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Comments on air cargi supply chain : essay of identification, assessment and control of risk

Jun Song

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THÈSE

Pour obtenir le grade de

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Présentée par

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Dans l'**École Doctorale de Sciences de Gestion ED 275**

Chaîne d'approvisionnement du fret aérien: Essai d'identification, d'évaluation et de contrôle des risques

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Chapter 1 Introduction

Every year, The World Bank will publish one World Development Report which is considered to be the core issue for the world development, and the report name of 2013 is Managing Risk for Development which will focus on risk managing for the world development. Risk is one world topic for everyone and every organization, as the 2013 report said, “The path of economic development is paved with risks and opportunities”.

As a practitioner in air cargo industry, I agree that the development path of Chinese air cargo industry is paved with risks and opportunities, while risk should be comprehensively and deeply studied by the researchers, practitioners and other stakeholders. At the same time, air cargo industry is one young and promising industry which has close connection with national economy development. The purpose of this research is to understand the risk within air cargo industry and try to manage risks.

1.1 Risk in Air Cargo Industry

Air Cargo is a US\$50 billion business that transports 35% of the value of goods traded internationally and a critical part of the airline business which, as a whole, is the US\$490 billion heart of a value chain that supports 32 million jobs and US\$3.5 trillion of economic activity. It is an important industry that is critical to global business. (<http://www.iata.org/whatwedo/cargo/pages/index.aspx>)

Air cargo is highly fragmented. The presence of truly global players is limited which in the airline business can be explained by restrictions on cross-border ownership and control as well as designation of traffic rights by governments. A good illustration of the fragmentation is the fact that there are some 900 airlines, just four truly global integrations but there are approximately 4,500 IATA-accredited forwarding agencies and several thousand non-accredited

forwarders (Doganis, 2002)

Air cargo industry is easily influenced and affected by many external factors, such as war, economy, political events and environment. From the nature, it is one risky and fragile industry.

Under the background of world economy down, Chinese air cargo industry becomes the new engine of world air cargo industry, while there are still many risks which threaten the Chinese air cargo industry development.

1.2 About the Author

As a practitioner in air cargo industry, I have been working in this field for more than 13 years, from a worker in the basic line to the current region manager. In the past practical working, I have understood deeply this industry from daily working and data of my company. From 2006, I started to study in Grenoble University under the instruction of Professor Alain Spalanzani, this is the start point in theory. I have also attended some international conferences and meeting to further my understanding. Based on my own knowledge and experience, air cargo industry should be regarded through supply chain point and risk management, under the risky society background, we should manage air cargo industry from the point of risk management, because I have been meeting lots of risks and uncertainties in my daily work. If we can identify and control these risks in air cargo industry, it will be very beneficial for me, for my company and for the industry.

1.3 Research Questions and Objectives

1.3.1 How about the air cargo industry from the points of world level and in China

Air cargo industry is one international and multinational industry, which can be easily affected by international events, such as nature disasters, environment worsening, social activities. The world famous and strong airlines all have

international activities and business. In China, the top 5 airlines all have international air cargo business. Therefore, firstly we should understand the nature, developing history, industry structure and trends of air cargo industry on the world level. In this research, it tries to solve the Chinese problems, while it should give a clear explanation of air cargo industry from the points of China and world level.

1.3.2 How about the orientation, Evolution, current and future of Chinese air cargo industry

Chinese air cargo industry is one important and especial part of the world air cargo industry. It only has about 30 years history, and has a very high developing speed, while it contributes great to the world air cargo development. This research will focus to find out measures to solve Chinese air cargo questions under the world air cargo developing environment; therefore I should understand all the aspects of Chinese air cargo industry.

1.3.3 Which factors are the key risk factors in Chinese air cargo industry

Certainly, oil price, government policy, war, environment disasters and so on are parts of risks which can affect air cargo industry. Under the background of globalization, information technology advance, world environment worsening, there must be many risks in Chinese air cargo industry, and the key point is to dig out all the important risks. The question is to use some scientific and useful measures to dig out all important risks for Chinese air cargo industry; this is the question of risk identification.

1.3.4 How to evaluate and rank the risk factors?

We all know there are many risks in Chinese air cargo industry, for the government, maybe the human and goods security are the most important, and for the owner of airlines, the economic benefit is the most important. Different stakeholders have different opinions, so it is really important to find out scientific and practical tools or measures to evaluate all the important risks, and then to give a reasonable and practical explanation.

1.3.5 How to control important risks?

For any stakeholders, the final aim is to control the identified and evaluated risks, to be more sure and certain on the uncertainties. For some force majeure such as flood, typhoon, earthquake, insurance is the best way to control. For the oil price fluctuation, the options maybe are hedge, futures and oil store. While there still are many important risks, which we should control integrated.

1.3.6 Is there one practical and efficient platform which can control important risks?

Chinese government proposed one platform which will connect all the important stakeholders involving in the air cargo business, such as central government, customs, airlines, forwarders, carriers, consignees, banks, and so on. Because of the author's working in the committee, this platform perhaps can be the measures to control all important risks efficiently. In this research, the relationship between risk control and platform will be studied.

1.3.7 Objectives of this research

Firstly, before starting to do the research, it should take a deep and comprehensive understanding of air cargo industry, the nature, developing history, structure, developing trends of Chinese air cargo industry should be studied, including world level.

Secondly, facing many risks in air cargo industry, this research will use practical and useful tools and measures to identify these risks in Chinese air cargo industry. Then these identified risks should be analyzed.

Thirdly, these identified risks should be ranked, this is the process of evaluation, and then the ranking order should be analyzed.

Fourthly, it tries to figure out one possible platform to control risks in Chinese air cargo supply chain. As so far, there is one platform proposed by Chinese central government, the function of this platform should be studied.

Fifthly, in practice and theory, there are many tools and measures for risk identification and evaluations, while based on the air cargo supply chain, the practical and efficient measures and tools should be dig out.

1.4 Research Framework and Structure

This research is the cross research among air cargo industry, supply chain management and risk management. Organization behavior theory, marketing, strategy management, game theory and E-commerce are the concerned theories.

As showed in figure 1.1, the research framework figure describes clearly the research lines. Firstly, the industry background and concerned theories should be studied, and then to choose risk identification measures, in this step, it will do literature review on what measure should be chose, and why. Using practical and efficient measures, it will identify the risks in Chinese air cargo supply chain. After getting the identified risks, it will analyze all the risks.

After the process of risk identification, the next step is assessment. There are many risk assessment measures, such as fuzzy comprehensive evaluation method, Monte-carlo method, artificial neural network, factors analysis, SWOT method and ANP, it will do the literature review and analysis to answer why ANP will be chose. After the argumentation, it will use ANP to evaluation. Correspondingly, it will analyze the evaluation result.

For any identified and evaluated risks, the final aim is to control them. For different risks, there are many different options. The possible options will be analyzed, and base on the option analysis, the ACSCEP will be proposed. This research will analyze the function of this platform, and maybe it can control most of the important risks in Chinese air cargo supply chain.

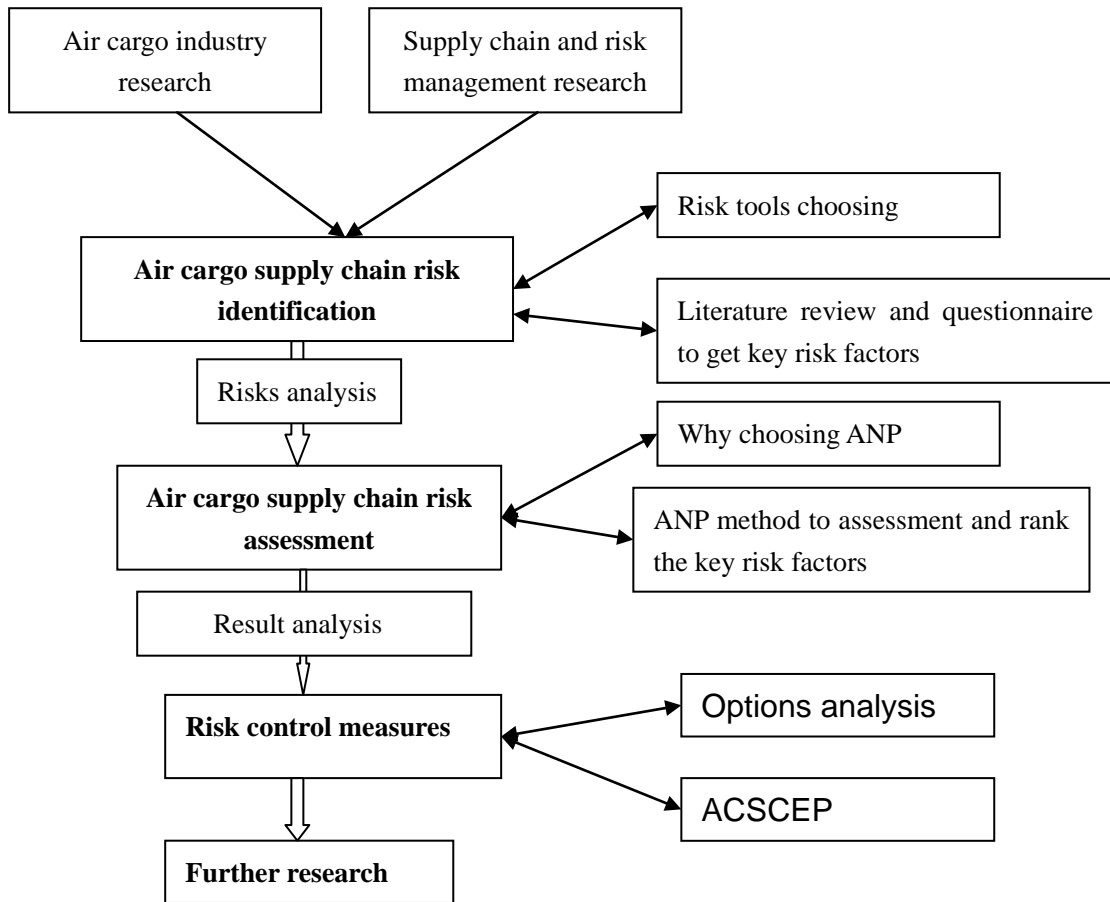


Figure 1. 1 Research framework

Based on the research framework, the structure of this research can be showed as following figure 1. 2.

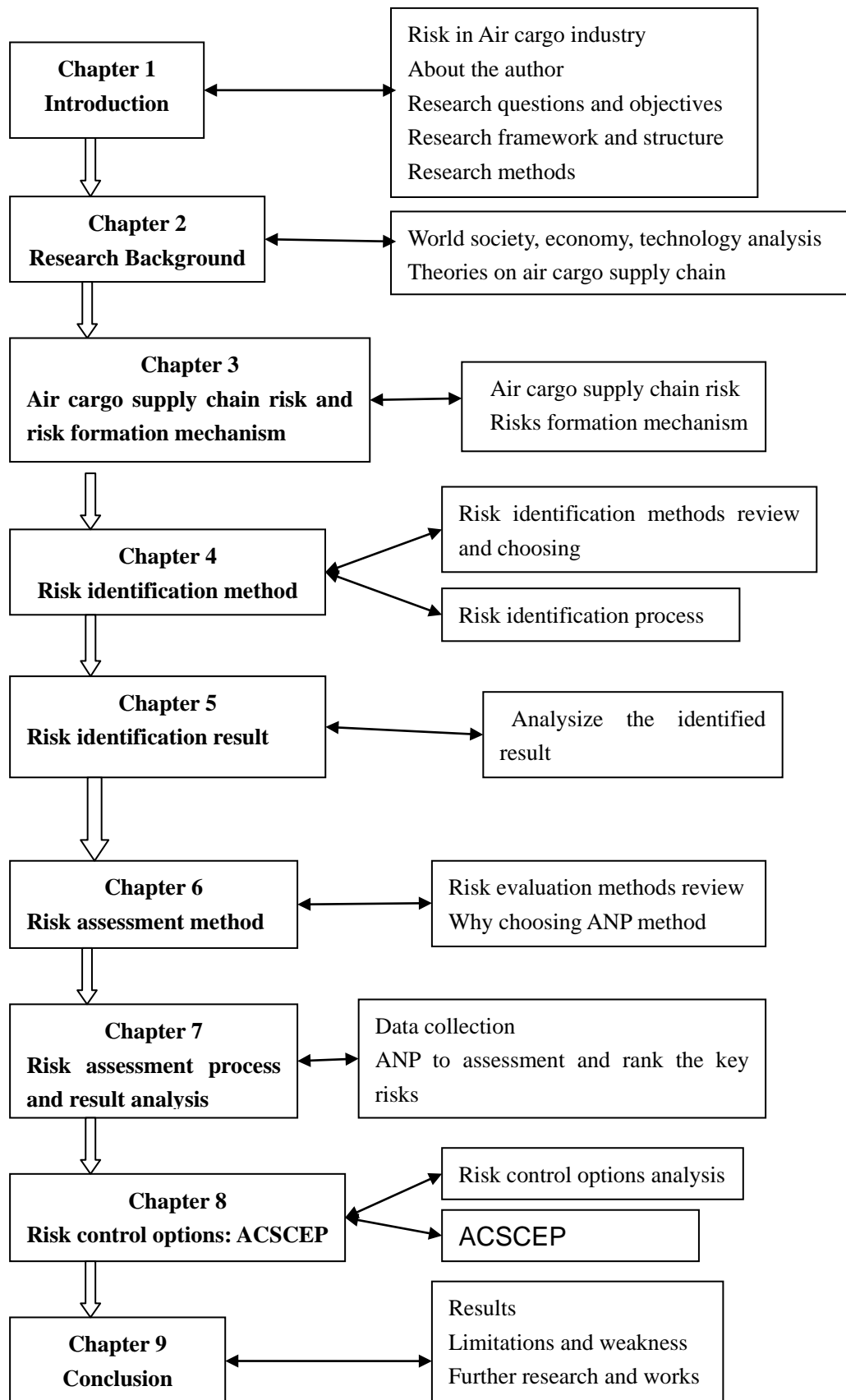


Figure 1. 2 Research structure

1.5 Research Methods

This research will focus on the risk management in the fields of air cargo industry in China under the concept of supply chain, therefore, it should make comprehensive literature review in air cargo industry, supply chain management, risk management, world economy and so on.

Literature review will be used on how to choose risk identification method, risk evaluation method, there are many methods on risk identification and evaluation, every method has different advantages and weakness, through literature review, it can find out practical and efficient method to identify and evaluate risks.

During the process of risk identification and evaluation, data will be collected through expert interviews and questionnaires, these data will be the input data for the final result.

The core method used is ANP method, it will be used to rank and evaluate the key risk factors, and Superdecision software will be used to get the final evaluation result.

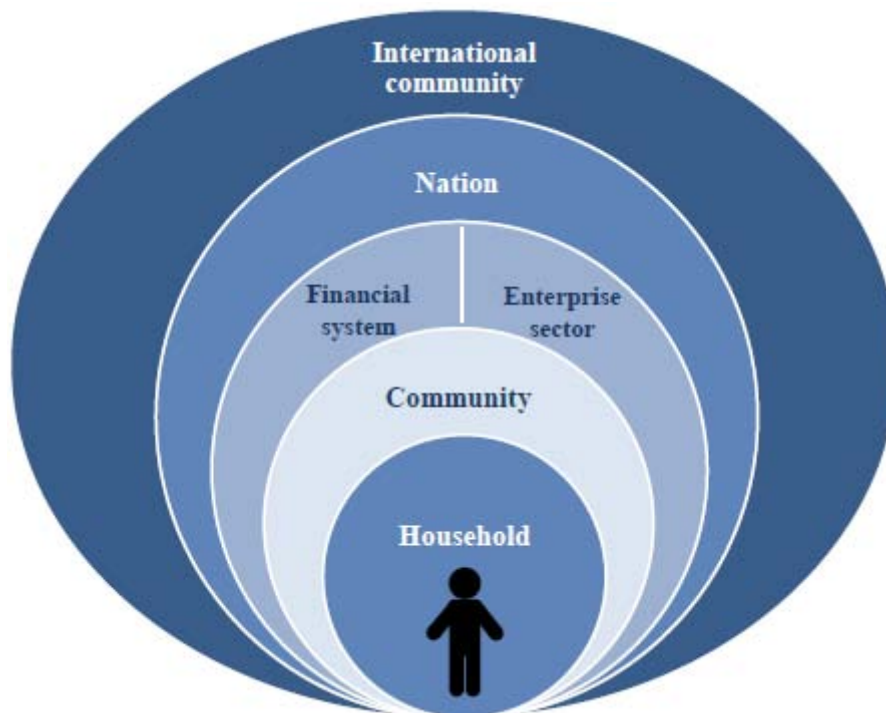
The ACSCEP model was proposed by China central government, through the qualitative analysis and experts interviewing, the feedbacks and the function s will be dig out.

