A sustainable fuel strategy for airlines

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Abstract

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The aviation industry is currently standing at a historic crossroads. With a growing global awareness of environmental protection, the aviation industry is also seeking ways to transform traditional business practices into more environmentally friendly and sustainable models. However, the current demand crisis, especially influenced by global climate change and sustainable development trends, is forcing airlines to undergo deeper structural adjustments. In this context, many airlines are actively exploring the path to zero emissions. This is not only a response to the market but also an investment in future sustainable development.

Based on this, the transformation of aviation towards zero carbon emissions could potentially help Chinese companies enter previously unexplored areas, achieving breakthroughs in business scale and strength. In the long run, the aviation industry's net zero emissions, along with efforts from other industries, will create a better future for humanity, with the sustainable development of the aviation industry being the foundation for this future. In the medium to short term, achieving net zero emissions will reshape the industry landscape and bring anticipated tangible benefits to innovators. However, this goal also faces threats in terms of technological feasibility, economic feasibility, and policy feasibility.

Key words
Sustainable Aviation Fuel, competitive strategy

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1 Introduction

In response to the current situation facing the aviation industry, this article combines specific circumstances of Airline A to conduct extensive research on the sustainable development and zero emissions of aviation enterprises, focusing on sustainable aviation fuels for in-depth analysis.

Nowadays, in the domestic aviation industry, aviation fuel used for civil aviation and general aviation, except for some aviation gasoline used in general aviation, is aviation kerosene, which is a non-renewable energy source. Since Pudong Airport is a civil aviation airport, this article does not study aviation gasoline and its alternatives. In this article, aviation fuel refers to kerosene-based aviation fuel. Sustainable aviation fuel, as an alternative to traditional fossil aviation fuel, is derived from biomass or waste and does not increase the use of non-renewable energy sources such as petroleum. It can also reduce carbon dioxide emissions. Currently, there are seven known types of sustainable aviation fuel in the aviation transportation field, which can effectively reduce net carbon dioxide emissions by up to 80% without affecting the performance or operation of aircraft. However, large-scale application of sustainable aviation fuel has not yet been achieved in China, but it has great prospects.

This article focuses on the competitive strategy of Company A in the sustainable aviation fuel business. By fully utilizing relevant knowledge and conducting in-depth analysis of Company A's own situation and the environment it operates in, it will compare the advantages and disadvantages of the enterprise in detail. Corresponding analysis methods and tools will be used, combined with relevant theories, to construct a strategic goal system for Company A's sustainable aviation fuel, and to develop a sustainable aviation fuel business competitive strategy plan that is reasonable, compliant, and safe, matching the company's future development.

2 Research Status at Home and Abroad

This part will take full account of the research on zero emission and sustainable fuel, the current status of a airlines and the problems encountered in achieving zero emission, based on the existing literature, analyze problems and propose solutions.

2.1 Domestic Research Status

Through the China National Knowledge Infrastructure (CNKI), 272 Chinese literature related to net zero emissions and 739 Chinese literature related to sustainable aviation fuel were retrieved on January 9, 2024. Many Chinese literature works are concentrated after 2020, which coincides with China officially proposing the "dual carbon goals." Since the 21st century, an increasing number of countries, regions, and international organizations have been involved in environmental protection and governance. In the civil aviation industry, due to the limitations of new energy technologies, many new energy sources that can effectively replace non-renewable energy sources in other industries are not applicable, leading to the emergence of sustainable aviation fuel. As an alternative to traditional aviation fuel, sustainable aviation fuel and traditional aviation fuel have intense competitive relationships in terms of production capacity. The emergence of sustainable aviation fuel has brought new means and methods for energy conservation and emission reduction in the aviation industry.

2.2 Foreign Research Status

Similarly, through the CNKI, 383 foreign literature related to net zero emissions and 290 foreign literature related to sustainable aviation fuel were retrieved on January 9, 2024. Member countries of the International Civil Aviation Organization (ICAO) have reached an agreement on the long-term goal of achieving net zero carbon dioxide emissions in the aviation sector by 2050. This marks a significant shift in the aviation sector from simply offsetting emissions to taking measures to significantly reduce aircraft and aircraft fuel carbon dioxide emissions.

2.3 Summary and Evaluation

In conclusion, the current research on zero emissions and sustainable fuels exhibits the following characteristics:

1. China officially proposed the "dual carbon goals," and member countries of the International Civil Aviation Organization (ICAO) have reached an agreement on the long-term goal of achieving net zero carbon dioxide emissions in the aviation sector by 2050. More and more countries, regions,

and international organizations are investing in environmental protection and governance, and research in this area is receiving increasing attention.

2. Research is gradually becoming more systematic and objective, shifting from subjective research to diversified and comprehensive evaluation criteria. With technological innovations, sustainable aviation fuel is synthesized from alternative and renewable energy sources in a more sustainable manner, which is crucial for helping the aviation transport industry achieve emission reduction goals. Actively promoting the industrial production and application of aviation biofuels is a trend that is consistent both domestically and internationally.（Joseph A ,Yaw D ,Sarah A,2022）

Based on the current research status, research on zero emissions and sustainable fuels is on the rise. The next step for the author is to analyze and propose solutions to the issues encountered in achieving zero emissions based on the current status of domestic airlines and existing literature.

Currently, Company A's development relies mainly on traditional aviation fuel, and no strategic analysis has been conducted regarding the business of sustainable aviation fuel. This paper primarily focuses on how to introduce high-cost but environmentally friendly and clean aviation fuel to replace or partially replace traditional aviation fuel in the context of "dual carbon" for Company A. The aim is to gain a competitive advantage compared to traditional aviation fuel, study and develop a sustainable aviation fuel business competition strategy that is most suitable for the company's development, and provide reference for other aviation fuel supply enterprises in China. The research includes the following aspects:

1. By analyzing the macro environment in which Company A operates and considering relevant national and industry policies, as well as the development and application of sustainable aviation fuel both domestically and internationally, the study provides data support for the formulation of the company's sustainable aviation fuel business competition strategy, taking into account the company's own capabilities and development direction.

2. As a leading Chinese enterprise studying the competition strategy of sustainable aviation fuel business, through internal and external environmental analysis, the study fully considers the significant role of sustainable aviation fuel in the context of "dual carbon" and combines the decarbonization requirements of airlines. It investigates and analyzes how the enterprise can formulate the best sustainable aviation fuel business competition strategy at the current stage.

3. By synthesizing the results of various analyses and research, the study identifies and selects the sustainable aviation fuel business competition strategy that is most suitable for Company A's development and formulates relevant measures.

4. After conducting relevant research, the identified competition strategy, along with its implementation, assurance, and control measures, is ultimately applied in practice to give the sustainable aviation fuel business an advantage in competition with traditional aviation fuel business.

3 Research Content and Methods

This part will carry on the depth analysis to the article research content, and has explained the research method simply.

