

# *Research on integrated Supply chain management of aircraft Manufacturing*

Fan Lu<sup>1</sup>, Mengsi Liu<sup>2,\*</sup>

<sup>1</sup>Parts Manufacturing Center, Chengfei Commercial Aircraft Company Ltd, Chengdu, 610092, China

<sup>2</sup>Business School, Sichuan University, Chengdu 610064, China

\*Corresponding author: laimoxixi@126.com

**Keywords:** aircraft manufacturing, Supply chain, Comparative analysis, Deficiency and Improvement

**Abstract:** The civil aviation manufacturing industry is characterized by high risks such as large investment, intensive capital and long cycle. Even if the aircraft manufacturer has the ability of independent research and development, it is difficult to bear the huge risk brought by the failure of the project. Under this background, the management mode of the civil aviation manufacturing industry will change. This paper mainly studies the application of supply chain management in aircraft manufacturing. Taking Boeing and Airbus as examples, combined with the current situation of domestic industries, it compares and analyzes the advantages and disadvantages of supply chain management in China's civil aviation manufacturing industry, points out the shortcomings and puts forward Suggestions for improvement.

## 1. Introduction

### 1.1 Supply chain and integrated Supply Chain

Supply chain refers to the relevant production organization mode of cooperative operation and production between upstream and downstream enterprises [1]. The traditional supply chain activities are usually scattered and spontaneous market transactions in the market economy. In recent years, enterprises began to incorporate supply chain management into management mode and enterprise strategy. The goal of supply chain management is to minimize costs and maximize benefits.

Integrated supply chain refers to the cooperative relationship between enterprises. It has the characteristics of stability, longevity and mutual trust. With the help of capital chain, logistics, technology flow and information flow, it integrates related enterprises and lays a solid organizational foundation for the cooperative innovation of integrated supply chain enterprises [1]. Integrated supply chain management (ISCM) is an end to end (E2E) management mode, which is simply a chain management with a head and a tail. The object of the whole management process is: front-end material production enterprise → manufacturing enterprise → retailer → end consumer. The goal of integrated supply chain management is to optimize the benefits of the

organization.

## **1.2 Current situation of large civil aircraft manufacturing industry**

Nowadays, large civil aircraft manufacturing industry has the characteristics of internationalization and globalization. The development of civil aircraft brings together all kinds of advanced materials, technologies and techniques, which is the concentrated expression of a country's comprehensive national strength. Nowadays, the international mainstream civil aircraft master manufacturers mostly adopt the master-supplier model to develop civil aircraft, that is, the supplier provides parts and materials, and the master-manufacturer is responsible for integrating the products provided by the supplier at the whole aircraft level and system level [2]. In this mode of civil aircraft development, involving thousands or even thousands of large and small parts and raw material suppliers. The main manufacturer's control over suppliers directly affects the progress and success of the project.

The fundamental challenge in the manufacture of large aircraft is not technology but management. With the increasingly fierce competition in the aviation manufacturing market and the process of technological progress, the international cooperation of large commercial aircraft manufacturing industry has become more and more extensive, gradually forming a supply chain system with the main manufacturer as the core and close relations among the main manufacturer, subsystem suppliers and component suppliers [3].

## **2. Research on Boeing and Airbus supply chain management**

### **2.1 Research on Boeing Supply Chain Management**

In the 21st century, the production organization mode has been further developed. The raw materials, WIP and finished products in the supply chain flow around the world, and the logistics activities among the main bodies in the supply chain are realized through the global import and export trade. This mode is called "global supply chain". At this time, the role of suppliers in the product supply chain has become increasingly prominent, the role of suppliers from the traditional parts production supplier to product parts assembly participating designers, become strategic partners.

The 787 programme USES a "global supply chain" model in which 90% of the aircraft's components are made by suppliers and up to 70% by foreign suppliers. Boeing is only responsible for a few parts production and final assembly tasks. The 787's main suppliers, in the United States, Japan, Britain and Italy, are taking on more responsibility for design, development and manufacturing than ever before. Japanese suppliers are responsible for about 35 per cent of the design and manufacture of the entire fuselage structure, including the aircraft's wings, which Boeing previously made in-house.

Boeing 787 adopts the new global supply chain strategy mode, distributes design and development costs with global partners, establishes a global cooperation system with suppliers, makes full use of global resources, speeds up the market response speed, promotes the global sales of Boeing aircraft, and improves the target market share [4].