Chapter 2 Research Background about the World and the Air Cargo Industry

Industry

2.1 Introduction

The focus of this research is on the risk of Chinese air cargo industry, and because of the international character of air cargo industry, it should describe the international economy as a whole and explain the structure of air cargo industry.



Source: World development report 2014(2012), p16

Figure 2. 1 Individual and society: risk management is shared responsibility

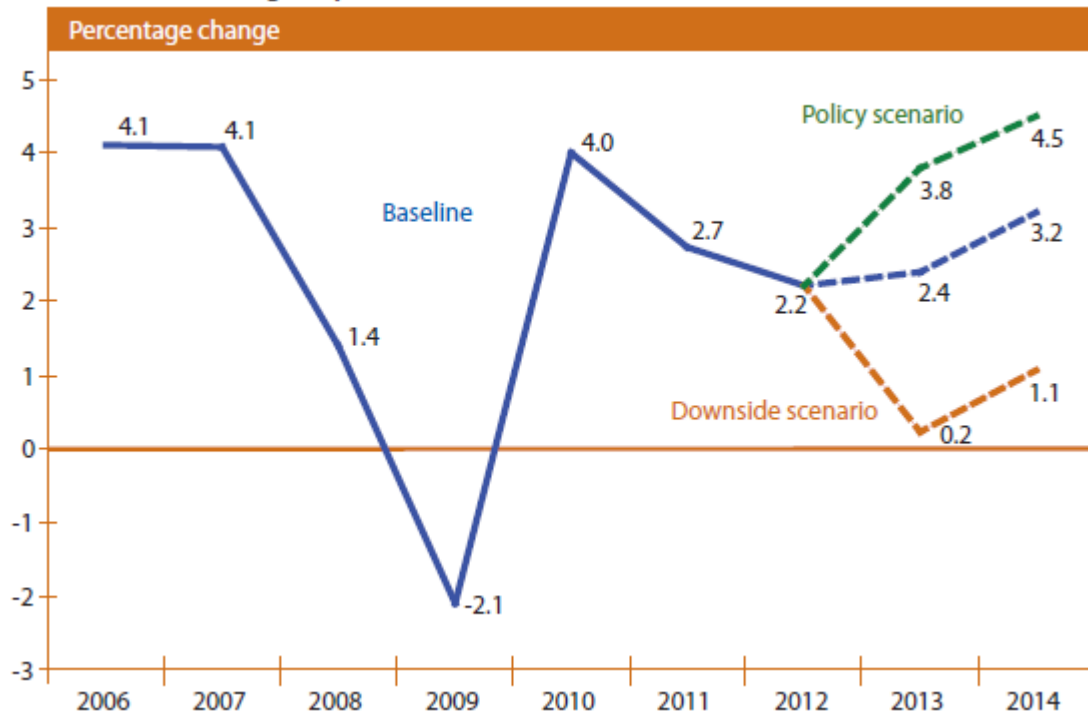
As showed in figure 2.1, for the risk management, five layers should be analyzed, such as international community, nation, enterprise (firms, financial system), community and household. In order to help to understand the risk management in Chinese air cargo industry, international community and industry should be described.

2.2 World community developing background

2.2.1 Global economic outlook

Based on the reviews of the past world economy development, since the world financial crisis in 2008, the downturn arrived on the bottom in 2009, and after that, it began to struggling to recover slowly.

During 2012, global economic growth has weakened further. A growing number of developed economies have fallen into a double-dip recession. Those in severe sovereign debt distress moved even deeper into recession, caught in the downward spiraling dynamics from high unemployment, weak aggregate demand compounded by fiscal austerity, high public debt burdens, and financial sector fragility. Growth in the major developing countries and economies in transition has also decelerated notably, reflecting both external vulnerabilities and domestic challenges. Most low-income countries have held up relatively well so far, but now face intensified adverse spillover effects from the slowdown in both developed and major middle-income countries. The prospects for the next two years continue to be challenging, fraught with major uncertainties and risks slanted towards the downside.(World economic situation and prospects 2013, P1, 2013)



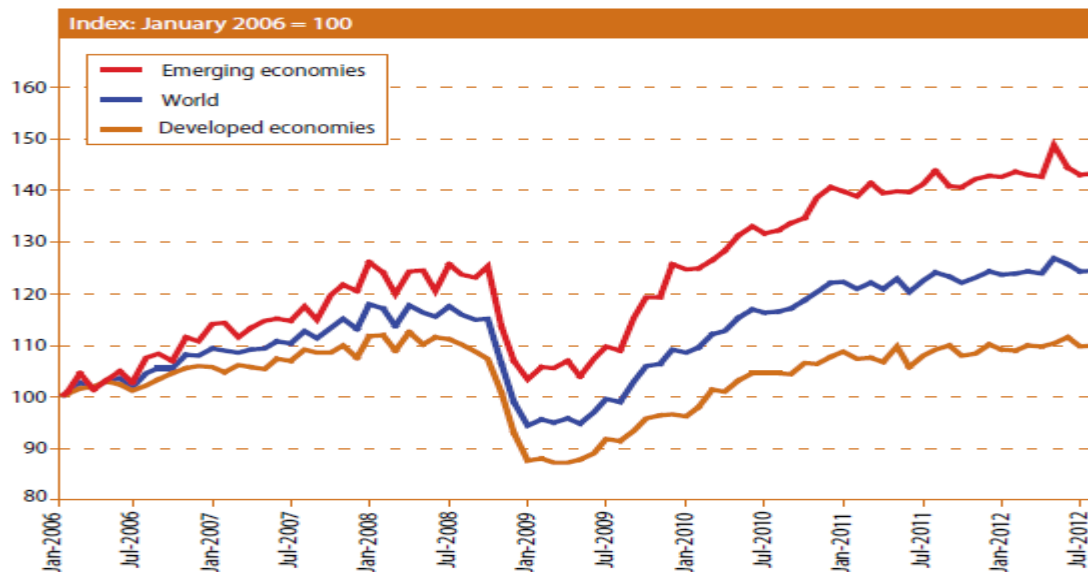
Source: UN/DESA

Figure 2. 2 Growth of world gross product, 2006-2014

From the figure 2.2, based on the past development from 2006 to the end of 2012, from 2013, there will be three scenarios. The economy development risk will be happened under the downside scenario.

2.2.2 International Trade

Air cargo is one important transportation measure in international trade, and the trade trends and volume will affect air cargo directly. As showed in figure 2.3, it had experienced Great Recession in 2009 with the plunging by more than 10 percent, and rebounded strongly in 2011. From then, it began to recover slowly. Because of the declining import demand in Europe and America aggregate demand in the United States and Japan, the growth decreased sharply in 2012, correspondingly, the export volume in developing countries, such as China and India, has been keeping a flat growth.



Source: CPB Netherlands Bureau for Economic Policy Analysis Rebased by UN/DESA.

Figure 2. 3 world merchandise exports volume, January 2006—August 2012

2.2.3 World environment development

Air cargo industry has close and complex interactive relationship with world environment. Some world environment events can affect the growth of air cargo industry, and correspondingly, air cargo industry can influence the world environment, such as the gas emission pollution by aircraft and oil resource no sustainability

Because of the weaker whole economic growth, green house gases produced by the countries of the Kyoto Protocol have fallen by about 2 percent per year during the period between 2011 and 2012. This is against the 3 per cent increase in emissions by these countries in 2010. Emissions decreased by 6 per cent in 2009 with the fall in GDP growth connected with the Great Recession. Based on the continuous moderation in global economic growth, emissions of these countries are expected to decline further in the following years. (World economic situation and prospects 2013, P9, 2013). For these developing countries, such as Brazil, India and China, they have been keeping high GDP growth in the past 5 years, so they need to produce more green house gas to support the growth. While perhaps there are some new changes for China, such as the heavy smog in east China, the Chinese central

government must take measures to help people breath healthily.

With the development on the theory and practice of sustainable development, more and more strong NGOs and world organizations begin to push the energy saving and sustainable growth, no doubt, their efforts will influence the development of air cargo industry.

2.2.4 Technology advance

Driven by information revolution, globalization and other factors, technology development has been faster and faster, and has been one critical facilitating driving factor to the whole world development. In the past decades, the main advanced technologies are biotechnology, smart materials, information availability, agile manufacturing, nanotechnology, integrated Microsystems and so on. (Philip S. Anton, 2001)

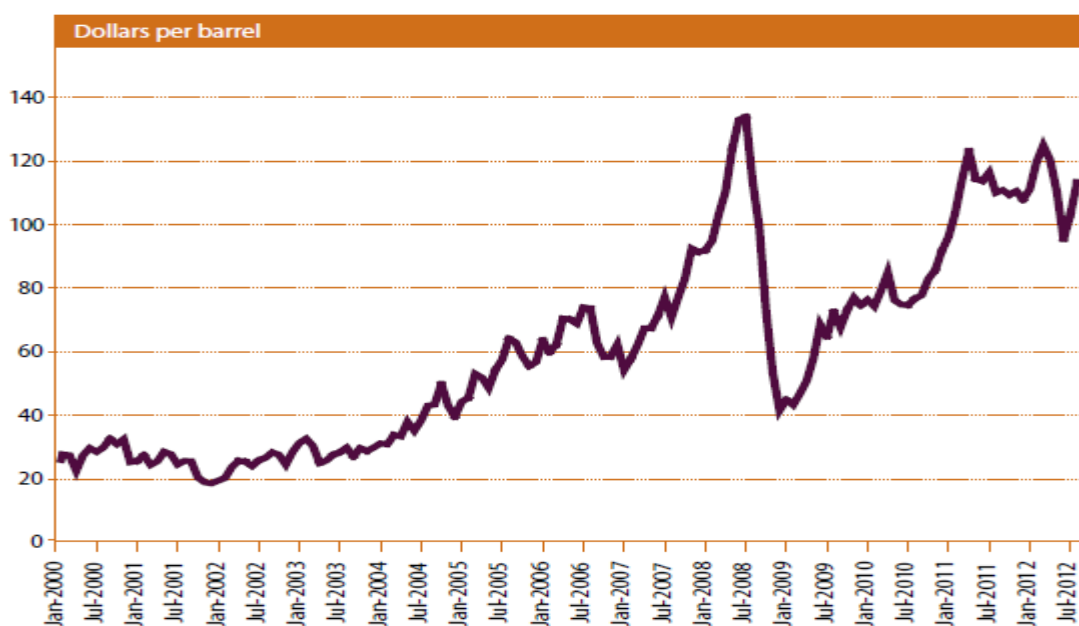
For the air cargo industry, the concerned technologies are in aircraft manufacturing, logistics devices, information systems, smart materials and so on. Especially in recent years, the air cargo growth is benefited from electronic scanning, smart transportation, smart materials, electronic tracking and so on.

2.2.5 World political stability and instability

Air cargo industry growth needs the cooperation among different nations and regions, in other words, it needs a stable political situation among nations and regions. Air cargo industry will be blocked in the case of war, political convulsions, and riots. In the past years, the tension between China and Japan has decreased the air cargo volume between them. Generally, China has been keeping a stable political situation for a long time, and it has been cooperating with many countries in open sky and international trade. While situation in Africa is not so optimistic, the political situation in Middle East is worsening.

2.2.6 Oil

Oil accounts for 30-40% of the total cost for air cargo airlines, and the fluctuation has damaged the benefit of air cargo industry. In the figure 2.4, weaker global demand tended to push prices down, while heightened geopolitical risks in several oil-producing countries put upward pressure on prices. Global oil demand decelerated somewhat to 0.9 per cent in 2012. Global supply was affected by sanctions imposed by the EU and the United States on Syrian and Iranian oil exports. This was compensated to a large extent, however, by the preventive increase in oil production in Saudi Arabia, the resumption of production in Libya and higher-than-expected output in North America, Latin America and the Russian Federation. Yet, spare capacity dropped to 2.8 million barrels per day (mbd), down from an average of about 4 mbd during 2006-2011.(World Economic Situation and Prospects 2013)



Source: UN/DESA

Figure 2. 4 Brent oil price, January 2000-October 2012

2.3 Development on world air cargo industry

The earliest air cargo service in the world started in 1919, and the main lines

were Vienna-Kiev, Berlin-Weimar, Paris-Brussels and Paris-Cherbourg. In the United States, the earliest air cargo appeared in 1921 (Andreas Otto, 2008.p365). After almost one hundred years' development, Goods transported by air now account for 5% by volume of all goods transported globally but 36% by value(IATA, 2006), and the transported volume has doubled every 10 years since 1970(Chang et al.,2007). 40% of air cargo is carried by cargo craft, and generally the air cargo income accounts for 13% of all the incomes, but it changes as in different regions or countries.

The world air cargo is realized by the agreements and regulations from IATA and different countries, and the main agreements are Warsaw Pact and Hague Agreement

2.3.1 1940's and 1950's

According to the research of Allaz(1998), the history of air cargo industry was summarized as the following. The real world economy and trade growth accelerating was in 1950's, and the two milestones were GATT in 1947 and European Economic Community (EEC) in 1958. In 1941, air cargo was only one very small branch of postal service and air passenger, and the four airlines at that time created air cargo companies to carry out the scheduled air cargo flight service.

After world war II, air cargo industry started to bloom in United States based on the resource from the war, like retired pilots and military crafts. Some new entrants came into the air cargo market with better service and competitive price, for example, NSFC was one earlier carrier. Because of the declining price, Air Commission of United States at that time had to propose one Lowest Fee Act to protect big air cargo service providers' benefit, and this act had been carried out until 1953. (US Centennial of Flight commission: www.centennialofflight.gov)

During that period, R&D was done by American companies, and the standard

for shelf and container and infrastructure gradually came into being.

IATA was founded in 1944 and it made systemic organization, technology standard and index for the infrastructure. IATA dedicated to the safety, normal and economic air transportation. (www.tata.org)

The standard relationship between airlines and forwarders came into being because of the sign of Standard Agency Agreement in 1952. In air craft technology, propeller aircraft turbofan made it possible for the development of jet-powered aircraft.

2.3.2 1960's

World GDP grew fast in 1960's, while extended fiscal and financial policy caused serious inflation and imbalance among world trade participants, and world air cargo benefited from this imbalance. In this period, IATA worked for the safety of air transportation and technology, regulations and automatic operation, improving of Standard Agency Agreement, isolation between air passenger and air cargo. The relationship between carriers and forwarders was becoming professional. In aircraft, B707 was introduced into practice by Lufthansa.

2.3.3 1970's

High inflation and low economy growth were two typical characters for the 1970's. Oil price increased from 3 dollar to 12 dollar because of the Arab oil embargo in 1973, and this increasing led scaled and wide inflation. Flexible exchange rate was introduced to counter this inflation, but it was regarded as the root of instability. European Economic Community began use European Money System in 1979 to decrease the fluctuation with semi-fixed exchange rate.

Air bus was created in 1970 by the combination of France, Germany, Spain and England to compete with the monopoly of Boeing. A300C was the first

airliner finished in 1980 which can change into cargo craft.

The transportation power was becoming bigger with the technology innovation of wide-body aircraft. Containerization was introduced into the DC-10 CF part. New cargo craft which was only for cargo transportation was put into use. Lufthansa began use nose lifting cargo aircraft in 1972 and forklift appeared. During this period, the governance policy in United States changed a lot. Air cargo service companies had more power to set the price and explore more lines, and they began provide diversified service at the same time. The policy change made the birth of UPS, FedEx, DHL and Cargolus's.