3.1 Research Content

Currently, Company A's development mainly relies on traditional aviation fuel, and there has not been a strategic analysis of sustainable aviation fuel business. The main focus of this study is on how Company A, under the context of dual carbon goals, can introduce high-cost but environmentally friendly aviation fuel to replace or partially replace traditional aviation fuel, gain competitive advantages compared to traditional aviation fuel, research and develop the most suitable sustainable aviation fuel business competitive strategy for the company's development, and provide reference for other aviation fuel supply companies in China. The research content mainly includes the following aspects:

(1) By analyzing the macro environment in which Company A operates, combining relevant national and industry policies, as well as the development and application of sustainable aviation fuel domestically and internationally, considering the company's own capabilities and development direction, providing data support for the formulation of the company's sustainable aviation fuel business competitive strategy.

(2) As a Chinese company pioneering the research on competitive strategies for sustainable aviation fuel business, through internal and external environmental analysis, fully considering the important role of sustainable aviation fuel in the context of dual carbon goals, and combining the demand for carbon reduction by airlines, studying how the company can formulate the best sustainable aviation fuel business competitive strategy at the current stage.

(3) Integrating the results of various analyses, selecting the sustainable aviation fuel business competitive strategy that is suitable for Company A's development, and formulating relevant implementation, security, and control measures.（Joseph A ,Yaw D ,Sarah A,2022）

(4) After relevant research, the competitive strategy and its implementation, security, and control measures are ultimately applied in practice, enabling the sustainable aviation fuel business to gain an advantage in competition with traditional aviation fuel business.

3.2 Research Methods

(1) Literature Review

By collecting relevant information on sustainable aviation fuel domestically and internationally, including refinery production, aircraft manufacturer and OEM verification, fuel supply by oil companies, and usage by airlines, comprehensively understanding the development history, current status, and important events of sustainable aviation fuel, summarizing relevant information that is meaningful for Company A, sources of information include CNKI database, Wanfang database, Engineer Index, Civil Aviation Administration of China, International Air Transport Association, and other official websites.

(2) Interview Method

The competitive strategy for sustainable aviation fuel business of Company A discussed in this paper requires support from multiple departments such as operations and procurement, customer service, finance, corporate development, and safety technology, therefore, purposeful communication and interviews with responsible persons and employees of relevant departments in the company are needed to obtain more detailed information with reference value.

(3) Questionnaire Survey

In the internal strategic environmental analysis of Company A's sustainable aviation fuel business competitive strategy, a questionnaire survey is designed to collect relevant data and information from employees on various dimensions such as understanding of sustainable aviation fuel, employee information, human resources information, corporate culture, safety management, etc., in order to obtain the necessary data support and provide reference basis for the formulation, implementation, and control of the company's sustainable aviation fuel business competitive strategy.

4 External Analysis of Zero Emission Civil Aviation for A Company

Looking at both domestic and international scenarios, there currently isn't a very clear guidance on the development plan for sustainable aviation fuels. Domestically, in 2022, the Civil Aviation Administration of China successively issued the "14th Five-Year Plan for Civil Aviation Development" and the "14th Five-Year Plan for Green Development of Civil Aviation." Internationally, different countries have varied requirements for the application of sustainable aviation fuels. Currently, some airports in countries like Canada, the United States, Japan, and Germany have begun using sustainable aviation fuels, forming their own regulations. The International Civil Aviation Organization (ICAO) introduced "Innovation Driving Sustainable Aviation" in 2021, providing direction for the use of sustainable aviation fuels. Therefore, this chapter will use the PEST model to analyze the external environment of A Company, focusing on political, economic, social, and technological aspects, to provide goals and insights for the competitive strategy formulation of A Company's sustainable aviation fuel business.

4.1 Macro Environment Analysis

4.1.1 Political Environment Analysis

(1) Domestic Policies

In the traditional aviation fuel sector, in 2006, the Civil Aviation Administration of China issued the "Aviation Kerosene Sales Price Reform Plan (Trial)" and officially implemented it, shifting the pricing mechanism of aviation fuel from government pricing to primarily government-guided pricing. From 2009 to 2016, the pricing mechanism for aviation fuel was continuously improved, gradually transitioning from government pricing to market-based pricing, but a purely market-oriented pricing mechanism has not yet been completed.

The "Business Tax to Value-added Tax (VAT) Reform" policy implemented since 2012 made domestic airlines aware that the overall oil prices for domestic flights were more than 200 yuan per ton lower than those for international flights. As a result, they expressed their intention to lower the prices of domestic international flights to the State Administration of Taxation. On August 1, 2013, the Ministry of Finance and the State Administration of Taxation issued the "Notice on the Suspension of the Policy of Using Bonded Aviation Fuel for Civil Aviation International Flights," canceling the bonded policy for domestic international flights and adjusting the corresponding price difference of aviation fuel.

In terms of energy conservation and emissions reduction, various policies have been successively introduced domestically. In August 2017, the Civil Aviation Administration of China issued the "Thirteenth Five-Year Plan for Civil Aviation Energy Conservation and Emission Reduction," proposing that by 2020, the average annual ratio of energy consumption and carbon dioxide emissions per unit of transportation turnover of industry units would decrease by more than 4% compared to the "Twelfth Five-Year Plan" period, and the average annual energy consumption per unit of passenger throughput at industry transportation airports would decrease by more than 15% compared to the end of the "Twelfth Five-Year Plan" period. Since 2021, several documents have been successively issued, such as the "Opinions on Deepening Civil Aviation Reform Work During the '14th Five-Year Plan' Period," the "14th Five-Year Plan for Civil Aviation Development," and the "Shanghai Carbon Peak Implementation Plan."

It can be seen that in the process of aviation fuel development in China, in terms of pricing, due to the more mature development of traditional aviation fuels, domestic policies mainly revolve around traditional petrochemical aviation fuels to formulate and improve the domestic aviation fuel price system, with the development trend gradually moving towards internationalization and marketization. Sustainable aviation fuel, as an emerging alternative product, still lacks specific policies and regulations. In terms of policies and regulations, further top-level design is still needed. However, in terms of energy conservation and emissions reduction, domestic policies, except for the policy introduced in 2017, have mainly focused on the formulation of sustainable aviation fuels, especially after the proposal of the "dual carbon" policy, the status of sustainable aviation fuels has been further elevated. In terms of usage, Zhuhai Refinery's sustainable aviation fuel has already obtained approval from the local authorities, and the sustainable aviation fuel business is facing brand new opportunities and challenges.