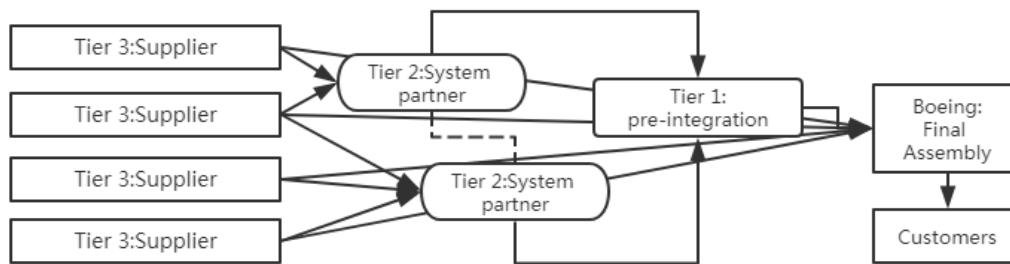


Figure. 1 Boeing 787 integrated supply chain

At present, most countries have established a system of adverse drug reaction/event reporting, among which the US FAERS (FDA Adverse Event Reporting System) is highly utilized. China joined the WHO International ADR Monitoring Cooperation Program in 1998 and became a member of the program, and formally established the National Center for Adverse Drug Reaction Monitoring. As of December 2002, ADR monitoring centers have been established in 31 provinces, autonomous regions and municipalities across the country. In March 2004, the State promulgated and implemented the Measures for the Reporting and Monitoring of Adverse Drug Reactions. At present, the reporting system for adverse drug reactions in China has gradually improved, the scope of monitoring has been continuously expanded, and the number and quality of case reports of adverse drug events have been continuously improved. The monitoring system for adverse drug reactions has made great progress.

## 2.2 Research on Airbus Supply Chain Management [5]

By the 1990s, airbus could no longer afford the project costs and risks of developing new aircraft due to the increase in the overall profit level of aviation manufacturing industry and the stipulation in the US-European civil aircraft Agreement that government subsidies should not exceed 30% of the development cost of civil aircraft.

In 2005, Airbus officially launched the A350XWB program to compete with Boeing's 777 and 787 series. Airbus manufactures 50% of its components from suppliers. But unlike Boeing, Airbus's tier 1 suppliers are mainly from different countries and possess core technologies. Its strategy is more conservative than Boeing's. In 2009, due to the regulation that government subsidies for new aircraft development should not exceed 15%, Airbus further optimized its supply chain, transforming itself from "complete machine manufacturer" to "system integrator" and forming closer strategic partnership with suppliers.

## 3. Manufacture of large aircraft in China

### 3.1 China's civil aircraft manufacturing supply chain development

China started early in the development of large commercial aircraft. For example, the Yun 10 [6] started in the 1970s, and today's large aircraft C919 [7] can only be counted as the initial stage.

With the constant change and development of the supply chain management mode of civil aircraft major manufacturers, risk sharing has become the mainstream mode of cooperation between major manufacturers and suppliers. Similar to Boeing and Airbus, this mode has the following advantages:

- (1) Reduce project development costs: In the case of the risk-sharing model, the main

manufacturer does not need to pay for the finished product to the supplier immediately, but only after the aircraft is sold. In this way, the R&D cost of the project is divided among the various suppliers.

(2) Reduce the technical risks of the project: in addition to helping the main manufacturer to share the project costs, the risk sharing partners will also share the technical risks.

### 3.2 Domestic large aircraft supply chain management advantages

In addition to the innovation of aircraft design technology, the most important aspect of civil aircraft competition is the ability to control the supply chain. Domestic large aircraft manufacturers have the following advantages in supply chain management:

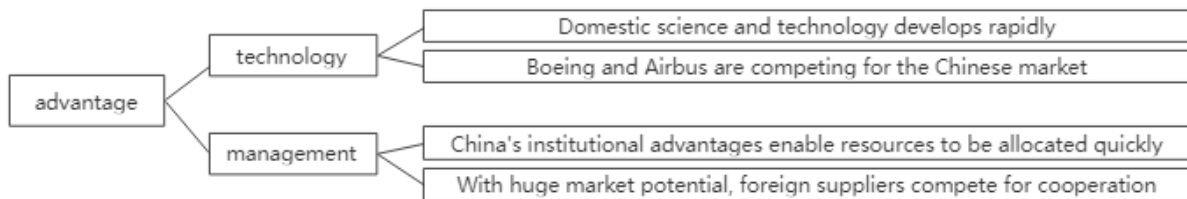


Figure. 2 Advantages of Supply Chain

### 3.3 Dilemma and analysis of China's large aircraft supply chain management compared with Europe and America

Last century in our country on the civil aircraft manufacturing attempt failed for many times, but it would be pleased to enter the new century, our country on the feeder, trunk line aircraft manufacturing progress, but compared with Europe and the United States, the development of either technology or management level there is a big gap, especially on the supply chain management, our country also faces more challenges. This paper makes the following elaboration on the three dilemmas:

**Lack of diversification of project funds:** When developing and manufacturing large civil passenger aircraft, an important factor to promote the success of the project is the source of funds. In fact, the aviation industry is difficult to attract commercial capital because of its high investment and high risk, and it is usually funded through government subsidies.