2.3.4 1980's

In the first of 1980's, OPEC increased the oil price from 13 dollar to 32 dollar which weakened the buying power of industrialization countries. The main driving power for world air cargo was the JIT which was invented by Toyota producing system.

Handling time and cost was reduced because of the technology improvement, special handling equipment and the systemization. Cargo was put into the belly space and the transportation power was increasing. Stimulated by the policy, system, standardization and international clearance, some express companies became the integrator.

2.3.5 1990's

In this decade, stimulated by the open policy and state-owned company's privatization, the economy growth was high and stable. At the same time, the stock becoming smaller because of the stock control methods and outsourcing.

World trade was strengthened by WTO which was built based on the Umbrella Agreement. The air cargo was stimulated by liberalization, low cost countries development, the popular of JIT and the development of internet. The

transportation power was increasing by the factors of ACMI, new A300 and A310.

2.3.6 2000—2004

Air cargo industry was challenged in new century by the economy deterioration, for example, bankrupt of internet and telecommunication companies, corporate governance scandals, terrorist attacks, Iraq war, SARS and so on. Many airlines had to decrease their lines number and lines density, and even some air crafts were put into desert to wait for the recovery.

Facing the pressure and economic downturn, Cargo 2000 was proposed by IATA to make the airline operation in high quality standard and in the sense of supply chain. In country side policy, the first multilateral sky open agreement was signed by America, Brunei, Chile, New Zealand and Singapore.

In the depression, it was good for the A&Q. so FedEx and UPS become bigger because of the A&Q.

2.3.7 After 2004

From 2004, world air cargo logistics has went into world supply chain (Renato Chiavi). The world structure is different after economy recovery, and developing countries become the engine for the world economy. According to data of Boeing (2010), China will be the new flag for the world development, as the figure 2.5 showed.

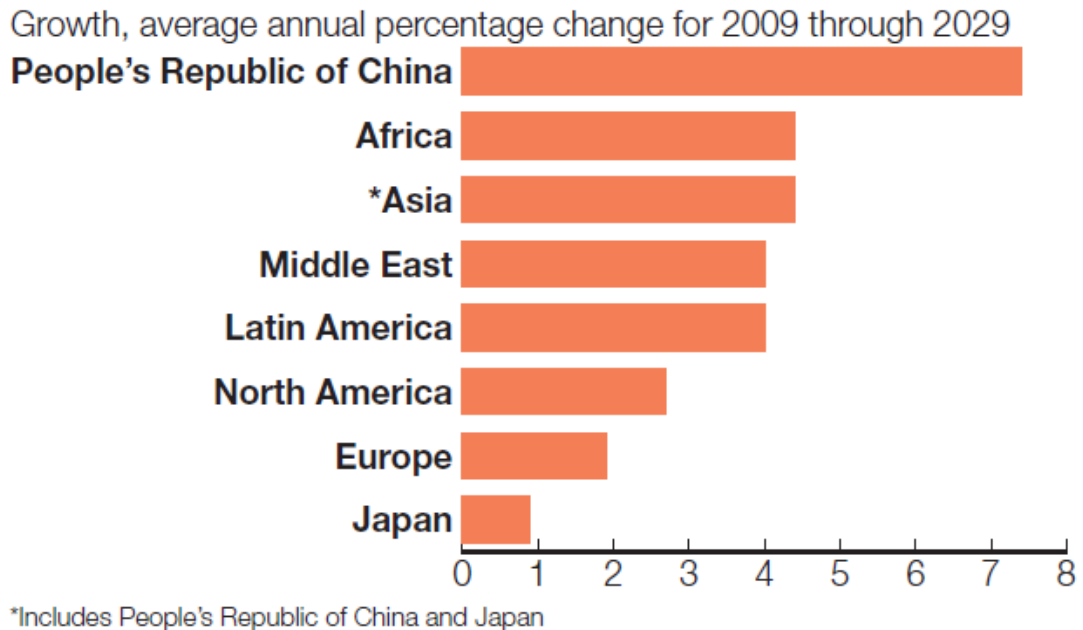


Figure 2. 5 GDP forecasting from 2009 to 2029

Air cargo growth will be different according to different regions, and the main increasing power is in Asia. The world trade liberalization and globalization will continue, and the scope of FTAA covers Middle America and South America. IATA strengthens the cooperation with countries and the numbers of IATA now include 188 countries and 270 airlines. (www.flyingtigerline.org/history.htm)

2.4 Air cargo and world economy

Led by a convergence of aviation, globalization, digitization and time-based competition, the new speed-driven, globally-networked economy certainly has a relationship with air cargo development. (John D. Kasarda, Johnathan Green.2004)

The key important influential factors on air logistics are world economy and trade, and world economy growth will influence air cargo traffic growth directly (Boeing, 2010). Generally, air cargo traffic is measured by RTKs, and economy development is measured by GDP, so the relationship between economy and air cargo can be measured by the relationship between GDP and RTKs.

Kasarda & Green (2005) pointed that there must be an established statistical relationship between air cargo volume and GDP, when economy and trade

grow, the demand for air logistics will increase synergistically.

Based on the data between 1980-2000 in different regions, John D. Kasarda, Johnathan Green.(2004) presented a strong correlation between GDP and air cargo, to further the research of air cargo, they also concluded that air cargo can be influenced by numerous factors, such as one country's overall logistics infrastructures, policy environment and so on.

MDS Transmodal et al(2001) explained that the air cargo growth rate is 3.18 times of GDP with simple linear regression model, and at the same time, the demand of air cargo is the function of economy activities, transportation cost, exchange and price.

According to Boeing (2010), World air cargo growth typically outpaces GDP growth by a factor of two, as explained by the figure 2.6. In the past ten years from 1989 to 2009, world GDP developed in the same trends with RTK.

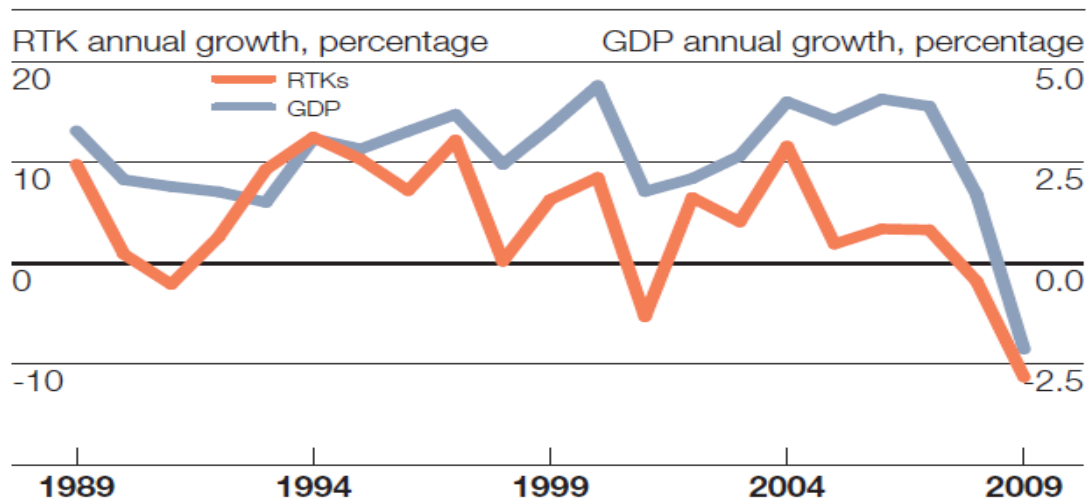


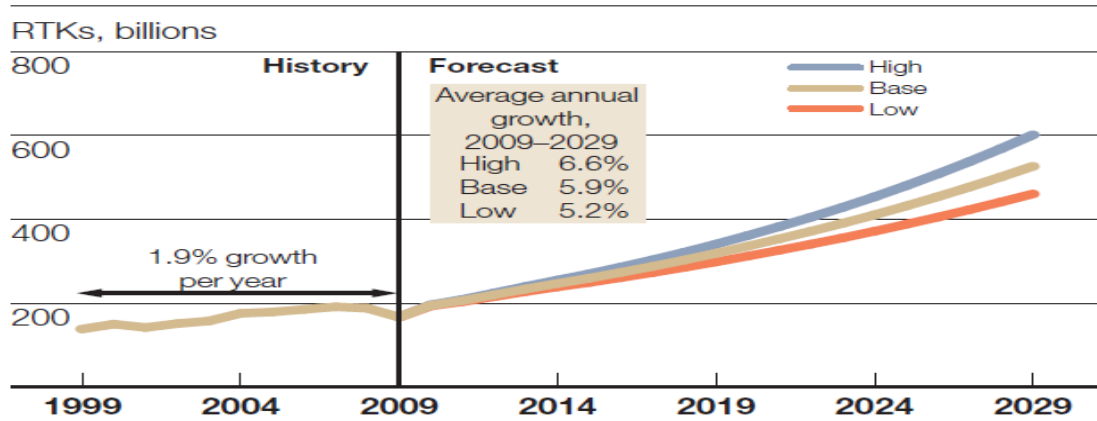
Figure 2.6 GDP and RTK growth percentage

2.5 Trends of Air cargo industry

2.5.1 Growth

The world economy will increase for the next two decades, correspondingly the air cargo will grow with the same direction, according to Boeing (2010), the world GDP and world cargo will grow as the figure 2.7 showed. The average

growth per year through 2029 is 5.9%, and the GDP is forecast to grow an average 3.2% per year through 2029.

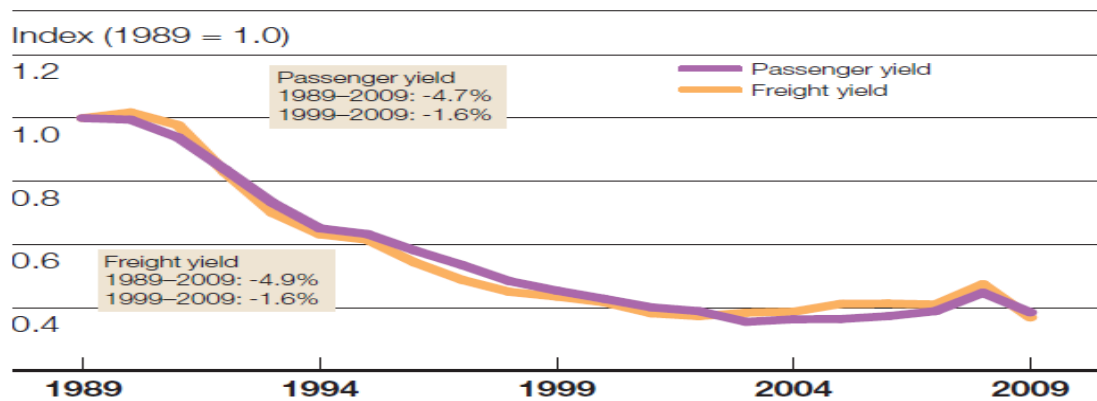


Source: Boeing (2010) P16

Figure 2. 7 World air cargo growth history and forecast

2.5.2 Air freight yields declining

Because of productivity gains, technical improvements, and intense competition, the overall freight yield tends to decrease during the past development. As showed by figure 2.8, the freight yields have decreased at an average of 4.9% rate in the past two decades.



Source: Boeing(2010)

Figure 2. 8 Freight yield trend

2.5.3 Diversified development in different regions

Although the overall trends for air cargo development is growth, different

regions and different lines will have different rates, from the past data(see figure 2.9), Asia and the lines connecting with Asia have a significant growth.

	Historic 10 Years (1999–2009)	Forecast 20 Years (2009–2029)
World	1.9%	5.9%
Intra-North America	-2.5%	3.0%
Latin America–North America	-0.7%	5.7%
Latin America–Europe	2.5%	5.6%
Europe–North America	-1.5%	4.2%
Intra-Europe	0.1%	3.6%
Middle East–Europe	6.5%	6.0%
Africa–Europe	3.3%	5.1%
Asia–North America	1.4%	6.7%
Europe–Asia	4.1%	6.6%
Intra-Asia	3.4%	7.9%
South Asia–Europe	4.1%	6.5%
Domestic China	13.1%	9.2%

Figure 2. 9 Air cargo development in different regions before and after 2009

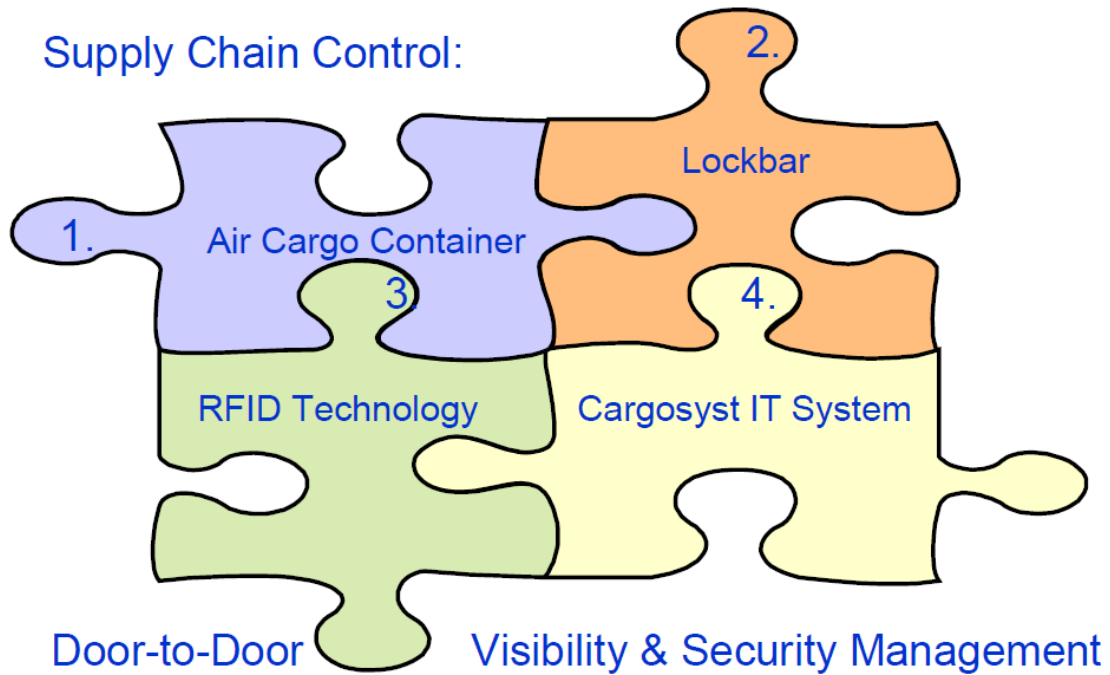
Air cargo in domestic China has a good growth in the past decade, and will further the growth in the future two decades at an average of 9.2% growth. The main drive of this growth is the economy development within China.

2.5.4 From Air cargo to Global supply chain

Air cargo is one important part of world supply chain which will satisfy the need of one-stop buying and factory transfer worldly. (Peter Gronlund, Robert Skoog, 2008) . For example, the Intel factory moved to Chengdu from Shanghai, the air cargo structure of Chengdu and shanghai will do some changes to satisfy the need of Intel.

The International Air Transport Association (IATA) called upon the entire air cargo value chain to drive efficiencies and improve competitiveness by supporting IATA e-freight. In the sense of supply chain, air cargo will bring more value to the chain.

In practice, IBM designed one Cargo box solution using supply chain concept, namely Air Cargo Integrated System Solutions, as showed in figure 2.10.



Source:http://www-05.ibm.com/be/events/download/pdf/IBM-Conversations-for-a-smarter-planet-mobility-Henk_Hilders_v1.0.pdf

Figure 2. 10 Cargo box solutions for air cargo supply chain

With the idea of supply chain, the air cargo supply chain will include four parts, air cargo container, lockbar, and FRID Technology and Cargo IT system.

2.5.5 Electronic development

With the development of internet, communication telecom and other technology innovation, electronic technology and device will be used in the air cargo industry. One example is the use of Cargo 2000. in China, the government designed on electronic platform to connect participants with custom to avoid the smuggling. More and more technologies are used in air cargo industry, such as CF-X, goods input service CPS, RFID and GPS.