(2) International Related Policies

Internationally, the civil aviation industry and the field of aviation fuel have been more advanced in energy conservation and emission reduction than in China. As early as December 1997, representatives from 149 countries and regions gathered in Kyoto, Japan, and passed the "Kyoto Protocol" aimed at limiting greenhouse gas emissions from developed countries to curb global warming. It was proposed in the protocol that the International Civil Aviation Organization should be responsible for "reducing or limiting global CO2 emissions from aviation activities." The Kyoto Protocol officially came into effect on February 16, 2005, marking the first time that greenhouse gas emissions were globally regulated through international regulations. Since the formal implementation of the Kyoto Protocol on February 16, 2005, the European Union adopted the European Emissions Trading Scheme (EU-ETS) to fulfill its commitments for the third phase of the

Kyoto Protocol from 2013 to 2020. The aviation industry was officially included in this trading scheme in 2012. The development of sustainable aviation fuels abroad has a significant advantage, with Pudong Airport having a large number of international and cargo flights. The acceptance of sustainable aviation fuels is higher among foreign airlines than domestic carriers, providing opportunities for the use of sustainable aviation fuels. However, it is also important to note that currently, domestic sustainable aviation fuels mainly rely on the hydroprocessed esters and fatty acids (HEFA) synthesis process provided by Zhenhai Refining & Chemical Company, involving issues such as process confidentiality. CORSIA has not yet calculated the carbon emission reductions of the sustainable aviation fuels produced by them, posing certain challenges to the sustainable aviation fuel business.

4.1.2 Economic Environment Analysis

(1) Analysis of the Domestic Economic Environment

Looking back at China's development process, due to major strategic decisions and national policies such as reform and opening up, and joining the WTO, economic development has achieved rapid growth.（http://www.stats.gov.cn/search/s?qt=GDP） Reflecting on the economic development of the past decade, before the COVID-19 pandemic, China's GDP experienced rapid growth. However, due to the impact of the COVID-19 pandemic, the GDP growth rate has slowed down, especially with Shanghai, where A Company is located, experiencing negative GDP growth.

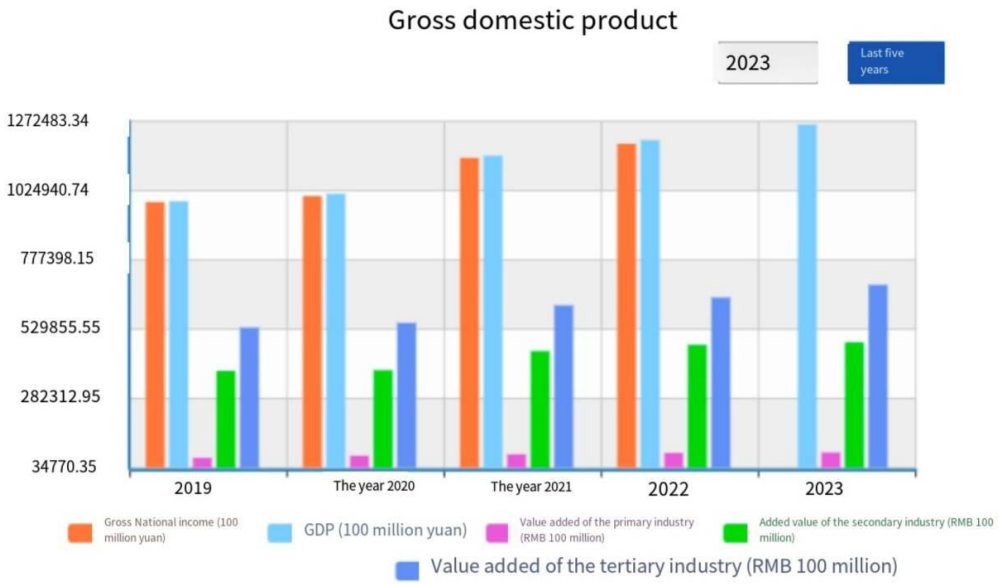

Figure 1. Gross domestic product statistics.（http://www.stats.gov.cn/search/s?qt=GDP）

Although the growth of GDP allows more and more people who have never taken a plane to board flights, making air travel the preferred choice for more people, the industry's development is essential to better promote related businesses. Due to its proximity to the main sustainable aviation fuel production base in Zhenhai Refining & Chemical Company, Shanghai, where Company A is located, enjoys lower transportation costs. Significant cost savings can be achieved in transportation costs, marine transport insurance fees, and other areas, leading to a downward shift in costs. Both airlines and consumers can benefit from this cost advantage. In the current generally sluggish economic environment, the highlighted advantage in transportation costs is increasingly attracting sustainable aviation fuel operating companies and user enterprises.

(2) Analysis of the International Economic Environment

In 2023, the Russia-Ukraine conflict erupted, leading several Western countries to close ports and airspace to Russia and seize civilian aircraft leased by Russia. The Group of Seven (G7) and the European Union revoked Russia's "Most Favored Nation" status, effectively excluding it from the World Trade Organization. The United States and Canada banned the import of Russian oil, while the UK is expected to end imports of Russian oil by the end of this year. The EU plans to reduce its direct imports of oil from Russia by about one-third by the end of the year to reduce its energy dependence on Russia. Germany will halt the operational approval process for the Nord Stream 2 natural gas project.

Ukraine is the world's largest exporter of wheat, while Russia is a major agricultural producer and a leading exporter of fertilizers. With the escalating conflict, Ukraine's grain planting and exports will be significantly restricted, leading to an international shortage of food, especially wheat, corn, sunflower oil, and other agricultural products. Additionally, exports of essential agricultural fertilizers such as nitrogen, phosphorus, and potassium fertilizers will also be restricted, causing sustained price increases in grains and oilseeds on the international market. The soaring prices of commodities such as oil, food, and fertilizers may not only plunge the world into an energy and food crisis but also potentially lead to uncontrolled inflation at its highest level in over 40 years.

For Company A's sustainable aviation fuel business, the complex international situation, the multiple impacts of the pandemic and war, the significant increase in international oil prices, the continuous rise in traditional aviation fuel prices, and the heightened pressure on carbon dioxide emissions in Europe all present opportunities for the development of sustainable aviation fuels. The Russia-Ukraine conflict, extreme weather events, rising raw material prices, and the substantial increase in food prices, one of the raw materials for sustainable aviation fuels, pose challenges that need to be addressed. However, the sourcing of sustainable aviation fuel raw

materials from waste cooking oil in the food industry can seize a larger market space in response to these challenges.

4.1.3 Analysis of Social Environment

(1) Population and Geographic Factors

China has a vast territory and abundant population resources, but there exists an imbalance in development between the eastern and western regions. Since the reform and opening-up policies, with the rapid economic development in China, the modes of transportation chosen by the people have been increasing. Especially in the last decade, the rapid development of high-speed trains and airplanes has greatly facilitated the travel of the citizens. However, the number of air travelers in China still lags far behind that of developed countries. According to surveys, approximately 1 billion people in China have never taken a flight, accounting for about 70% of the total population, which is significantly lower compared to the 40% in developed countries.（Yi W J ,Jake S ,Adam P,2023）

On one hand, this data indicates that there are still certain shortcomings in China's aviation transportation industry. On the other hand, it also suggests that there is a huge potential in the aviation transportation industry, especially in the less developed provinces and regions of China. Often, constructing high-speed railways and highways in these areas poses significant challenges, while aviation can more easily cover these regions. By simply building a 2km branch runway, these areas can be connected to the world. The construction of airports can also bring more possibilities for the development of sustainable aviation fuel operations.

