perspective of cargo aircraft occupancy verification, it is found that the error between the simulation value and the actual value is not more than 10%, which proves that this research model is effective.

4.2. Output value measurement

In the production value budget, the number of decommissioned aircraft, refitted cargo aircraft and aircraft dismantling should be defined. Therefore, the price values related to refitted passenger aircraft and aircraft dismantling should be collected and substituted into the calculation formula of the FA model to obtain the results as shown in Table 3 below:
Table 3. Forecast results of potential output value in utilization of retired aircraft in China (unit: ten thousand yuan)

| time  | S1     | S2     | s      |
|-------|--------|--------|--------|
| 2018  | 90.725 | 456.718| 547.444|
| 2019  | 153.225| 404.366| 557.592|
| 2020  | 189.515| 354.904| 544.420|
| 2021  | 181.451| 359.340| 540.791|
| 2022  | 157.257| 385.549| 542.807|
| 2023  | 209.676| 565.186| 774.862|
| 2024  | 219.757| 475.670| 695.427|
| 2025  | 187.499| 405.845| 593.344|
| 2026  | 173.386| 525.266| 698.653|
| 2027  | 197.580| 464.850| 662.430|

Combined with the analysis in the above table, it can be seen that the potential output value of China's decommissioned aircraft utilization industry continues to rise at the rate of 6.16 billion yuan per year, and can reach 61.57 billion yuan in the next few years. Therefore, the market development potential of decommissioned aircraft utilization is unlimited.

5. How to develop the retired aircraft reuse industry in an orderly way in the new era

5.1. The government should increase support on the basis of attention

On the one hand, it is necessary to build a systematic and standardized secondary trading market. By establishing a systematic supervision system for used aviation materials suppliers and clarifying the specific requirements for the application of used aviation materials, the sustainable development of the retired aircraft recycling industry can be ensured, and the aviation industry chain can be ensured to be perfect, so as to control the operating costs of domestic aviation enterprises. From the perspective of the operation of the international aviation industry, the circulation of used aviation materials is very common, and meets the legal provisions and requirements of international and some foreign countries. However, from the perspective of China’s practical development, the overall market construction is not perfect, and there is no clear standard for the application and maintenance of used aviation materials. In this way, the subsequent operation is easy to be affected by internal and external factors and cause unnecessary problems. Therefore, it is necessary to get support from the government, organize and analyze relevant information and data on the basis of building a specialized second-hand trading platform, and ensure the transparency of market transactions in the sharing application.

On the other hand, based on the cooperation of the Civil Aviation Administration, a clear technical operation standard should be put forward for the aircraft dismantling industry. Because the process of aircraft dismantling is more complex, which involves a lot of precision instruments, so in order to master the skilled application of technology and dismantling process, it is necessary to make clear the risk of practical work. Although international aircraft manufacturers and AFRA have put forward clear technical guidance manuals for dismantling, China has not established relevant technical operation standards for market development, which will not only affect the
efficiency of industry supervision, but also limit the sustainable development of the industry. Therefore, in order to ensure that the retired aircraft reuse industry can make steady progress, the Civil Aviation Administration should put forward clear technical operation standards based on understanding the current market development trend.

5.2. Society shall optimize industrial layout in the course of sustainable development

It is the core content of the current decommissioned aircraft reuse industry to optimize and innovate the industrial development layout through comprehensive investigation and understanding of the application of aircraft resources in combination with the innovation and development trend of the new era. Industry development direction as the focus of attention of retired aircraft reuse requires a combination of across China's total plane, airline fleet age structure, dismantling technology and modification and dismantling economic efficiency for accurate judgment, but also in industry, on the basis of different stages of development, industry layout for scientific planning for the future. In this way, not only the actual industrial development needs can be met, but also the over-saturated capacity can be avoided in the mature stage. According to the operation situation of China's general airports, because the internal business is not busy, the use mode is very flexible, so after refitting and re-using, it can better meet the work needs of changing passengers to goods and dismantling, and it can control the actual site application cost. Therefore, under the background of new era, facing the increasingly innovative development of aviation industry structure, aviation in China according to the different modification or dismantling, aircraft type, must want to consider current market operation, and reasonable control of the risks of practice development, only in this way can the reasonable use of retired aircraft, reduce the consumption of resources at the same time, Enhance the economic development level of China's aviation sector.

6. Conclusion

To sum up, decommissioning and recycling of aircraft, as an important link in the continuous development of the aircraft industry chain, plays a positive role in the sustainable development of China's aircraft industry. This operation not only enriches the experience of China’s aircraft technology research and development, but also lays a foundation for the economic innovation of civil aviation industry. Therefore, in the future technological innovation, it is necessary to strengthen the research on the reuse of decommissioned aircraft and pay attention to the optimization of related technology industries, so as to meet the increasingly innovative market demand and bring new opportunities and challenges to the social and economic development. At the same time, we should pay attention to the training of professional talents, learn to rationally use modern science and technology for technical research and development and empirical analysis, so as to put forward better suggestions for the reuse of retired aircraft in the future.

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