2.5.6 Strategic alliance

Partly intended to meet the challenges posed by regulation in the sector and by the growth of integrators, air cargo carriers have started to cooperate through common service options, sales and compatible information systems in

order to build global networks. Air cargo alliances first emerged in 2000 with the establishment of the WOW Alliance (initially named New Global Cargo) and of Sky Team Cargo. Several cargo carriers from APEC economies are members to these alliances. Singapore Airlines Cargo and as of 2004 Japan Airlines are part of the WOW Alliance, while Sky Team Cargo includes Delta Airlines, Korean Airlines and Aeroméxico Cargo.

For the airlines alliance, now there are three key alliances, Star Alliance, One World, and Sky Team. Most of the airlines are belonging to the three alliances. While at the same time, there are also some strategic alliance between carriers and forwarders based on the competitive environment. According to Peter Gronlund and Robert Skoog(2008), the motivations of join the alliances are improving the value, synergies, cost share, economic scale, network effect and so on.

2.5.7 Liberalization

In practice, it is called “freedoms” among the aviation negotiations, in general, aviation liberalization is most often characterized as some combination of liberalization of market entry, provision of ancillary services(e.g., ground handling) an trade facilitation.(John D. Kasarda, Johnathan Green.,2004), according to this research, aviation liberalization has a positive, significant correlation with freight, GDP and world trade.

In 1944, 52 nations signed on to the charter creating the International Civil Aviation Organization(ICAO), since then, more than 3000 bilateral aviation agreements have been signed. In 2009, the Istanbul Declaration and the Agenda: airlines and government officials from 42 countries jointly signed a declaration calling for more liberalization of the market. (<http://www.iata.org/events/agm/2008/istanbuldeclaration.htm>)

2.5.8 Integration

In recent years, the traditionally fragmented nature of air cargo firms has undergone profound change. Just-in-time manufacturing and decreasing product life spans, coupled with technology advances (e.g. real-time booking and tracking), have led to a reorganization of the industry towards more integrated, ground-linked structures. The most prominent challenge to the traditional air cargo system has resulted from the rapid expansion of integrated service providers. Until recently, a single shipment was handled by several airlines, multiple forwarders, as well as customs brokers, warehouse operators, and trucking firms. Express companies have thrived by reducing some of this complexity through the integration of air and ground functions performed by airlines, forwarders, and ancillary service providers (Bowen and Leinbach, 2002). As a result, integrated express operators such as FedEx and UPS now rank among the largest cargo airlines in the world.

Meanwhile, some large international freight forwarders are operating their own trucking fleet to handle goods on the way to and from the airports and are expanding into value-added services for comprehensive supply chain management. So-called third-party logistics handle warehousing, order fulfillment, inventory analysis and other logistics functions for multinational clients (Schwarz, 2005). Similarly, airlines are giving a higher profile to their cargo divisions, sometimes making them separate entities. For example, Cathay Pacific has expanded into the express industry with its Wholesale Courier and Cargo Express services (Dodwell and Zhang, 2000). These companies increasingly provide express services similar to those of the express operators. Airlines have also attempted to compete with integrators by forming partnerships with freighter and shipping companies. The distinction between express business and general air cargo business continues to blur (Boeing, 2010), this is a typical sign of industrial integration.

2.6 Structure of air cargo supply chain

From the concept, some researcher divided air cargo industry into two subsystems, the traditional airline cargo market and the integrated express market (Willem-Jan Zondag, 2006, p11). And the division standard is from the business model. While for the air cargo supply chain, the structure of cargo, relationship among participants and structure of carriers are different.

2.6.1 Cargo structure

For the goods transported by airlines, generally they are categorized into three types, general cargo, mail cargo and special cargo (Willem-Jan Zondag, 2006). In more detail, the specific goods are list in table 2.1.

Table 2. 1 Cargo categorization

Name	Description
Heavy goods(HEA)	General cargo
Chemical products, toxic products	Dangerous goods(DG)
Vegetables, flowers, fruits	Physical perish ability goods
Newspapers, clothes, electronics devices, live animals(AVI), human remains(HUM), jewelries (VAL),pharmaceuticals	Economic perish ability goods
.....

From the structure of cargo, we can find the reasons why customers choose air as the transportation style. Efstathiou & Anderson(2000) proposed some reasons for shippers to chose air services, as they may reduce the lead time, assist in maintaining a lean supply chain, minimize inventories, reduce procurement and distribution costs, help to focus on core competences and gain new businesses.

2.6.2 Carrier structure

Generally, there are two kinds of carriers for cargo transportation, combination carriers and all cargo carriers. The combination carriers transport passengers and cargos at the same aircraft, and all cargo carrier only transports cargos. As showed in figure 2.11, the all cargo carriers are including three kinds of specific carriers, full all cargo carriers, ACMI operator and niche carrier.

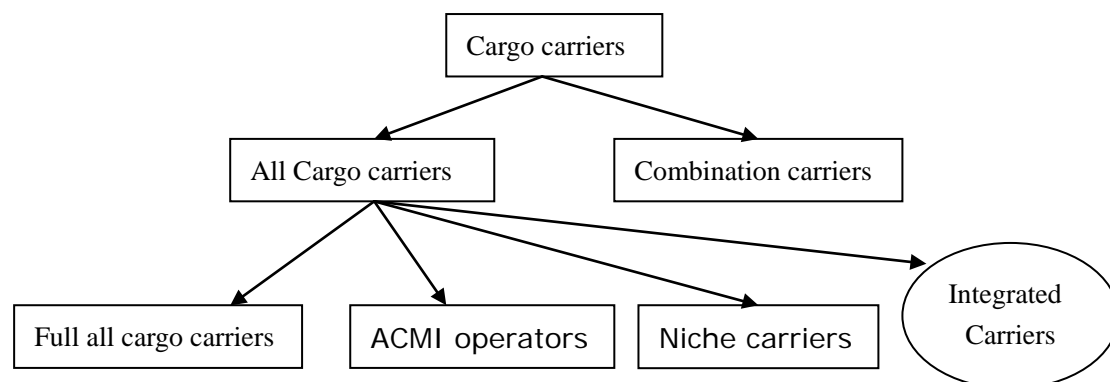


Figure 2. 11 Different types of carriers

Full all cargo carriers fly with self-operated freighter aircraft only on the airport-to-airport market, and they are highly cost aware as they are not confronted with cost allocation confusion with passenger business. For them, the common practice is cash-flow based pricing because of financially weak (Clancy and Hoppin, 2002)

ACMI means Aircraft, Crew, Maintenance and Insurance. The risk/reward profile of an ACMI operator is relatively low because an ACMI airline wet-leases its aircraft to other airlines against a fixed hourly price while an ACMI contract usually involves a minimum number of block hours per month (Willem-Jan Zondag, 2006)

Niche carriers have specialized in the movement by air of cargo needing specialized equipment, and they have specific expertise in flying oversized cargo or flying cargo to poor developed locations with inferior runways and handling equipment (Button, Stough, 2000).

Integrated carrier is the star in this industry because of the high profit, world big

network and developing speed. Here we usually refer to UPS, DHL, FedEx, TNT and others. This thesis will not discuss the integrated carriers.

From the market terminology, there are three main segments, passenger belly freight, express carriers and heavy freight, and Parscal Achard(2008) categorized the operators as All Cargo carriers, Belly Carriers and Express Delivery companies. According to John Gardiner & Stephen Ison(2007), passenger belly freight makes use of the available cargo carrying capacity of passenger aircraft. Express carriers operate dedicated freighter aircraft on a time-definite basis, often carrying smaller packages. The heavy freight offers dedicated cargo carrying capacity (often for larger items) either on a scheduled or charter basis.

From the points of different service, different kinds of carriers will focus on different services, and the service can be different according to speed and shipment type, as showed in figure 2.12.

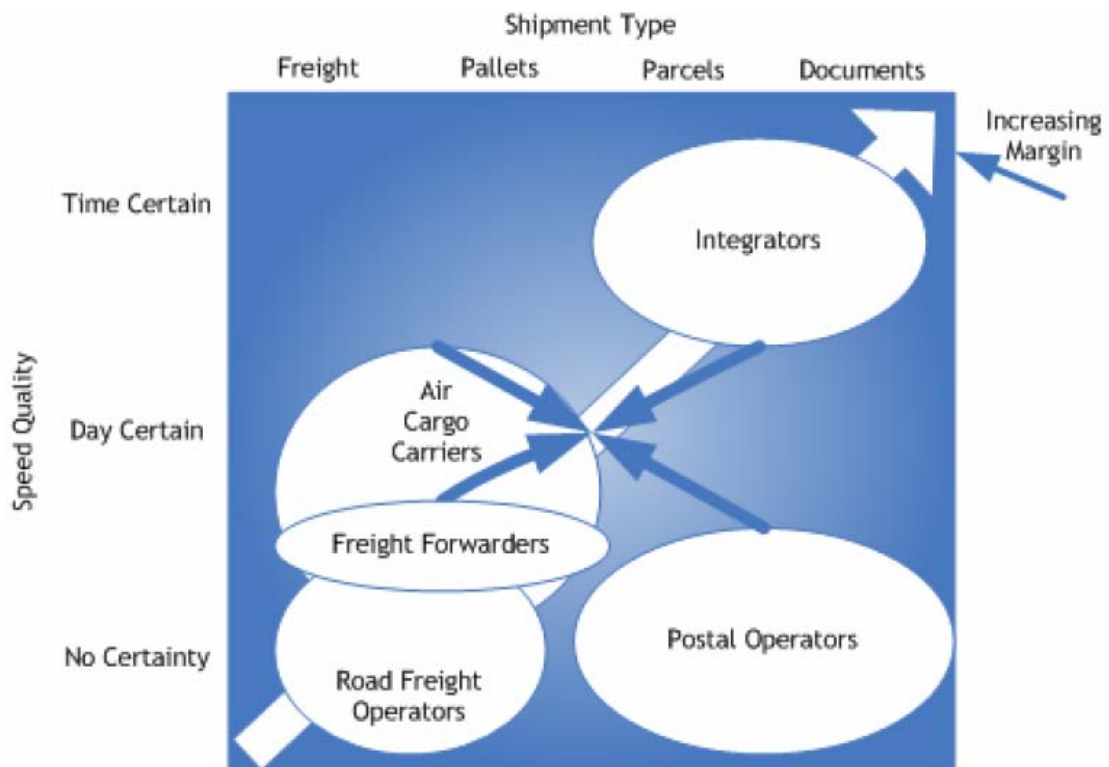
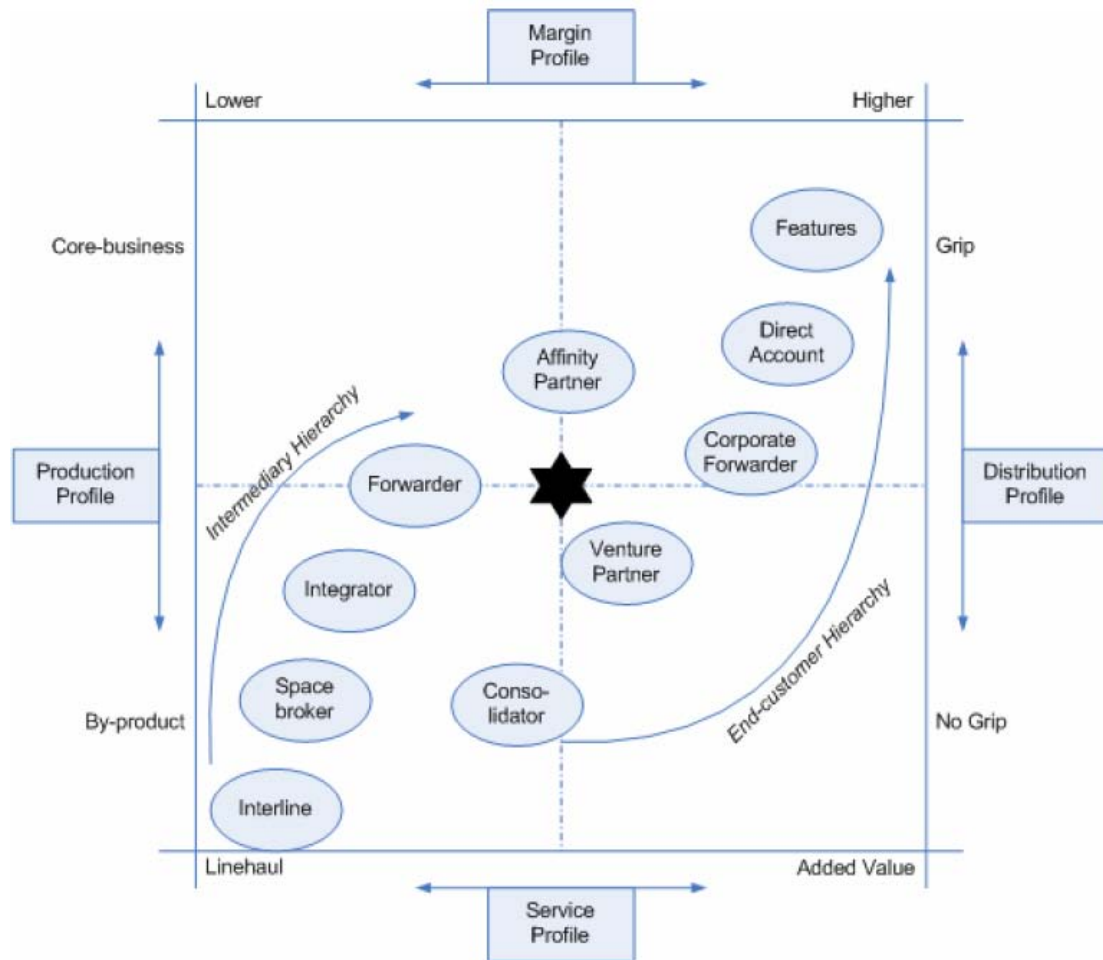


Figure 2. 12 Carriers and services

2.6.3 Relationship structure within air cargo supply chain

In the sense of air cargo supply chain, if we only care the three players (customer, forwarder and carrier), it seems the relationship is very simple. While if we care more participants, the relationship will be complex. According to Grin (1995), figure 2.13 was drawn out to show the relationship structure.



Source: Grin (1995)

Figure 2. 13 Air cargo supply chain relationship model

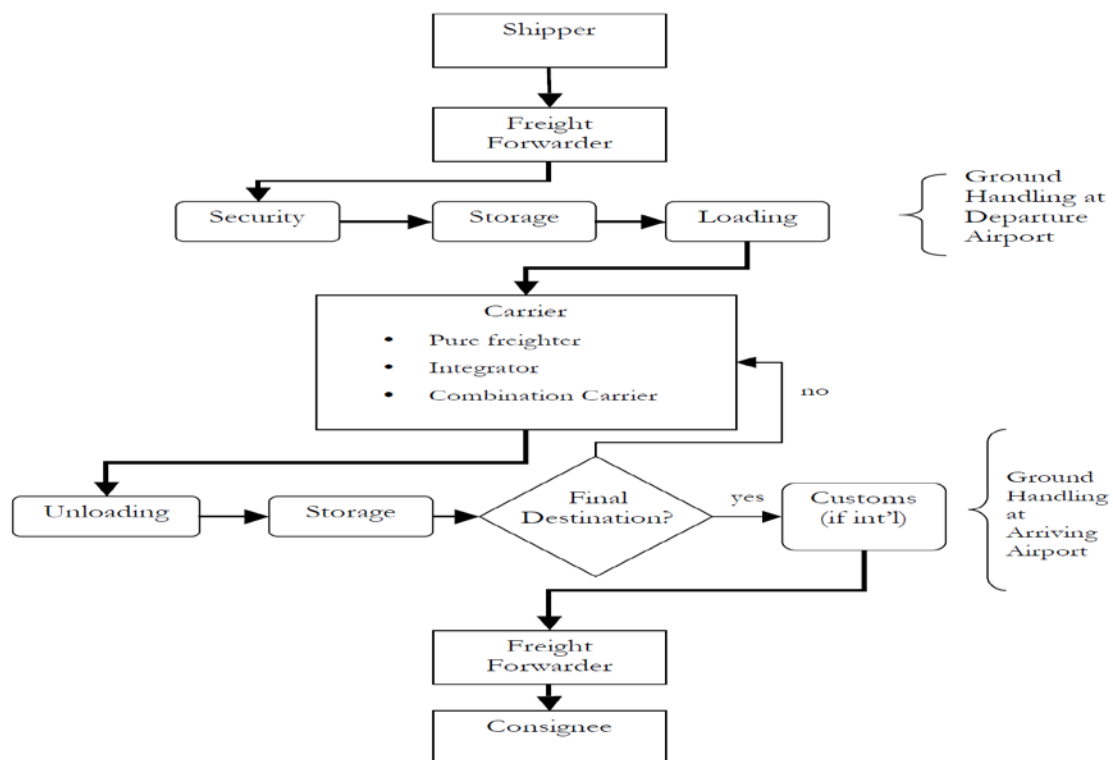
Figure 2.13 shows two hierarchies of customer relationship patterns; the intermediary hierarchy that runs from Interline to Forwarder and the end-customer hierarchy running from Consolidator to Features. The two ones shown in the middle of the figure (Affinity Partner and Venture Partner) are optional and only become a relationship pattern if they are deliberately created (Grin, 1995).