(2) Environmental Factors and Changes in Values

With the development and progress of society, contemporary lifestyles have undergone significant changes. People's needs have shifted from merely fulfilling material needs such as clothing, food, shelter, and transportation to demanding a high standard and quality of life. The emphasis on health, environmental protection, and sustainable development has been increasing. In terms of clothing, food, shelter, and transportation, people are also considering how to incorporate requirements related to health, environmental protection, and sustainable development to continuously enhance the quality of life. In industrial production, the Chinese government has put forward the concept that "green mountains and clear waters are as valuable as mountains of gold and silver," emphasizing that economic development should not come at the cost of sacrificing the ecological environment. With the introduction of the "dual carbon" goals, the aviation transportation industry has also joined the ranks of environmental protection and carbon reduction. In the aviation

transportation industry, especially in aircraft energy supply, aircraft parked on the ground have transitioned from traditional aviation fuel-powered air conditioning and lighting systems to being powered by electricity, while airport power departments are transitioning from non-clean to clean electricity sources. Sustainable aviation fuel is currently the most effective means for the aviation transportation industry to pursue environmental protection and carbon reduction, particularly for aircraft in flight.

4.1.4 Analysis of Technological Environment

(1) Technological Level of Sustainable Aviation Fuel

Sustainable aviation fuel is produced from renewable resources such as animal and plant oils or agricultural and forestry waste. During production, it absorbs carbon dioxide from the atmosphere and emits carbon dioxide when burned, with some of the carbon dioxide being in a cyclical state. Therefore, the production and use of sustainable aviation fuel have a carbon reduction effect. Compared to traditional aviation fuel, sustainable aviation fuel can reduce carbon dioxide emissions by at least 55% during the production process, with a potential reduction of up to 90%. The production processes of sustainable aviation fuel mainly include hydrogenation, gasification-Fischer-Tropsch synthesis, biomass pyrolysis, and catalytic cracking, with hydrogenation and gasification-Fischer-Tropsch synthesis being more commonly used. Countries such as the United States, Canada, Norway, and Finland have established a scaled market for sustainable aviation fuel, with a complete industry chain comprising raw materials, refining, transportation, fueling, and certification. Seven airports in the United States, Sweden, and Norway have achieved the blending and fueling of sustainable aviation fuel with traditional fossil aviation fuel, and eight airports have conducted batch fueling of products blended with sustainable aviation fuel and traditional fossil aviation fuel. Five types of sustainable aviation fuel have been included in ASTM D7566 appendix and have undergone fuel test flights. The hydrogenation route (hydrogenated oil deoxygenation-hydrogenation modification) in the hydrogenation process has been gradually put into production due to its lowest production cost.

4.2 Business Analysis and Market Environment Analysis

4.2.1 Civil Aviation Industry Overview

In 2023, China's civil aviation passenger market significantly rebounded (domestic route volume recovery outpacing international routes); domestic freight began to exert force in the second quarter, showing improved market performance, while the international freight market still faced uncertainties, leading to relatively weak growth. In 2023, civil aviation capacity supply orderly

recovered, transportation efficiency indicators increased, but had not yet returned to the level of 2019.

The release of domestic air passenger demand in 2023 drove a rapid recovery in transport volume, with domestic air passenger volume surpassing that of 2019; international routes and flights resumed in an orderly fashion, but due to factors such as geopolitics, air rights/slots/departure procedures/capacity at foreign airports, the recovery of international civil aviation passenger volume lagged behind. The air cargo market was slightly sluggish in the first quarter of 2023, but with the recovery of the consumer market in the second, third, and fourth quarters, as well as the increase in belly cargo capacity, the pace of freight transportation accelerated in the market. The international air cargo market was more affected by global trade uncertainties, resulting in relatively weak growth in 2023.（Civil Space Administration of China）

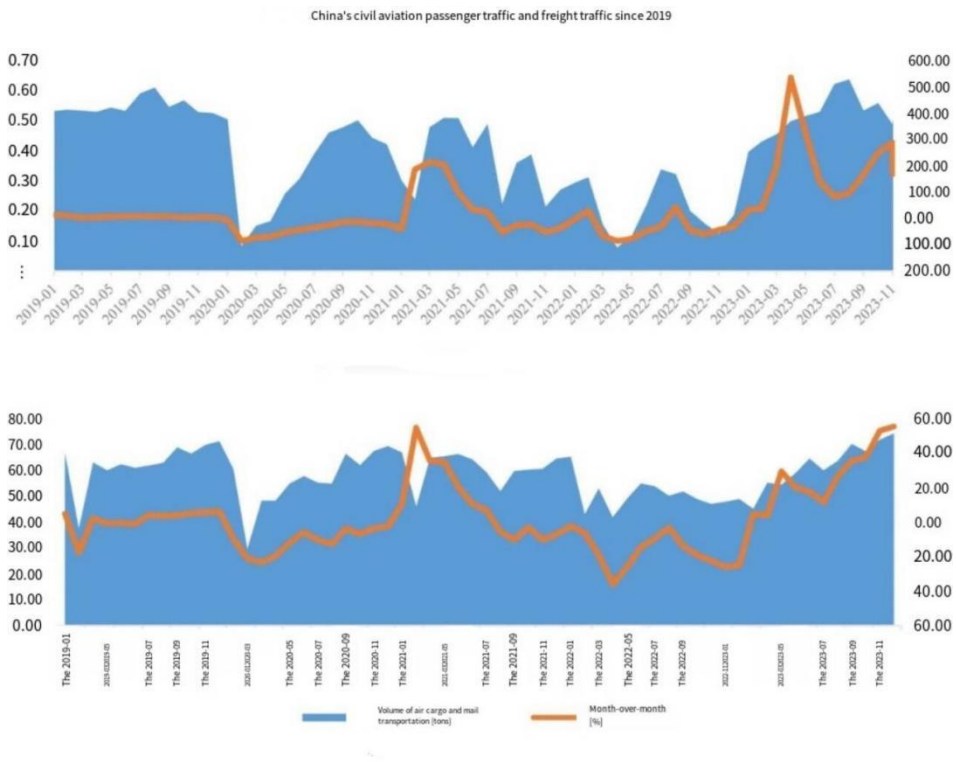

Figure 2. Passenger and cargo volume of civil aviation in China.（Civil Space Administration of China）

4.2.2 Petroleum Market Analysis

The petrochemical industry, also known as the petroleum chemical industry, typically refers to the processing industry that uses petroleum and natural gas as raw materials to produce petroleum or

petrochemical products. Petroleum products, also known as oil products, encompass various fuel oils such as gasoline, kerosene, diesel, as well as lubricating oils, liquefied petroleum gas, petroleum coke, paraffin wax, asphalt, etc. Aviation fuel belongs to the category of kerosene.