**Supply chain dilemma:** First, as mentioned above, one of the difficulties of China's large aircraft manufacturing is the lack of long-term strategic partners capable of benefit sharing, risk sharing and strength. Second, the supplier is relatively single. For example, the ARJ21 airframe components and airborne finished products of Shanghai Airlines all use the single supplier mode. Due to the lack of competition, the products supplied are of poor quality and expensive price. Third, China's supply chain management is relatively extensive [8]. In the past planned economy under the conditions of formation of the purchasing management is still not fully procurement market shift to the enterprises themselves, especially after civil aircraft to enter the market is still very weak, enterprise in product promotion, to target yield for the way of thinking, often purchase plan is too big, still take the old way of purchasing and rapid response ability to the market changes is poorer, lead to enterprise of raw materials, inventory is too large to airborne equipment, etc.

**Boeing and Airbus jointly suppressed:** Under the joint suppression of Boeing and Airbus, many countries failed to develop their own aviation industry. In addition to the MD90 project between China and McDonnell Douglas, Indonesia's N250 project was targeted by Boeing and Airbus when

it was on the verge of success. In addition, Bombardier, which has been active in regional jets, has been jointly suppressed by Boeing and Airbus when developing trunk aircraft.

#### **4. Suggestions on Chinese supply chain management from the successful experience of foreign civil aircraft manufacturing**

The following is the successful experience of foreign civil aircraft manufacturing for China's supply chain management from the three perspectives of capital, supplier management, resistance to the joint suppression of Europe and the United States.

How do you get enough money?

Boeing and Airbus have a significant number of tier 1 suppliers with whom they share the risk, plus they have accumulated over the last few decades, which gives them a much bigger advantage over us in terms of r&d funding. How do you get enough funding? This paper puts forward the following two Suggestions:

(1) It can be considered to realize capital diversification by applying for listing, raising funds from the public and issuing corporate bonds;

(2) The government may provide long-term low-interest loans significantly lower than the current national interest rate.

How to manage suppliers?

(1) "Change into a whole", increase the purchasing power of China's parts and integrated systems. China's civil aircraft project is still in the research and development stage. Compared with the production capacity requirements of Boeing and Airbus, China cannot compete with mature aviation products in terms of procurement quantity [9]. At the same time, China's aircraft is still in the development stage, technical immaturity may lead to the frequent replacement of materials. In order to solve this problem, we can cooperate with multiple factories to conduct joint procurement and "break the pieces into pieces" to improve our bargaining power with suppliers.

(2) Integrate the demand of downstream suppliers and centralize procurement. In addition to the above-mentioned alliances with other main manufacturers, consideration may be given to integrating the requirements of downstream suppliers, with the main manufacturers negotiating with some material suppliers centrally.

(3) Adopt a reasonable supplier selection method. According to different products, different supplier selection methods are adopted, which mainly include open bidding procurement, limited competitive bidding procurement, inquiry procurement and direct contract procurement [10].

(4) Classification of suppliers is easy to manage. From the perspective of stakeholders, Zhang Yali et al. [11] classified large aircraft suppliers from four dimensions of legitimacy, influence, urgency and trust. Suppliers with four attributes are called "key suppliers". Those with three attributes are called "adaptive vendors"; Those with two attributes are called "collaborative vendors"; A single attribute is called a "transactional supplier", which adopts different cooperation and management methods for different types of suppliers.

(5) Establish advanced enterprise information system. Change the status quo of people's power over system in state-owned enterprises, a ten-day inefficient office form such as audit. The application, examination and approval, circulation, bidding and payment of procurement have all realized the network transparency and informatization, accelerating the process of procurement.

How to resist the joint efforts of Europe and America (Boeing, Airbus)?

If China's civil aviation industry wants to achieve development, it must face and overcome this dilemma. How can it resist the concerted efforts of Europe and the United States? This paper puts forward the following Suggestions:

(1) Explore the way of operation suitable for domestic aircraft. For example, THE ARJ21 of

Shanghai Airlines is aimed at the regional jet market. For China, it should attach importance to this part of the market. On the one hand, the main line in Europe and The United States is the trunk plane, and they have little pressure on the regional plane. For example, Bombardier has made great progress in the regional plane field. On the other hand, the regional jet market is huge. Looking at China, especially northeast and southwest Of China, there is a huge demand for regional jets, and the regional jet market potential can be seen from ARJ21 and "Xinzhou" series exported to Africa, South America, Oceania and other countries. In addition to the "Belt and Road" opportunity, the building of the aerial Silk Road also continues the improvement of regional jets.