In general, within air cargo industry, forwarders are closer to end-consumer than carriers, here the consumers mean the shippers, and it is a marketing term. Carriers and forwarders can improve the relationship with shippers through shortening the distance with shippers.

2.6.4 Air cargo supply chain process

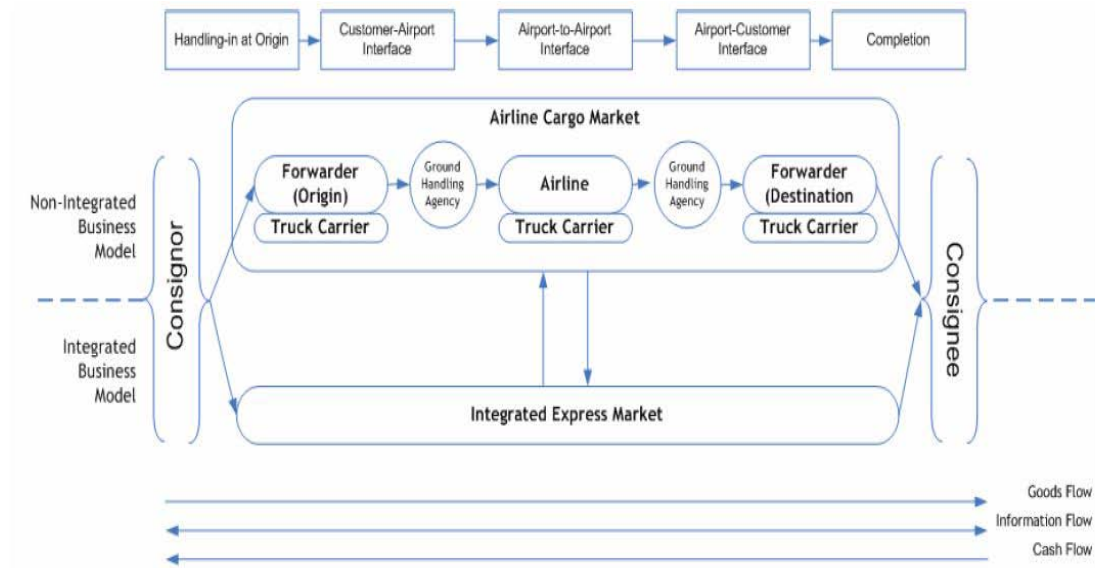
In the air cargo supply chain, different participants will provide different service, and all the services can create the value for the chain. J. Petersen (2007) and Willem-Jan Zondag(2006) individually proposed two process structures for air cargo supply chain, as in figure and figure.

In figure 2.14 and 2.15, we can see clearly the division of work for forwarder and carrier. But in figure we can get more understanding of activities, based on the three flows, traditional carrier and integrator are different. And for the forwarder, it can provide one single service, also it can consulate all the services but for air craft.



Source: J. Petersen 2007, p12

Figure 2. 14 Air cargo process



Source: Willem-Jan Zondag(2006)

Figure 2. 15 Air cargo activities classification

2.7 Air cargo industry in China

2.7.1 General condition

In the past two decades, China's domestic air cargo increased at an average of 18.1% growth since 1990, including mail and freight (see figure 2.16). In the world, US domestic air cargo market is the biggest, and Chinese domestic market is second with an annually 3.2 million tones transported by air. Different goods vary by region within China mainland, for example, in the Pearl River Delta region, the air transported goods are apparel, home electronics, telecommunication equipment, and light industrial products, in Yangze River Delta region, the goods are mainly textiles, apparel, perishable foods and live animals, as showed by table 2.2.

Table 2. 2 Air cargo goods classification

Region	Goods
Pearl River Delta	apparel, home electronics, telecommunication equipment, and light industrial products
Yangze River Delta	textiles, apparel, perishable foods and live animals, electronics
Northern region	Apparel, electronics, pharmaceuticals, cashmere, cut flowers
South-west	The future goods, pharmaceuticals, electronics, telecommunication equipment

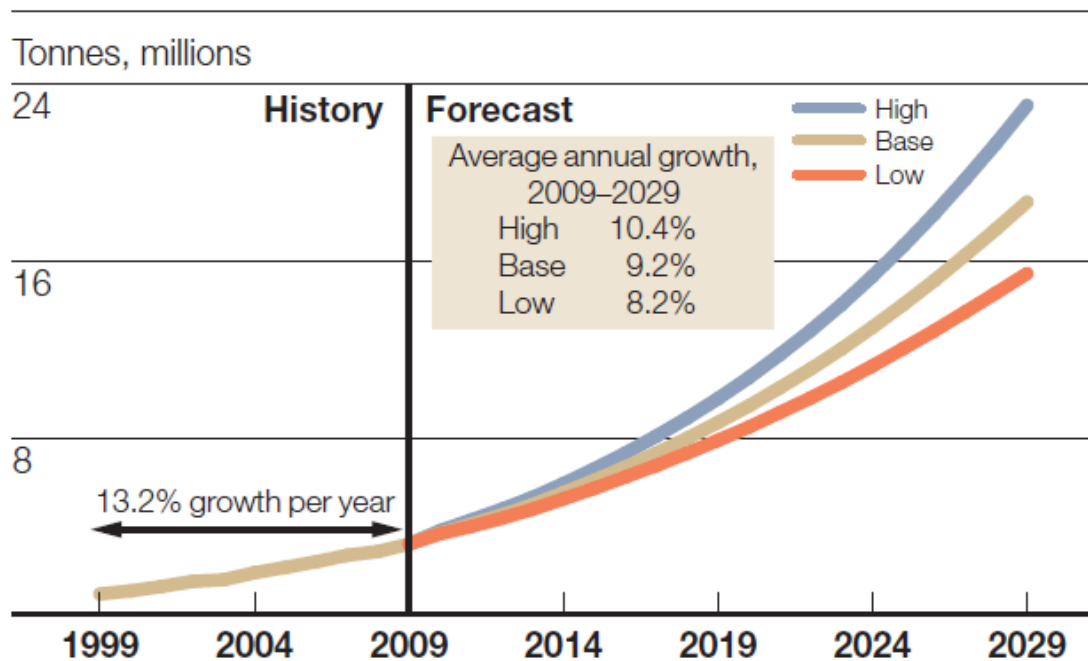


Figure 2. 16 World air cargo forecasting

Mostly in China, the main goods by air transportation are Electrical equipment, jewelry, nuclear equipment and parts, Optical instruments, fabric and clothes, Chemicals, Pharmaceuticals, Organic chemicals, Aircraft Instruments, live animals and so on.

The south-west region is promising engine for air cargo traffic in China. China has proposed a future developing plan for Chendu-Chongqing economy region, and large capital will be invested into this region. Based on the policy, world big giants has transformed their factories into this region, such as Intel, Foxconn,

and so on.

In order to support the air cargo industry, China will invest on air logistics infrastructures, as stated in the National Airport Allocation Plan which was announced by the State Council in 2008. In fact, the air cargo industry is one part of China's whole logistics plan, at the same time; China will develop high-speed rail network, sea shipment and road transportation.

2.7.2 General shares in different regions

Generally there are 13 important airports in mainland, and they were categorized into four levels according to the air cargo quantity as in table 2.3.

Table 2. 3 Market share of Chinese cities

Market share	City or region
Above 25%	Shanghai
12%-25%	Beijing, Guangzhou
5%	Shenzhen, Chengdu, Kunming
Below 3%	The rest air ports

The cargo of Shanghai, Beijing and Guangzhou accounts for more than 50% of all the cargo in mainland. Behind the data, we can know, the busiest lines are the triangle lines among these three cities, as showed in figure 2.17.



Figure 2. 17 Chinese air cargo flows

Air cargo industry is an international industry; it is meaningless to discuss the air cargo without the international context. In global context, the main trade partners are Europe countries, North America and east-north Asia. The line structure can be seen in the figure 2.18 clearly.

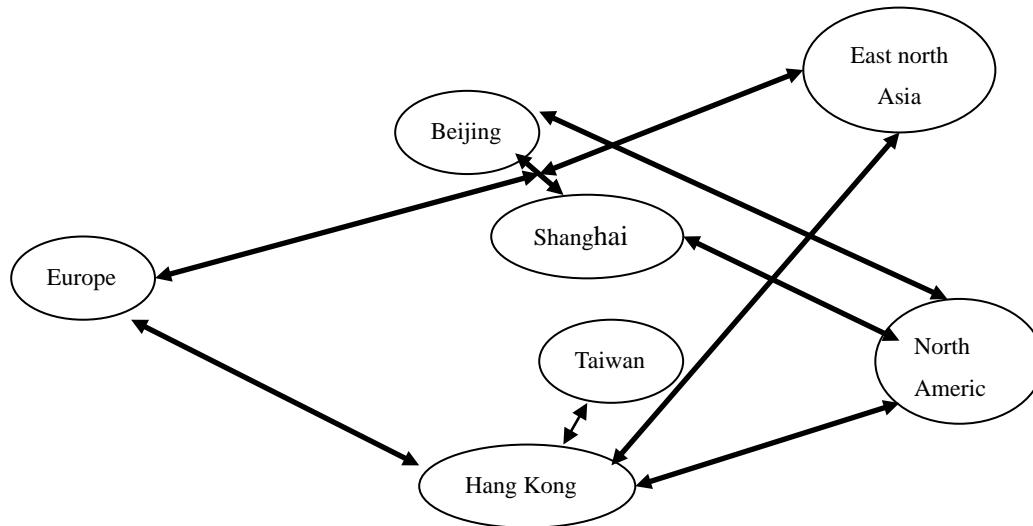


Figure 2. 18 Main world air cargo lines connected with China

2.7.3 The negative points

It is no doubt that Chinese air cargo logistics is a promising industry and will grow with the Chinese economy, the driving factors are including the restructure of Chinese aviation industry, IT development, globalization, global production fragmentation, Chinese manufacturing industry, the entry into WTO and so on. While at present, the Chinese air cargo industry is at the beginning state, the service provided is only transportation, and there is no high added value. From the integration perspective, air transportation does not connect with other surface transportation effectively. As for the IT, in China, the application is only in the starting point, many advanced IT can not be used because of many reasons (Zhang et al., 2005).

Statistics data are very important for researchers, government and the participants. While in China, the data on air cargo do not have the same

meaning with international standard until 1990s(Zhang et al., 2005). Before 1990s, the air cargo data are the sum of air transported cargo, posted cargo and luggage of passengers, from 1993, China began to classify the detailed cargo systemically.

2.8 Conclusions

In the first part, the technology advances, political situation, economy outlook, international trade and oil have been described from the point of international perspective. In the following years, there are still macro uncertainties and risks, such as the risk of deeper crisis in the Euro area, fiscal cliff of United States, hard landing of large developing economics, double-dip global recession. It can help to understand the role of risk in air cargo industry, because this research will be done under the background of internationalization.

Below international layer, air cargo industry is the focused field of this research. In the second part, it summarized the history development, structure, characters, trends of air cargo industry, especially the air cargo difference between China and world air cargo.

Only based on the background description of world layer and air cargo industry layer, the role of risk and risk formation mechanism can be analyzed, and the further risk factors identification can be done.

Chapter 3 Air Cargo Supply Chain Risk and Risk Formation

Mechanism

In the Chapter 2, the background on international economy, technology, resource and political situation has been summarized, and for the internal level of air cargo industry, the development history, structure, characters and trends have been described. The work of chapter 2 is the basis for this chapter to review the literature on risk theory and risk formation mechanism.

In theory, the research on air cargo supply chain risk is concerned with the theory on risk, risk management, logistics theory, supply chain risk and airlines. It is one cross field research which will consist of enterprise management, industrial economy, information technology, game theory, organization behavior, and sustainable development and so on. Only based on the theory literature review, the following work can be done scientifically.

The main objective of this research is to identify and evaluate the air cargo supply chain risk, and the source of risk should be analyzed. Through the digging of risk formation, we can know where the risks are coming from, and the risks can be studied.

3.1 Risk Origination, Concepts and Theories

3.1.1 Risk Origination and Concept

Although in theory it has been for several centuries, only in recent years, risk has been taken more and more attention in reality. In the daily life, people are facing more and more dangerous events, and for many enterprises, they were damaged or destroyed by all kinds of risks. Risk is a good or bad thing for an enterprise? According to Knight (1921), profit is from the risk of business, there will be no profit if risk does not exist. In the same logic, in finance, it is said more risk and more profit. In reality, risk should be researched according to

different industry and enterprise.

There are thousands of concepts and explanations for risk, and it does have a long history, while there is still no conclusion on who was the first to mention risk concept. Based on the summary of Terje(2011), there were several risk originations, as the table showed.

Table 3. 1 Risk Originations

author	Time	Origination
Bernstein	1996	From early Italian <i>risicare</i> , means "to dare", used by ancient sailors to warn the helmsman that rocks might be near.
Giddens	1999	Risk came to English from the Portuguese or Spanish, means sailing into uncharted waters Original Portuguese means "to dare"
Chambers Twentieth Century Dictionary	1946	Spanish <i>risco</i> refers to a rock
Wharton	1992	Firstly appeared in the Middle Ages, to designate the perils that could compromise a voyage
British Medical Association	1987	From Greek word <i>rhiza</i> , refers to "hazards of sailing too near to the cliffs: contrary winds, turbulent down draughts, swirling tides"

According to the above table 3.1, many researchers state that risk was derived from navigation which was the main transportation measure in the ancient time, the meaning is about the natural winds, waves or happened accidents.

3.1.2 Risk Subjective and Concerned Classification

Risk can not be reviewed isolated with the industry, field and stakeholders. It can be connected closely with risk perception, which includes personal feelings and affections on the possibility, sequences and so on. Different person has different knowledge, cognitive ability, education background and

judgment. Also in the different stage dealing with risk, the same person may have different attitude, risk decision making can be decided by decision makers per se, external influential factors and so on.

Renn(1992) analyzed the differences between statistical analysis, toxicology/epidemiology, probabilistic risk analysis, economics of risk, psychology of risk, social theories of risk and cultural theory of risk. Althaus(2005) focused on the distinguishes between logic and mathematics, science and medicine, social sciences, history and humanities, religion and philosophy. In all, risk is not only relevant with linguistics, but also depends on the fields, disciplines, areas or industry.

3.1.3 Risk Basic Elements and the Concept

From the Oxford English Dictionary (OED, 1989), the word of risk can be resourced back to 1661, with the French version of risque. Generally, De Moivre A(1711) was regarded as one typical author who gave a clear equation of risk, from then on, many authors mentioned there may be some other elements within risk, such as probability, uncertainty, consequence and other factors. Table 3.2 describes some key literatures.