In the Chinese market, taking China Petroleum & Chemical Corporation (Sinopec) as an example, the petrochemical industry still mainly focuses on gasoline and diesel, far exceeding the production volume of other products such as kerosene, ethylene, synthetic resins, etc. The energy concentration in the petrochemical industry is relatively high, making it one of the high-energy-consuming and high-emission industries in China's industrial sectors, accounting for 4%-5% of the national total emissions annually. According to forecasts by the International Energy Agency, by 2050, nearly half of the global increase in demand for crude oil will come from the petrochemical industry, surpassing freight, aviation, and maritime transport to become the largest driver of crude oil consumption growth.（Yi W J ,Jake S ,Adam P,2023）

During the "13th Five-Year Plan" period, the petrochemical industry in China embarked on an industrial upgrade with scale and refining integration as the main direction. However, factors such as the expansion of refining scale and the growth of ethylene production capacity have led to an overall increase in energy consumption in the petrochemical industry. The global COVID-19 pandemic has brought significant impact to the petrochemical industry. In the domestic petrochemical product market, the decline in kerosene production is particularly evident, reaching a decrease of 27.7%.

4.2.3 Carbon Market

The carbon market typically consists of primary and secondary markets. The former is the carbon quota trading market, where controlled-emission enterprises are the main trading entities, and the trading object is carbon quotas. Enterprises with actual emissions exceeding their initial carbon quotas can purchase surplus quotas from other enterprises. The latter is the carbon credit trading market, which primarily involves voluntary emission reduction enterprises, with carbon credits as the trading object. Controlled-emission enterprises can use carbon credits to fulfill their quota obligations, but to ensure effective emission reduction by controlled-emission enterprises, there are limits on the usage, generally not exceeding 5% or 10% of the carbon emission quotas that controlled-emission enterprises should clear.（https://www.chinacrc.net.cn/）

The carbon market operates under a total quantity control and trading model. The annual emission cap is determined based on policy requirements, and carbon quotas are allocated to controlled-emission enterprises. Subsequently, carbon quota and carbon credit trading are organized to find the lowest-cost emission reduction path through market mechanisms. The total quantity cap

determines the systemic impact on controlled-emission industries, while the quota allocation method determines the structural impact on controlled-emission industries.

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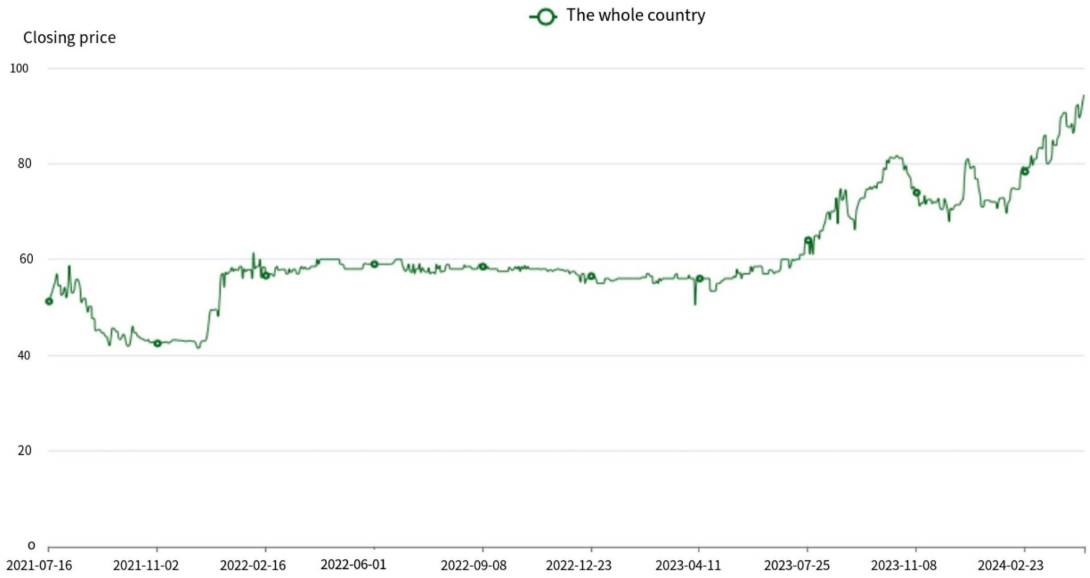

Figure 3. The 2021 Price and trading volume of the national carbon market from July to 2024 February.（https://www.chinacrc.net.cn/）

On July 16, 2021, China's carbon market officially launched online trading, with over 50% of key emitting units participating in trading. The cumulative trading volume of carbon emissions quotas reached nearly 200 million tons, with a total turnover of about 8.5 billion yuan. The market price remained between 80-90 yuan/ton for the past six months, a significant increase from the opening price of 48 yuan/ton on July 16, 2021.

However, China's carbon market also faces certain challenges. Firstly, the current trading entities in the national carbon market are only key emitting units in the power generation industry. The similarity in industry and entity attributes leads to similar trading purposes and risk preferences among trading entities. The transactions are mostly driven by compliance requirements, highly influenced by industry policies, and prone to forming a one-sided market.

Secondly, the national carbon market currently only deals with carbon emissions quotas in the spot market. Trading in emission reduction amounts is also relatively scattered, and the market structure has not yet formed a trend of synchronous advancement between primary and secondary markets. Carbon finance and carbon asset management products are still in the process of research and improvement, and there is a lack of effective tools for enterprise-internal financing, carbon trading, asset management, and risk management needs.（Yi W J ,Jake S ,Adam P,2023）

Furthermore, as a policy tool created through market mechanisms, in addition to carbon emissions trading, China also has energy rights trading, green electricity trading, pollutant emissions trading, carbon inclusiveness, and other environmental energy markets. However, there is a lack of systematic, comprehensive, and coordinated planning for greenhouse gas emission control and the allocation of other environmental energy resources.

4.2.4 Industry Competitiveness Analysis of the Sustainable Aviation Fuel Business

This section conducts an analysis of the industry competitive structure for the sustainable aviation fuel business based on Porter's "Five Forces Model." The "Five Forces Model" provides a basis for analyzing the strengths and weaknesses of Company A's sustainable aviation fuel business within the industry and for formulating competitive strategies for sustainable aviation fuel.