(2) UN foreign civil aircraft manufacturers break the blockade barriers. Cooperate with foreign civil aircraft manufacturers (Bombardier, Canadian aircraft manufacturers, etc.) to jointly resist the oppression, cut costs and challenge the monopoly position of Boeing and Airbus in the case of individual development difficulties. .

(3) Expand domestic flight market through the role of the government. Please refer to the following Suggestions:

A. The import of similar foreign aircraft is prohibited;

B. Provide long-term loans significantly lower than the current national interest rate to compensate for the impact of loans to buyers and sellers of aircraft;

C. Reduction of VAT on the import and sales of domestic aircraft;

D. Reduction or exemption of the civil aviation infrastructure fund handed over from the operating income of domestic aircraft;

E. Reduction or exemption of airport construction fees for passengers travelling on domestic aircraft;

F. Airport charges in passenger transit fees for domestic aircraft halved.

## 5. Conclusion

At present, the development of civil aircraft manufacturing in China is faced with arduous challenges. After overcoming technical difficulties one by one, the management of supply chain has always been in front of the aircraft development personnel in China. For big aircraft, you can't look at it from a purely technical point of view. To some extent, the challenge of big aircraft is not technology but management. With the large number of ARJ21 put into use, the first flight of the third C919 has been successful. I believe that in the near future, we can travel by the big plane produced by Chinese people.

## Acknowledgements

The authors gratefully acknowledge the financial support from EIP (2017ZZ003).

## References

- [1] Liu Quan. *The significance and method of implementing integrated supply chain management in state-owned military enterprises* [J]. *China management informatization*, 2015, 18 (08): 88-89.
- [2] Li Yun. *A brief analysis of the impact of civil aircraft supply chain problems on the project schedule* [J]. *Horizon of science and technology*, 2018 (23): 272-273.
- [3] Zhang Jun, Li Hongqi, Zhang Lu. *Investigation and evaluation of global large commercial aircraft manufacturing supply chain enterprises* [J]. *Journal of Beijing Jiaotong University (Social Science edition)*, 2015, 14 (04): 81-88.
- [4] He Lihua. *Transformation of aerospace parts manufacturing plant based on integrated Supply chain* [N]. *Air China News*, 2016-08-25 (A02).
- [5] Bao Li. *Research on supply chain development of large civil aircraft manufacturing industry* [D]. *University of International Business and Economics*, 2015.
- [6] Ouyang Liang. *Da Chang -- The holy land of final assembly of Chinese civil aircraft* [J]. *Large aircraft*, 2014 (01):

29-33.

[7] *China's first successful flight of the C919, the question you most want to know is here [J]. Today's science and technology*, 2017 (05): 22.

[8] Ma Zhenjiang. *Research on Supply chain management of China's Civil Aircraft Industry enterprises [C]. //China civil Aircraft Industry development Symposium in the new century. Beijing: 2001: 73-80.*

[9] Ruan Huihui. *The present situation and tentative plan of supply chain management of domestic large aircraft [J]. Logistics engineering and management*, 2015, 37 (04): 74-75.

[10] Ye Jian. *A Brief discussion on supplier management in civil aircraft procurement process [J]. Modern business*, 2013, (21): 116. DOI:10.3969/j.issn.1673-5889.2013.21.072.

[11] Zhang Yali, Hou Lizhen, Zhao Lei. *Research on the Management Mode of Large Aircraft Supplier -- Based on the New Perspective of Stakeholders [J]. Aeronautical manufacturing technology*, 2013 (17): 96-99.

[12] Qi Ting. *The operation of domestic aircraft [J]. Large aircraft*, 2018 (01): 52-55.

[13] Emma Cosgrove. *Inside Boeing's digital supply chain turnaround [J/OL]. <https://www.supplychaindive.com/news/Boeing-digital-supply-chain-transformation/538630/>, 2018.*

[14] BOHA ALA. *Boeing Strategic Supply Chain Management Project Report [J/OL]. <https://bohatala.com/boeing-strategic-supply-chain-management-project-report/>, 2014.*

[15] Steve Krcek. *The Optimal Supply Chain in Large Aircraft Manufacturing [Z]. 2015.*

[16] Dr. Kevin Michaels. *Key Trends in Commercial Aerospace Supply Chains [J]. Aero Dynamic ADVISORY*, 2017.