Table 3. 2 Key elements within risk

Author	Elements
De Moivre A 1711	Risk=Expected value(loss) The risk of losing any sum is the reverse of Expectation, and the true measure of it is, the product of the sum adventured multiplied by the probability of the loss
Haynes J. 1895	Risk= Probability of an(undesirable) event Risk is the chance of damage or loss
Willett AH 1951	Risk= Objective Uncertainty Risk is the objective correlative of the subjective uncertainty; uncertainty considered as embodied in the course of events in the external world

Angell FJ 1959	Risk = Uncertainty Cost, loss or damage
Riegel R Miller JS	Risk: potential/possibility of a loss Risk is the possibility of and unfortunate occurrence
Pfeffer I	Risk: probability and scenarios/consequences/severity of consequences A combination of hazards measured by probability; a state of the world rather than a state of mind
Rosa EA.	Risk: Event or consequence A situation or event where something of human value
Kaplan S. GarrickBJ.	Risk: consequences/damage/severity + uncertainty Uncertainty; damage
ISO	Risk: effect of uncertainty on objective

From the table 3.2, we can draw out some key elements of risk, such as uncertainty, probability, damage, consequence and loss, these elements are drew out through the key concepts summary, while combined with the practice working, we should add new element, uncontrollability. In the decision making process, for the given and identified risks, we should evaluate the occurrence rate (probability), loss made by risks and uncontrollability, because the risk control is the fundamental and important work for enterprises.

Generally, it is agreed that the risk definition is the effect of uncertainty on objective, this definition was proposed by Chinese experts in the ISO meeting, and was implemented in the world wide ISO standards.

In the report of Enjeux techniques de la maintenance (<http://www.techniques-ingenieur.fr/base-documentaire/genie-industriel-th6/enjeux-techniques-de-la-maintenance-42136210/sommaire.html>), it proposed one method AMDEC(L'Analyse des modes de défaillance, de leurs effets et de leur criticité). En années 1950, la méthode FMECA (Failure Modes, Effects and Criticality Analysis) est introduite aux États-Unis dans le domaine des

armes nucléaires. Et en années 1960, cette méthode est mise en application en France sous le nom d'AMDEC pour les programmes spatiaux et aéronautiques.

Here in the table 3.3, one example was proposed. Experts can give their marks on the three indexes, probabilité, Gravité and Probabilité de non-détection, 10 is the highest and 1 means lowest.

Table 3. 3 Three key risk characters

Note F	Fréquence ou probabilité d'apparition	Note G	Gravité	Note D	Probabilité de non-détection
10	Permanent	10	Mort d'homme	10	Aucune probabilité de détection
5	Fréquent	5	Conséquences financières et/ou matérielles	5	Un système de détection est en place mais n'est pas infaillible
1	Rare	1	Pas grave	1	Le système de détection est infaillible

Here, the risk can be evaluated by the following fomula :

$$R = F \times G \times D.$$

R, evaluated value of risk

F, Fréquence ou probabilité d'apparition

G, Gravité

D, Probabilité de non-détection

According to the different degree, we can use different color to stand for the dangerous degree.

Table 3. 4 Risk matrix in French

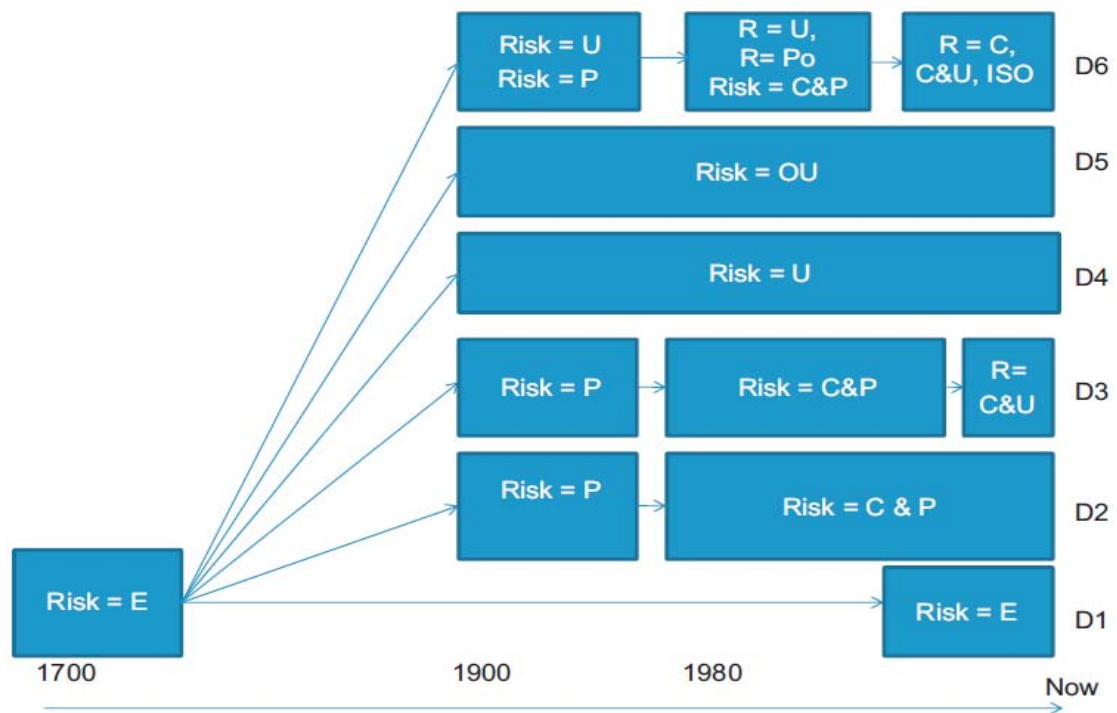
		Niveau de Gravité			
		Insignifiant	Marginal	Critique	Catastrophique
Fréquence	Fréquent	Indésirable	Inacceptable	Inacceptable	Inacceptable
	Probable	Acceptable	Indésirable	Inacceptable	Inacceptable
	Occasionnel	Acceptable	Indésirable	Indésirable	Inacceptable
	Rare	Négligeable	Acceptable	Indésirable	Indésirable
	Improbable	Négligeable	Négligeable	Acceptable	Acceptable
	Invraisemblable	Négligeable	Négligeable	Négligeable	Négligeable

Source:http://fr.wikipedia.org/wiki/Analyse_des_modes_de_d%C3%A9faillance,_de_leurs_effets_et_de_leur_criticit%C3%A9

From the French version of AMDEC, in the domain of engineering, maintenance and technology, risk can be assessed through three elements, probability, loss and the probability which can not be detected. For the probability not detected, it means uncontrollability.

In theory and practice, there are thousands of different definitions and concepts according to different research fields, different authors and different aspects. Until now there is no one universal and agreed definition for everyone, based on the different definitions, risk has the character of multi-dimensions. From the literatures and reviews, some concepts are concerned with opportunity, expected value, chance, and probability, some with the danger, unexpected events and damage. Some concepts are based on the subjective character, whether it is negative or not depends on the subject who makes decisions. Aven and Renn(2009), Aven et al(2011) have studied the strength, weakness and rationales, while one dimension was ignored by most researchers and authors, that is the time dimension which was studied comprehensively by Terje Aven(2011) from the perspective of historical and development trends. Through the literature summary, Terje Aven generated one historical chart, as the figure showed. From the figure, we can see, from 1900's, uncertainty, events occurrence probability, damage, loss and other

factors began to appear in the research work, more and more concerns appeared in the latest years.



Source: Terje Aven (2011, p.40)

Figure 3. 1 Historical analysis on risk concept

Peter L. Bernstein(1996) is one professional researcher on risk, who gave a original resource of risk, originally, risk was stem from Italian risicare, the meaning is be afraid. According to the summary of Wang(2011), there are so many definitions of risk from different researchers, until the coming of ISO31000. In the guidelines of ISO31000, named” Risk management-principle and guidelines”, Chinese expert proposed one concept, “risk is the effect of uncertainty on objectives”. Now this is the agreed definition for most researchers. It proposed advices on how to maximize risk management, while some researchers (Mariaelena Bartesaghi et al, 2012) argued that this is no universal concept, the risk definition and risk management should based on different field and industry. They regarded three fields can reduce uncertainty: banking, computer science and disasters.

In summary, the concept of risk depends on the context. In different context, risk means differently. In financial industry, many people like risk, it is

considered to be the volatility of returns. In construction industry, risk means negative consequence on the result of security and economy loss.

3.1.4 From Risk to Risk Management of Air Cargo Industry

As showed in former parts, risk taking is the shared responsibility for every stakeholder, such as individual person, household, organization (community and enterprise), nation and international organization. Basically, the literatures on the concept of risk should be reviewed, and then the main risk subjective should be clear.

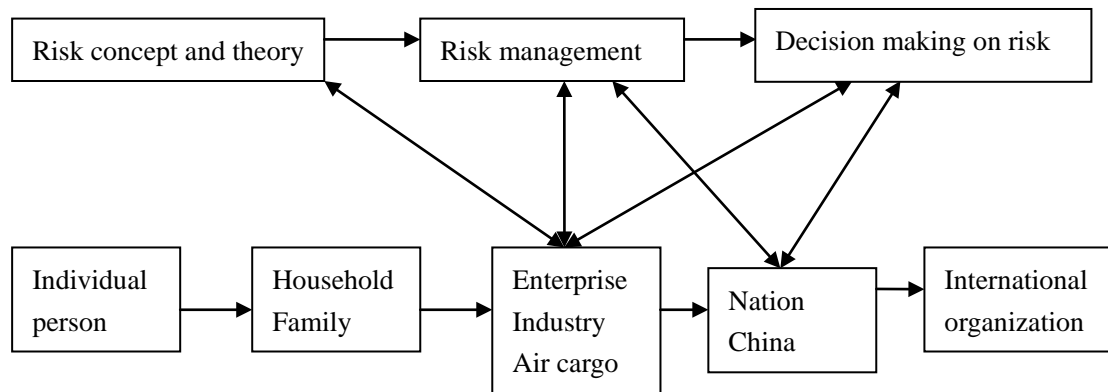


Figure 3. 2 Two research lines

As figure 3.2, there are two research lines, one is about theory line which starts from risk concept to risk management, then to decision making on risk. Another line is on practice, from the micro perspective of individual person to the macro perspective of international organization. In this research, the double -arrow lines have showed the research questions. The main focus is on how to implement risk control within air cargo industry in China.

3.2 Basic Concepts Concerned with Air Cargo Supply Chain

For this research, the concerned basic concepts are logistics, air cargo supply chain, air freight, air logistics and others.

Logistics is a general and comprehensive idea, although there are millions of different definitions, according to Ballou(1992), logistics is mainly about the process of planning, implementing and controlling the efficient, cost-effective

flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements. Daskin(1985) defined logistics as “the design and operation of the physical, managerial, and informational systems needed to allow goods to overcome time and space”. From the understanding of logistics, air cargo industry is one part of or one kind of logistics, so the concept of air logistics came into being. Air logistics is defined as consisting of revenues generated from freight and mail transportation by air. (Datamonitor Report, 2008).

Air cargo is one daily used and popular concept, and in this research, we think air cargo, air freight and air transportation have the same meaning. Air cargo is much more than just the ‘air’ component; isolation from other transport modes does not make sense, as air cargo transport has an inter-modal nature by definition. (Willem-Jan Zondag, 2006 p17)

Compared with other surface transportations, air cargo has its own special advantages and disadvantages. According to Uniconsult(2005), the advantages are the velocity of air cargo transport on medium and long distances, high standards of safety, high reliability in cargo transport and dense international flight networks. On the other side, the negative factors are expensiveness, its lack of applicability on short distances and the difficulty to obtain economies of scale by cost digression due to the restraint capacities of cargo vehicles.

Supply chain is one more general and wide concept which can include not only all the transportations, but include industrial manufacturing activities. Because it is a so mature concept and there are so many researches on it, here this research does non explain the supply chain in detail.

According to Andreea Popescu(2006), air cargo supply chain is composed of shippers, freight forwarders, and airlines. The shippers send their shipment to freight forwarders, who are responsible for contacting the airlines and procuring space to ship the cargo according to the shippers' needs. And from

the essence of air cargo industry, John A. Muckstadt et al (2009) regarded air cargo supply chain as a high velocity supply chain. For shippers that move their products by air, lead times are critical and speed is of the essence; they are willing to pay significant premiums for it over other modes of transportation. The structure of air cargo supply chain can be showed in figure 3.3.

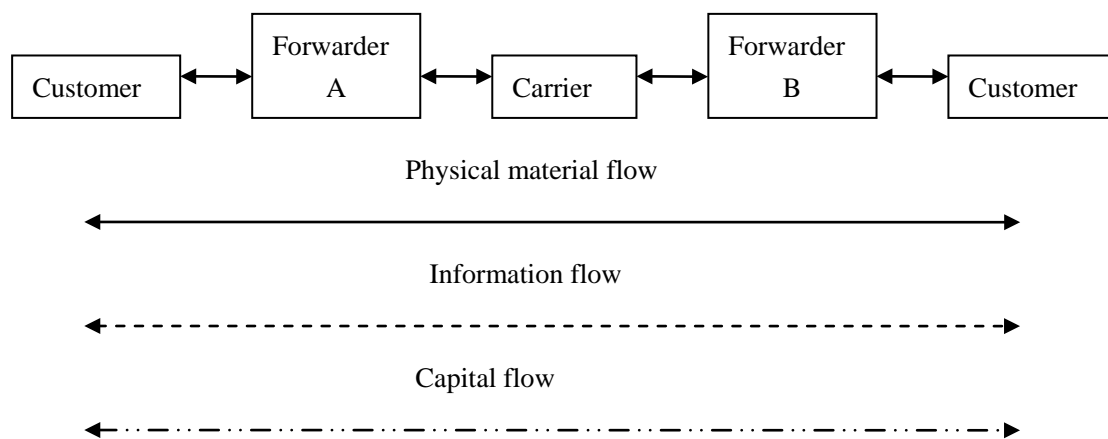


Figure 3. 3 Air cargo supply chain structure

In the air cargo supply chain structure, the customer can be named as client, shipper, consignor or consignee, and some times they are the same. For the forwarder, it acts as intermediary in the air cargo chain buying air cargo space from airlines as a wholesaler and offering this space with additional services as a retailer to shippers(Willem-Jan Zondag,2006). Some times forwarder A and forwarder B are the same one. The carrier is the airline company who carrying on the goods by aircraft. In the air cargo supply chain, capital flow, information flow and physical material flow are the three key flows.

3.3 Enterprise Risk Management (ERM) Process

3.3.1 ERM Importance and Definition

Risk management started from America in 1930's, because of the economic crisis during 1929 to 1933, American economy went into great depression and about 40% banks and companies went into bankrupt. Based on the influence of great depression, many companies built their risk management department

within the company to counter the risks; this is the original start of enterprise risk management (ERM).

In 1950's, ERM came into being as an academic subject, from that moment, ERM became a hot research subject by many western researchers, and from 1980's, many countries began to propose national ERM policies. In 1986, Europe Risk Research Association was established by 11 European countries, and the first national risk management standard AS/NZS4360 was built by Australia and New Zealand in 1995. While the first global mandatory risk management act was signed by American president Bush in 2002, it was Sarbanes-Oxley Act. And the most influential ERM action is ERM-Integration Framework, which was proposed by America in 2004. This is the first risk management act considering the enterprise strategy. (Hua Xiaoning et al, 2007)

Summarized from many ERM researchers, we can conclude that the general ERM process is including risk identification, risk evaluation, risk decision, risk control and risk warning, as figure 3.4.

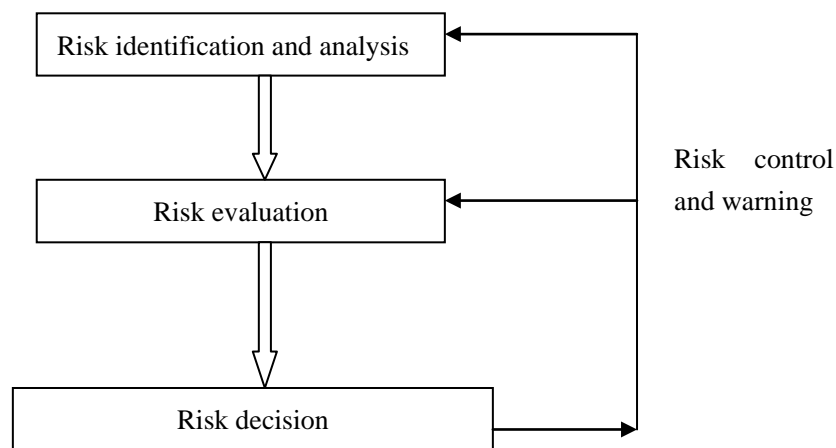


Figure 3. 4 Risk control model

From the theory point, some research (Terje Aven, 2011) argued that risk per se should be distinguished clearly with risk management and risk control, while from the daily practical working; risk can not be departed from risk management and risk control. Basically, the objective to know and research risk is to manage and control risk, here in this research, it concerns with risk management for airlines which dealing with cargo transportation. As Beck (1992) states: "Risk may be defined as a systematic way of dealing with

hazards and insecurities introduced by modernization itself”.