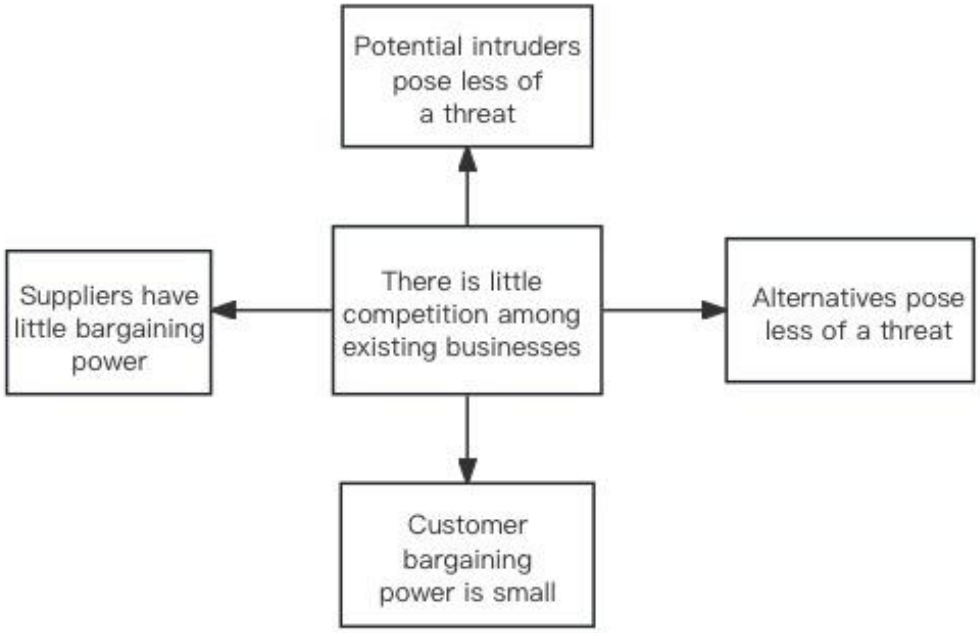

Figure 4. Porter's five forces model for sustainable aviation fuel operations

(1) Low Threat of Potential Entrants

According to the requirements of CCAR Part 55, entities that have not obtained the "Civil Aviation Fuel Supply Enterprise Airworthiness Approval" issued by the Airworthiness Department of the Civil Aviation Administration of China (CAAC) are not allowed to engage in aviation fuel supply business. In the traditional aviation fuel supply market, the supply of aviation fuel in China is currently dominated by China Aviation Oil or joint ventures in which China Aviation Oil participates in various forms. On the other hand, sustainable aviation fuel belongs to a new type of aviation fuel production technology [26], with high requirements for the entire chain from raw materials to processes. Therefore, the supply market for sustainable aviation fuel is consistent with the conditions of traditional aviation fuel, and even higher requirements for downstream inspection and testing. Based on this, it can be concluded that the barriers for potential entrants are very high, and the threat is relatively small.

(2) Low Threat of Substitutes

Currently, the main substitutes for sustainable aviation fuel are green energy sources such as electric batteries, liquefied electricity, and hydrogen energy. Due to limitations in aircraft engines, aircraft fuel tanks, production and refining processes and technologies, the technical barriers are

high. Only a very small number of small aircraft have conducted verification flights internationally, and in the short term, they will not impact sustainable aviation fuel. Therefore, the possibility of new substitutes entering the market is very small.

(3) Low Bargaining Power of Suppliers

Company A's domestic suppliers of traditional aviation fuel mainly come from eastern coastal regions such as Nanjing, Quanzhou, Zhoushan, Ningbo, Dalian, and Qingdao, while foreign suppliers mainly come from East Asian and Southeast Asian countries such as South Korea, Singapore, and Malaysia. For domestic suppliers, due to policy influences, their bargaining power is relatively small. For foreign suppliers, the market is more mature, and there is a certain room for negotiation. Currently, sustainable aviation fuel is refined and supplied domestically by Zhenhai Refining & Chemical, and international sources have not been introduced yet. Referring to the domestic suppliers of traditional aviation fuel, their bargaining power is relatively small.

(4) Medium-Low Bargaining Power of Customers

Due to pricing by the National Development and Reform Commission, there is little room for negotiation in domestic customers' purchase prices. However, for the international routes of the three major state-owned airlines, there is a certain room for negotiation, and they can usually be given certain discounts. Foreign airlines have a higher level of marketization and thus have some room for negotiation. Therefore, overall, the bargaining power of customers should be considered medium-low.

(5) Non-Intense Competition among Existing Enterprises

Sustainable aviation fuel is a new type of aviation fuel. Since the aviation fuel supply market is dominated by China Aviation Oil and its joint venture subsidiaries, and according to the life cycle theory, the sustainable aviation fuel business is in its initial stage, with very few competitors engaged in sustainable aviation fuel supply. Especially in the Yangtze River Delta region, there are even fewer competitors. It is currently known that China Aviation Oil East China Branch has engaged in sustainable aviation fuel business, while aviation fuel supply companies at other airports in the Yangtze River Delta region only provide single traditional aviation fuel refueling. Therefore, from the perspective of sustainable aviation fuel business alone, the competition among existing enterprises is not intense.

5 Company A's Internal Analysis for Zero Emissions in Aviation

5.1 Capability Analysis

(1) Aviation Fuel Supply Capability

Currently, the main refineries that can supply aviation fuel to Pudong Airport within Shanghai are: Shanghai Petrochemical, Gaoqiao Petrochemical, and SECCO Petrochemical. Shanghai Petrochemical and Gaoqiao Petrochemical are the main suppliers, while SECCO Petrochemical serves as a backup. Shanghai Petrochemical is a holding subsidiary of China Petroleum & Chemical Corporation (Sinopec), located in Jinshan District, Shanghai. Its current aviation fuel production capacity is 16 million tons per year, and with capacity adjustment, it can produce up to 22 million tons of aviation fuel annually. The total aviation fuel storage capacity of Shanghai Petrochemical's plant is 95,000 m³. It mainly transports aviation fuel through wharf shipping, with about one-third supplied to Puhang Oil Depot. Gaoqiao Petrochemical is affiliated with China Petrochemical Corporation (Sinopec Group) and is located in Pudong New Area. Its current aviation fuel production capacity is 15 million tons per year, and the total aviation fuel storage capacity is 40,000 m³. The aviation fuel produced by Gaoqiao Petrochemical can directly enter the Gaoqiao Transit Oil Depot through pipelines from the refinery. Apart from Shanghai, other refineries that supply aviation fuel to Shanghai from other regions mainly include Yangzi Petrochemical (Nanjing), Sinochem Quanzhou (Quanzhou), Zhejiang Petrochemical (Zhoushan), Zhenhai Refining & Chemical (Ningbo), Dalian West Pacific (Dalian), Qingdao Petrochemical (Qingdao), etc. They are mainly located in the eastern coastal areas and transport aviation fuel to Shanghai via 10,000-ton oil tankers to ensure the aviation fuel supply of Pudong Airport.

(2) Aviation Fuel Transportation Capability

Currently, the main oil pipelines that can transport aviation fuel to Pudong Airport in Shanghai are: Puhang Oil Pipeline and Gaohua-Pudong Airport Oil Pipeline. The Puhang Oil Pipeline runs from Puhang Transit Oil Depot to Pudong Airport Oil Depot. It was completed and put into operation in 2009, with a total length of about 18.5 km, a pipe diameter of DN500, a design pressure of 6.4 MPa, and an actual operating pressure of 2.5 MPa. There are 4 oil pumps in the oil pump shed of the Wuhaogou Transit Oil Depot, responsible for pumping oil to the Pudong Airport Oil Depot. Since the Wuhaogou Transit Oil Depot needs to share a section of the pipeline for supplying oil to both Pudong and Hongqiao Airports, a time-sharing transmission method is required. If supplying oil to Pudong Airport alone, the annual transmission capacity can reach 10 million tons. The Gaohua-Pudong Airport Oil Pipeline runs from Gaoqiao Transit Oil Depot to Pudong Airport Oil Depot. It was completed and put into operation in 1999, with a total length of about 42 km, a pipe

diameter of DN300, an oil flow rate of 500 m³/h, and a design pressure of 5.0 MPa. Due to its proximity to residential areas, the State Administration of Work Safety has restricted its use at reduced pressure, and the operating pressure must not exceed 1.5 MPa, with an annual transmission capacity of 3.5 million tons.（Sustainable Aviation Fuel (SAF) Production,2022）

(3) Aviation Fuel Testing Capability

The Inspection and Measurement Center under Company A obtained the Airworthiness Certificate issued by the Airworthiness Certification Department of the Civil Aviation Administration of China in 2017 and passed the re-evaluation in 2019. Its testing capabilities cover all specification inspection items for aviation fuels such as Jet A-1 jet fuel and No. 3 jet fuel, and it has obtained the "CNAS" accreditation certificate. It has the ability to independently carry out full-specification inspections of aviation fuel.

Figure 5.CNAS certification（Internal information of the company）

6 Threat-Based Strategic Decisions

Company A's overall strategy is "integrated operations, maximized economies of scale, and in-depth informatization". Revolving around the "three-ization" strategy, the company actively responds to new market competition situations, adapts to customers' higher and newer requirements, continuously improves the company's core competitiveness, and provides customers with safer, more efficient, and more professional support services. The company closely follows the development pace of world-class aviation fuel supply enterprises, benchmarks against industry leaders at home and abroad in an all-round way, and takes "safe aviation fuel, responsible aviation fuel, benchmark aviation fuel, valuable aviation fuel, and happy aviation fuel" as the main paths and important starting points to strive to achieve the company's grand goals and realize the company's beautiful vision.

The competitive strategy for the sustainable aviation fuel business is a specific embodiment of the company's overall strategy, and its core is to gain a competitive advantage for the company in this business segment to achieve high-quality development of the company. The previous text systematically analyzed the external and internal environments of Company A and identified the main internal and external factors affecting the development of Company A's sustainable aviation fuel business.

6.1 SWOT Analysis

In the information matching stage of the SWOT analysis, the opportunities and threats in the external environment faced by Company A, as well as the strengths and weaknesses in its internal environment, are matched and combined with each other. Based on the combined comprehensive factors, strategic planning and consideration are carried out.

Therefore, based on the above analysis, Company A should prioritize a differentiation strategy for its sustainable aviation fuel business, fully recognizing its internal weaknesses, effectively responding to external threats and challenges, and continuously making up for its shortcomings. The company should further plan and construct the fuel supply infrastructure at Pudong Airport, seek more sustainable aviation fuel supply sources, explore new aviation fuel refueling models, and enhance its ability to carry out sustainable aviation fuel refueling.

6.2 Implementation of Competitive Strategy for Sustainable Aviation Fuel Business

The sustainable aviation fuel business is a relatively special type of aviation fuel business, and its specific business strategic objectives still cannot be separated from the company's overall strategic objectives. Therefore, the realization of the competitive strategic objectives of the sustainable

aviation fuel business will help Company A achieve its overall strategic development goals. According to the results of the strategic choice for the sustainable aviation fuel business in the previous chapter, Company A's competitive strategy for the sustainable aviation fuel business should first choose a differentiation strategy.

A differentiation strategy refers to a company being different from other companies in terms of the products, services, and even corporate cultural concepts it provides, so that the company's products and services are differentiated from competitors' products, thereby gaining the specificity to attract consumers to purchase, obtaining premium benefits and competitive advantages. By implementing a differentiation strategy in certain business areas, companies can effectively prevent competitors' encroachment, form entry barriers, avoid the competitive threat of substitutes, enhance their ability to respond to suppliers, and weaken consumers' bargaining power.

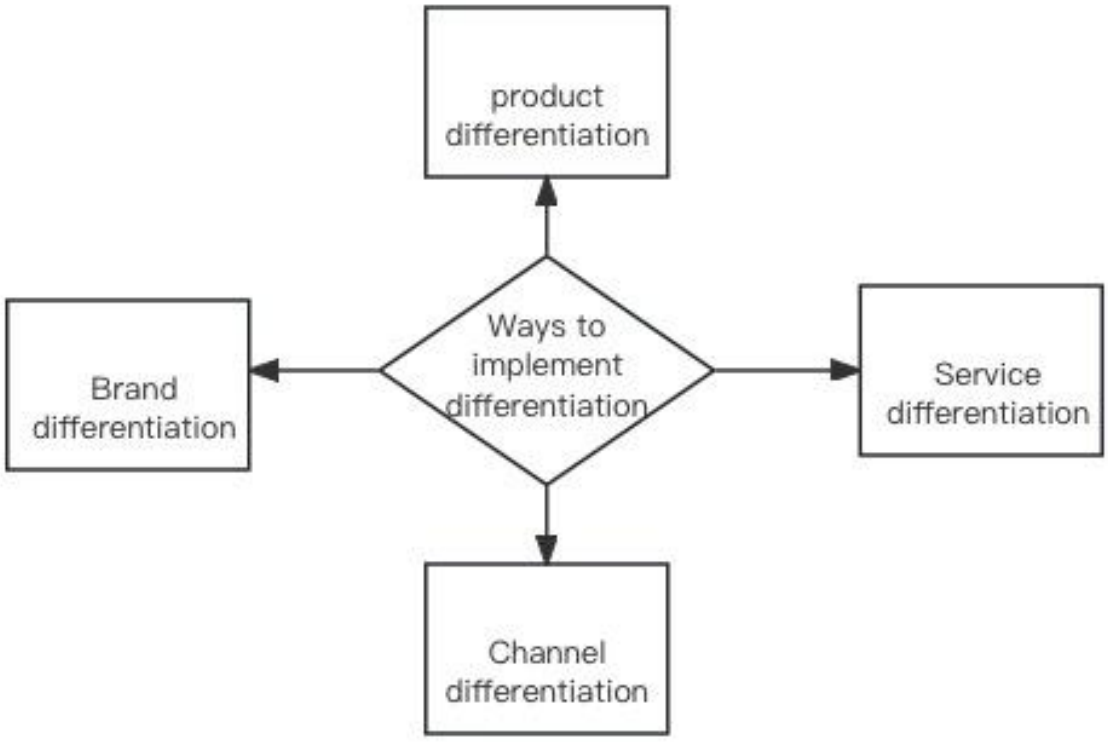

Figure 6.A company to implement the strategy of differential competition

Company A should first clarify the promotion plan and strategic objectives of the sustainable aviation fuel business competition strategy, and focus on advancing the deployment of related work around the four aspects of product differentiation, brand differentiation, service differentiation, and channel differentiation in the differentiation strategy.