Why ERM is important for enterprise? According to the saying in the website of Price water house Coopers LLP (PWC):”With tremendous market uncertainty and growing demands from regulators, shareholders, rating agencies, and others, organizations face an environment where the margin of error on critical decisions is increasingly tight. A disciplined approach to managing risk can help companies become risk resilient — avoiding unanticipated losses, managing uncertainty and capitalizing on opportunity. An effective enterprise risk management capability enables management to drive greater clarity throughout the business and make better informed decisions with confidence — transforming risk into opportunity.”.

(<http://www.pwc.com/us/en/index.jhtml>) For many strong international consulting groups, such as PWC, Deloitte & Touche LLP, McKinsey & Company, Anderson Consulting and Hewitt Associates LLC, they all propose risk management as their main active and beneficial activity.

Because of the importance of ERM, some international organizations have implemented strong acts or guidance to enforce enterprise to management the risks, such as the new International Risk Management Standard ISO 31000, ERM assessment in Standard & Poor's (S&P)'s ratings for non-financial companies starting in 2009, NYSE corporate governance rules, Sarbanes-Oxley Act requirements of 2002 and Chinese central government risk management guidance.

According to the definition of COSO(http://www.coso.org/documents/coso_erm_executivesummary.pdf.p.2.r etrieved 2013-02-15): “*enterprise risk management is a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to b within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives*”. Search CIO also gives a clear definition of ERM as the following:

“Enterprise risk management is the process of planning, organizing, leading, and controlling the activities of an organization in order to

minimize the effects of risk on an organization's capital and earnings. Enterprise risk management expands the process to include not just risks associated with accidental losses, but also financial, strategic, operational, and other risks."

(<http://searchcio.techtarget.com/definition/enterprise-risk-management>.retrieved 2013-02-15)

Although there are many definitions of ERM, most of the definitions are from the perspectives of practical working. From the above two definitions, we can see generally, ERM includes a process to deal with risks. What is more, it can include the decision making board, goal setting and other factors.

3.3.2 Two Typical Framework

A. Casualty Actuarial Society (CAS) framework

The Casualty Actuarial Society (CAS) defined ERM as the discipline by which an organization in any industry assesses, controls, exploits, finances, and monitors risks from all sources for the purpose of increasing the organization's short- and long-term value to its stakeholders in 2003. (Overview of Enterprise Risk Management. Casualty Actuarial Society. pp. 8. <http://www.casact.org/research/erm/overview.pdf>. Retrieved on 2008-09-15.)

According to this framework, there are four types of risks should be managed as the standard process.

Table 3. 5 Risk types and risk management process

Four types of risks	
Hazard risk	Liability torts, Property damage, Natural catastrophe
Financial risk	Pricing risk, Asset risk, Currency risk, Liquidity risk
Operational risk	Customer satisfaction, Product failure, Integrity, Reputation risk
Strategic risks	Competition, Social trend, Capital availability
Risk management process	
Establishing Context	Includes an understanding of the current conditions in which the organization operates on an internal, external and risk management context.
Identifying Risks	Includes the documentation of the material threats to the organization's achievement of its objectives and the representation of areas that the organization may exploit for competitive advantage.

Analyzing/Quantifying Risks	Includes the calibration and, if possible, creation of probability distributions of outcomes for each material risk.
Integrating Risks	includes the aggregation of all risk distributions, reflecting correlations and portfolio effects, and the formulation of the results in terms of impact on the organization' s key performance metrics.
Assessing/Prioritizing Risks	Includes the determination of the contribution of each risk to the aggregate risk profile, and appropriate prioritization.
Treating/Exploiting Risks	Includes the development of strategies for controlling and exploiting the various risks.
Monitoring and Reviewing	Includes the continual measurement and monitoring of the risk environment and the performance of the risk management strategies.

Table 3.5 was summarized according to the analysis of Casualty Actuarial Society framework which was proposed in 2003. For an enterprise, there are four types of risks should be managed, hazard risk, financial risk, operational risk and strategic risk. This framework also stated the guidance process, from firstly establishing context, to the final monitoring and reviewing, and this will be helpful for enterprise to follow up.

B. COSO ERM framework

The COSO "Enterprise Risk Management-Integrated Framework" published in 2004 defines ERM as a "...process, effected by an entity's board of directors, management, and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives."(Enterprise Risk Management — Integrated Framework: Executive Summary. Committee of Sponsoring Organizations of the Treadway Commission. September 2004. http://www.coso.org/Publications/ERM/COSO_ERM_ExecutiveSummary.pdf. Retrieved 2008-09-16.)

According to the COSO Internal Control-Integrated Framework published in 1992 and amended in 1994, there are eight components, four objectives

categories and four layers within enterprise, showed as figure 3.5.



Source: Compiancy Enterprise Risk Management.

http://www.google.com.hk/search?q=enterprise+risk+management&hl=en&newwindow=1&safe=active&tbo=d&source=Inms&tbm=isch&sa=X&ei=tgwdUY7QHPCalQXAVYCQDQ&ved=0CAoQ_AUoAQ. Retrieved February 15, 2013.

Figure 3. 5 COSO framework

From the figure, the risk management process is firstly internal environment analysis, objective setting, event identification, risk assessment, risk response, control activities, information & communication and monitoring. This is also guidance for enterprise, while compared with CAS framework; this one is more in detail and more practical in real working environment.

C. UK Risk Management Process

From the website of <http://www.airmic.com/>, Institute of Risk Management, The Association of Insurance and Risk Managers, and the National Forum for Risk Management in the Public Sector published their united standard for risk management work; figure 3.6 shows the detailed process and elements.

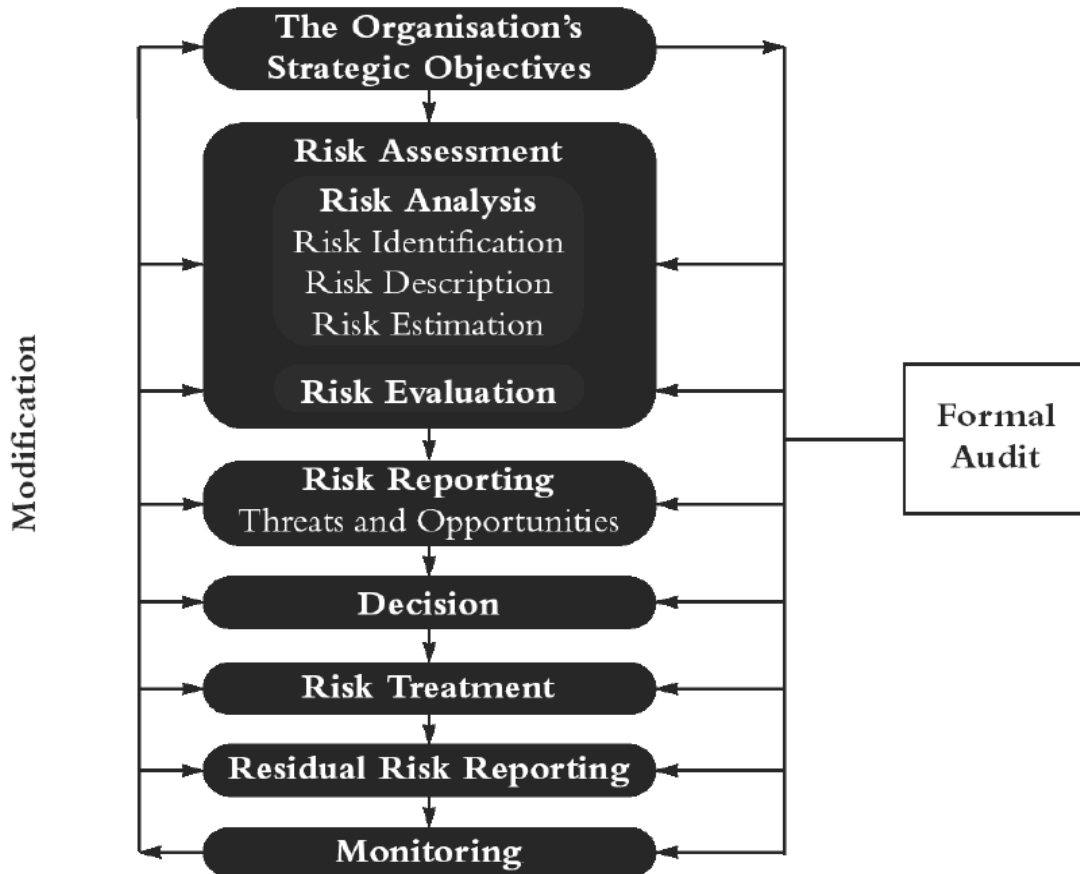


Figure 3. 6 UK Risk Management Process

3.4 Risk in Air Cargo Supply Chain

For example, in the storm weather, snow is the risk factor, accident is the risk peril, and the death of accident is the loss. This is the risk generation mechanism chain relationship. For any risk analysis, the transfer mechanism from risk factor to the final risk loss must be clarified.

Based on the analysis of Wang (2100), there is a risk generation mechanism chain, from this point, we can see, risk can be realized when it cause loss or damage compared with expected outcome, as in figure 3.7.

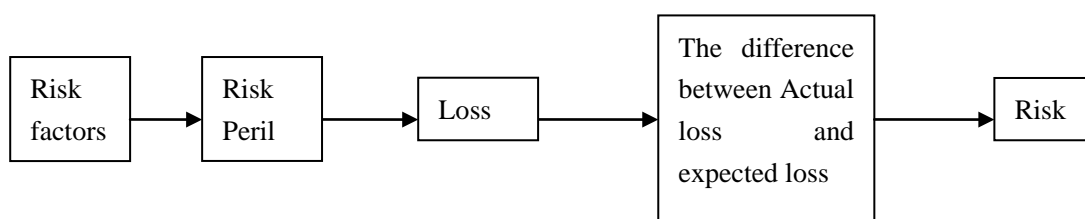


Figure 3. 7 Risk generation mechanism

From the nature of risk, we can find one typical character of risk, the transitivity, the risk can be spread through information, society, organization and person relationship, during the spread process, the probability and loss can be changed based on different conditions. So we can understand the influence of risk in air cargo supply chain, the risk of forwarder will influence all the stakeholders within the chain, not only itself.

3.4.1 Risks in Airlines

For a long time, even until now, most of the risk researches are focusing on the risks in airlines, this is because of the characters of airlines industry itself. It is agreed that air transportation industry is a capital-intensive, labor-intensive and technology-intensive industry with full of all kinds of risks and uncertainties. Especially during the past decade, 911 event, globalization, fluctuation in oil price, infectious virus, environment damage, global industry structure transfer and so on are key influential factors for airlines. In order to categorize the risks of airlines, Kichisaburo Nomura (2003) proposed one overall risk categorization, as the figure

The risks were classified into four general risks, finance risk, strategic risk, disaster risk and operation risk, but sometimes they are overlapping, for example the oil price, it can be a strategic risk because it is so important for the strategy for airline, also it can be external economic disaster. Based on the interview with managers of airlines, Oliver Wyman company (2010) got the same four general risks.

From the systemic point, many researches are focusing on systemic risks. Yuan Chuang et al(2006) did a detail research according to the loss and probability of different risks for airlines, and got one conclusion as figure 3.8.