6.3 Safeguard Measures for Zero-Emission Business

6.3.1 Human Resources Guarantee

The construction of a talent team is the standard of a company's core competitiveness, and excellent human resources can ensure the smooth implementation of various strategies. Improvements can be made in the following aspects.

First, it is necessary to improve the business quality of employees, encourage employees to actively participate in various aviation fuel-related training and learning, especially knowledge in the field of sustainable aviation fuel, obtain multiple types of certificates, and cultivate dual-channel talents with both professional titles and skills; second, optimize the job setup, reasonably allocate employees according to production and operation needs, ensure that the type and difficulty of employees' work match their positions, especially for the sustainable aviation fuel business, full-time or part-time positions and personnel should be established to adapt to the development of the business; third, establish a sound long-term performance appraisal mechanism, fully implement a performance appraisal system for all employees, reasonably assess the workload of employees, appropriately increase the income gap between employees, and improve employee satisfaction; fourth, strengthen the intensity of corporate internal training and continuously improve the comprehensive quality and ability of employees. The sustainable aviation fuel business also requires collaboration, especially in countries and regions such as Europe and the United States, which have rich experience and a long operating history in the field of sustainable aviation fuel business. Therefore, it is also necessary to continuously strengthen technical exchanges with domestic and foreign sustainable aviation fuel supply fields, and use visits or introduce foreign experts or technical teams to the site to guide the sustainable aviation fuel business.

6.3.2 Information Technology Guarantee

In recent years, Company A has successively established professional information technology software such as ERP management system, metering and inventory system, customer business system, electronic invoice system, OA office system, equipment management system, and safety information system, which greatly improved work efficiency and reduced errors caused by human misoperation and carelessness. However, the existing information systems all require PC computers for operation. In fire and explosion-proof areas, PC computers cannot work, and only by further promoting explosion-proof computers and mobile phone operations can various operational activities be carried out more portably. Only more intelligent and convenient information technology can be better applied to the supply guarantee of sustainable aviation fuel.

It is necessary to make full use of information system means, such as the existing ERP system, to do a good job in the procurement management, in-transit transportation management, inventory dynamic management and adjustment of sustainable aviation fuel, actively develop information software in the field of sustainable aviation fuel operation, such as new functions of the ERP system, quality testing software that meets the requirements of the laboratory system, and billing software that meets the needs of airlines.

6.3.3 Public Relations Guarantee

Maintaining public relations is extremely important for companies to maintain and enhance their brand image, and it is also of great significance for winning government policy support and gaining customer satisfaction and favorability. Therefore, in the implementation process of the sustainable aviation fuel business competition strategy, efforts should be made to maintain good public relations, which are mainly reflected in the following three aspects:

(1) Maintain good relations with government departments, and set up a government affairs group led by the corporate development department or finance department. With the implementation of the "dual carbon" policy and its full deployment in the civil aviation field, the Civil Aviation Administration of China and Shanghai have successively issued relevant documents to support the commercial application of sustainable aviation fuel. However, due to price factors and the calculation of carbon emission reductions of sustainable aviation fuel, relevant government departments need to provide further policy support, including but not limited to financial subsidies and carbon emission reduction offsets.

(2) Maintain good relations with surrounding airport aviation oil companies and establish a strategic development research group for sustainable aviation oil. Jointly establish a strategic development research group for sustainable aviation fuel with Shanghai Hongqiao Airport, Hangzhou Xiaoshan Airport, Ningbo Lishe Airport, etc., to discuss and analyze the most suitable supply model for sustainable aviation oil and the problems found in the supply process, allocate supply resources, and provide better sustainable aviation fuel supply services.

(3) Maintain good relations with customers, actively carry out customer exchange activities, regularly visit customers, set the number of customer visits and the effects achieved as corresponding KPI indicators and incorporate them into the performance appraisal of the customer service department; implement dedicated personnel for key customers and focus on risk customers management, maintain close contact and dynamic monitoring; large customers and customers with high contribution rates can be given certain discounts in terms of price differences. Finally, on the basis of maintaining good customer relations, fully communicate with domestic and

foreign airlines, especially airlines with certain experience in using sustainable aviation fuel and cargo airlines, and sign purchase and sales contracts for sustainable aviation fuel on the basis of providing sufficient quality testing, and gradually promote the daily supply of sustainable aviation fuel.

6.3.4 Financial Guarantee

The company's sustainable aviation fuel business adopts a differentiation strategy, especially the need for infrastructure construction, which will face large capital expenditures. Currently, the civil aviation industry is facing epidemic prevention and control and large fluctuations in international oil prices, and the company is at risk of losses. The company should actively strengthen the collection of accounts receivable, adjust the inventory management of aviation fuel, adopt a sales-based procurement model, and properly deal with the epidemic and oil price situation. If sustainable aviation fuel can develop rapidly, then infrastructure construction should be put on the agenda as soon as possible, and the company's investment will be greater, specifically as follows:

(1) Ensure timely capital recovery. Customers without agreements can be charged a certain percentage higher.

(2) According to the international oil price and the aviation fuel price released by the National Development and Reform Commission, combined with the company's sales situation, do a good job in the strategy of purchasing based on sales to optimize inventory management. When oil prices rise, it is necessary to ensure that there is a certain amount of inventory that can realize the appreciation of inventory. When oil prices fall, it is necessary to ensure that there is no excessive inventory that causes inventory depreciation.

(3) Make reasonable use of the annual safety production funds to carry out the necessary infrastructure construction in the field of sustainable aviation fuel business. At the same time, apply for new financial support from shareholders to complete infrastructure construction in the early stage of the business to cope with the rapid development of subsequent business.

7 Conclusions and Improvements

Based on the relevant theories of strategic management, this paper fully uses relevant tools and methods to conduct related research with a focus on Company A's sustainable aviation fuel business. In the research process, the PEST model, Porter's five forces model, and SWOT matrix were used to analyze the sustainable aviation fuel business and provide data reference for the formulation and selection of competitive strategies for the sustainable aviation fuel business. Literature analysis, interview method, questionnaire survey method and expert survey method were used to investigate and analyze relevant literature in the field of sustainable aviation fuel business at home and abroad and relevant experts in the same industry in China, and discuss what competitive strategy Company A should formulate in the field of sustainable aviation fuel business, and corresponding conclusions were drawn.

According to the analysis and statistics of relevant research results, Company A should give priority to a differentiation strategy. In order to ensure that the company's sustainable aviation fuel differentiation strategy can be effectively applied to the company's production and operation activities, relevant measures are proposed in terms of strategy implementation according to the four elements of product differentiation, brand differentiation, service differentiation and channel differentiation in the differentiation strategy; in terms of strategic guarantee, corresponding contents are proposed from four dimensions: human resources guarantee, information technology guarantee, public relations guarantee, and financial guarantee. The implementation of the above-mentioned measures will help Company A smoothly carry out sustainable aviation fuel business, become an aviation fuel supply company with unique competitive advantages, and further move towards the overall goal of "creating a world-leading benchmark aviation oil company".

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Appendices

Appendix 1. SWOT analysis