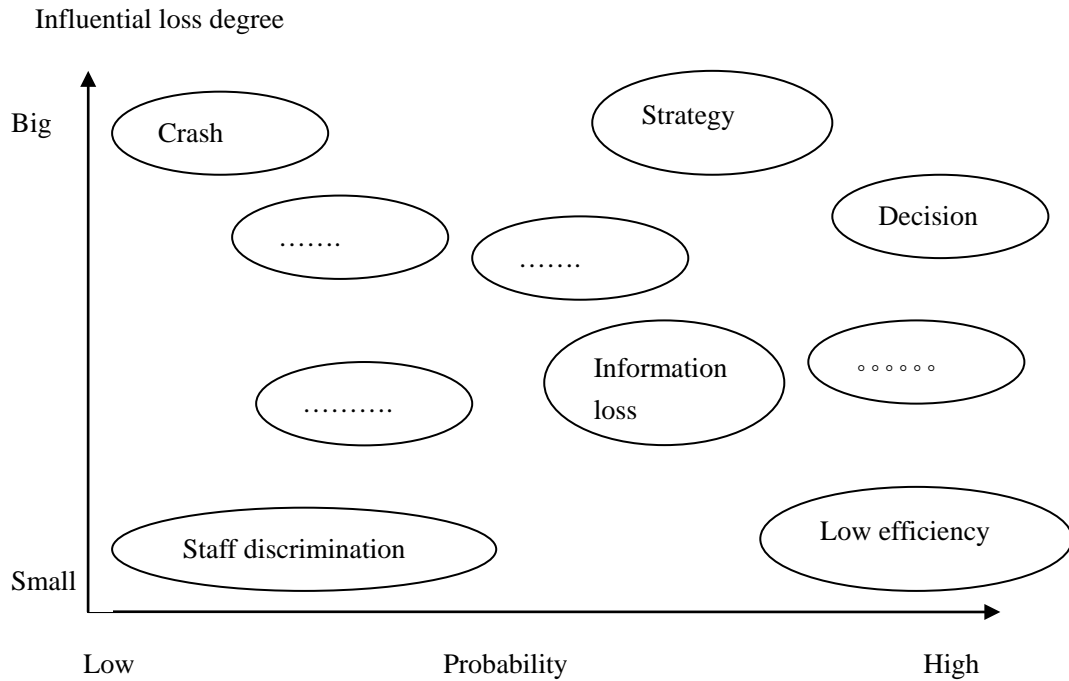


Figure 3. 8 Risk location according to loss and probability

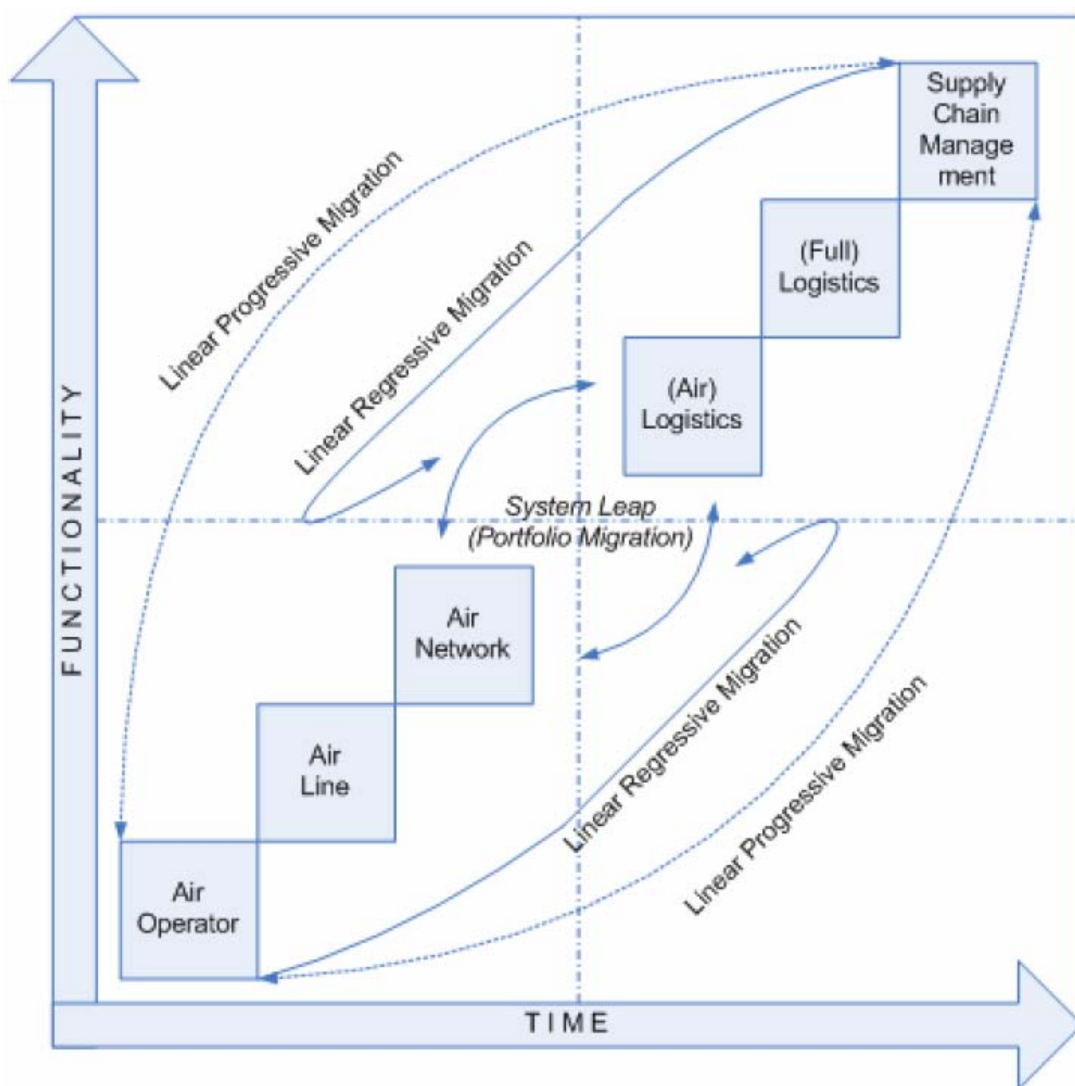
3.4.2 Air Cargo Supply Chain Risk

As for supply chain, there are so many researches in theory and so many practices in business, the supply chain management refers to the whole material transportation process from the first supplier to the final user, and any interrupt may cause a risk for the whole supply chain. (Donald Waters, 2007). This is the intuitive understanding of supply chain. From the point of flow, Peck (2006) regarded supply chain as a series of flow including material flow, information flow and capital flow. With the development of supply chain management, value was abstracted from supply chain, Christopher (1998) argued that supply chain is one process of value adding, all partners during the chain can benefit from the chain. Different researchers can explain supply chain from different aspects, such as organization behavior (Larson and Halldorsson,2004), integration solution of all flow(Handfield and Nichols, 1999).

As for supply chain, there are two kinds of relationships with air cargo. From the general macro environment, air cargo is one special point in the global

supply chain, especially for the international companies, such as Intel, Apple, and LV and so on. From the nature of air cargo itself, the process of air cargo operation is one small supply chain, which including information flow, cash flow and physical goods flow. Based on the above two explanations, many researches are focus on the topic of supply chain.

In order to realize one-stop buying, global logistics companies try to make air cargo integrate into supply chain strategy, in this way, global consumers' diversified need can be satisfied (Renato Chiavi,2008, p393)



Source: Grin(1995)

Figure 3. 9 Air cargo business positioning

As figure 3.9 showed, supply chain management is the top level in air cargo industry, with the time and multiple functions; one play can become a supply

chain value provider.

Air cargo is enforced by four main factors, globalization, customer need, airlines competition and innovation on IT and infrastructure, and mainly influenced by political environment, economic environment, and industry development and governance policy.

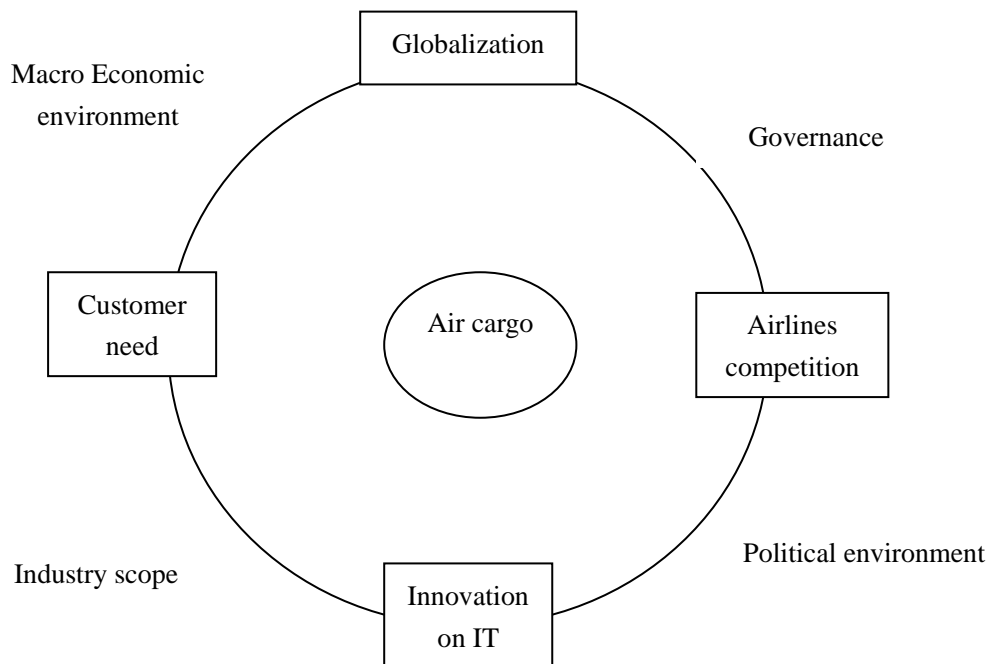


Figure 3. 10 Air cargo position

Based on the supply chain management and value chain of Porter, Zou(2006) proposed the concept of air cargo service chain to provide added value to customers, as showed in the figure 3.10.

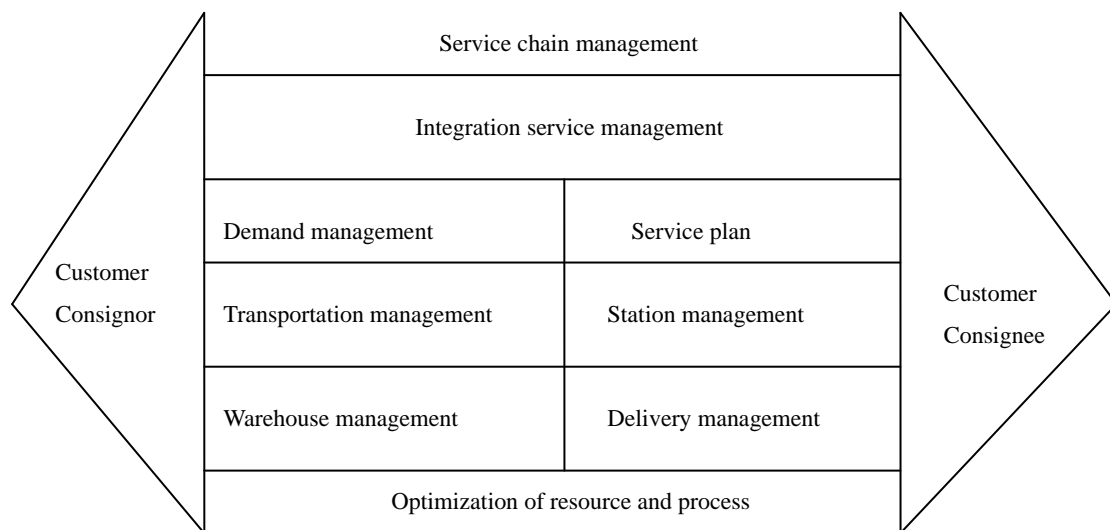


Figure 3. 11 Air cargo service chain

Despite the different understanding of supply chain, all the researchers agree that supply chain has risks because of the globalization, competition, vulnerability, outsourcing, integration and international trade from inside and outside. (Donald Waters, 2007). According to convention, Donald Waters(2007) categorized supply chain risk into internal risk and outside risk.

The fourth party logistics is one innovative and new coming trend for supply chain, while also there are risks in the fourth party innovation. Peng Yan (2006) identified and categorized the risks in the fourth party logistics, as showed in table 3.6.

Table 3. 6 External risk and internal risk of the 4th party logistics

External risk	Nature risk	Disaster from storm, flood
	Society risk	Political and war
	Economy risk	Economic crisis, exchange rate
	Technology risk	New technology
	Market risk	Market need and competition uncertainty
Internal risk	System risk	Efficiency, management, capital
	Organization risk	Not coordination, Moral hazard
	Information risk	Delay, asymmetric

The focus of this research is the risk in air cargo supply chain, so we can get the intersection between supply chain and air cargo. Air cargo transportation can be regarded as one special and specific supply chain, maybe it is one part of a supply chain, and maybe it is one supply chain specialized in air cargo transportation.

Summarized from many researches, all most all the researches on the air cargo supply chain risk are focusing on the goods security and flying security. As for the strategy management and operation management of air cargo industry, the researches are focusing on the revenue management, booking system, insurance control, and competition (Raphaele L.Vojtovic,1997; Andreea Popescu, 2006; Lama Moussawi,2006; John A. Muckstadt et al, 2009). According to the present researches, few researches are located on the

strategy risk, finance risk, operation risk; while it is time to do the research to find out how about these risks in air cargo supply chain.

3.5 Air Cargo Supply Chain Risk Formulation Mechanism

3.5.1 From the Point of Stakeholder Relationship

As explained in the air cargo supply chain structure in figure 4.1, the three key stakeholders are carrier, forwarder and client, at the same time, the supporting participants are including banks, customer, airport, government, oil supplier, insurance, consulting agencies and others. All the stakeholders are expecting to benefit from the air cargo supply chain, while the relationship among them is not always harmony. The discord relationship will be the risk source in the air cargo supply chain.

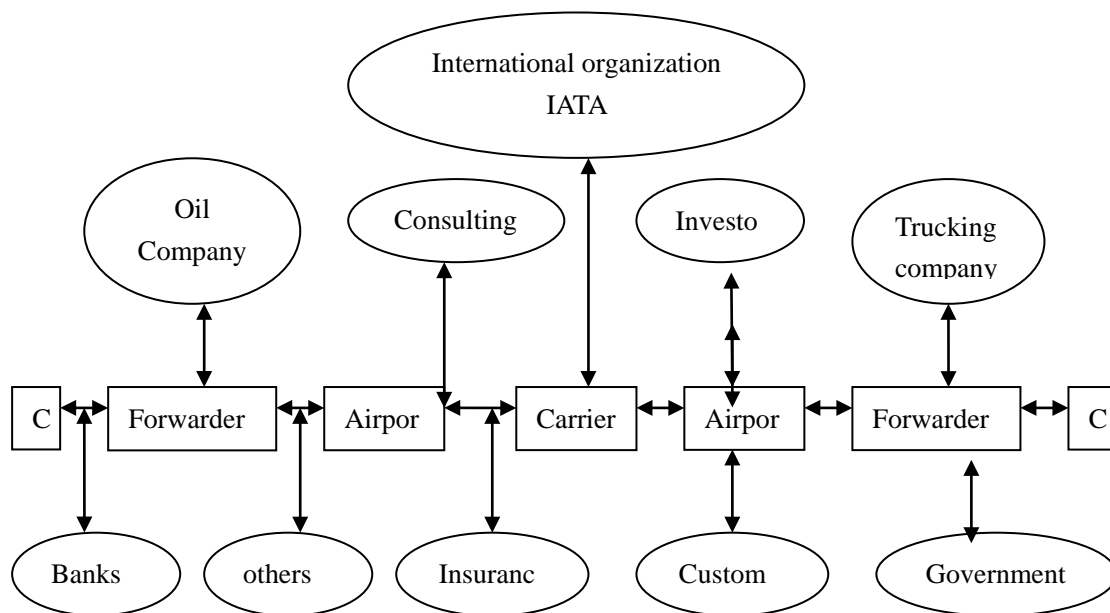


Figure 3. 12 Stakeholders in air cargo supply chain

The differences on objective, benefit and motivation among different participants are the uncertainty factors which will be the potential risks. From the organization behavior, inefficient organization communication always will cause misunderstanding. From the figure 3.12, we can see, local governments

and IATA have the strongest positions compared with other participants, and custom and banks have the stronger position, this organization hierarchy will cause the power unbalance.

3.5.2 Risk from Information Transformation

Air cargo transportation is a complex operation process, before the cargo aircraft taking off; many stakeholders have to do a comprehensive preparation. The shipper must pass the cargo information to forwarder, after receiving information from more than one shipper; the forwarder will consolidate all the information and then pass the information to airlines. The final schedule of airlines is decided by the information from shippers and forwarders. At the same time, the transportation must need the support from banks, insurances, airport, and custom and so on. Information flow, material flow and capital flow are three flows in the air cargo supply chain.

According to Andreea Popescu(2006), the most important operation during the supply chain is the process of acquiring capacity, and there are two key phases:

In stage one, six to twelve months before the actual departure, freight forwarders bid for cargo space the airlines have to offer; the cargo capacity committed during the auction process is called allotted capacity;

In phase two, a few days before the actual take off, the freight forwarders have to confirm the allotted space, either returning unwanted space or confirming the need of the whole allotted capacity. For the airlines, the remaining capacity available for free sale. From the process, we can see the actual goods transportation is decided by the information flow, any delay and error information will be risk for the whole supply chain.

The above is about the risk from information transformation, also risk can be from the information sharing.

Cargo information must be shared by all the concerned parties, such as

custom, forwarder, airline and government, any asymmetric information or delay will bring loss and inefficiency. From the legal aspect, some delay or wrong information will cause illegal consequence, such as tax evasion, smuggling, moral hazard and credit loss.

3.5.3 Force Majeure

In the contract, force majeure is the forgive reason for the violation, the main forces are nature disaster, war, political movement, social crisis and so on. In most cases, we can use insurance to control the risk, but the insurance only can make up part economic loss, inevitable, it will bring risks for the participants.

3.5.4 Technology

Technology can improve the advance, applicability, reliability and efficiency for the whole supply chain, while it is also a risk for the stakeholders. Short board effect always happens in the air cargo process, for example the information technology asynchronous. Technology bottlenecks, such as the technology to counter nature disaster, goods information transformation and so on, are the potential risk for the whole chain.

IT development can be a double-edged sword for air cargo, as Taylor & hallsworth(2001) argued, air cargo players can benefit from the risk of electronic communication and information exchange means, however, it has become a threat as e-mail and attachments to e-mail have declined the demand for air transportation, on the other side, sales of tangible products via website to consumers has caused demand by e-commerce.

Many innovative business solutions are based on adoption and utilization of information technology. Today's level of information technology sophistication is capable of impacting alternative business strategy and organizational structural choice to a greater degree than ever before (Bowersox and

Daugherty, 1995). Under the influences of IT, logistics organizations will have several important changes, such as more transparent organization structure, more strategic alliance and greater reliance on time-based strategies.

Prior to the 1990's, business information exchanged digitally was achieved using EDI, where connections between businesses had to be pre-arranged. In the early 1990's, with the commercialization of Internet and the advent of open computer technology, connectivity becomes affordable not only for businesses but also for individuals. According to Leung et al. (2007), there have been four eras: Pre-Web (prior to 1990), Reactive-Web (early 1990's), Interactive-Web (mid-1990's), and emerging Integrative-Web (end of 1990's to early 2000's). In all, the development of IT enable the air cargo development, for example, as a leading standing IT system for air cargo ground handling, ELWIS(Electronic Logistics & Warehouse Information System) was invented by Lufthansa Systems to be used in 28 airports. There are other kinds of systems, such as Cargo 2000, IATA's DGR e-list online integration, e-invoicing, WLAN, interfaces to stacker systems, weight scales, FRID technology.

3.5.5 Market

Risk is based on the uncertainty, and market uncertainties are demand uncertainty and competition uncertainty. Because of the nature reason, economy reason, political reason, or consumption model change, the demand for air transportation will fluctuate irregularly, accordingly, the supply can not always match the demand, in this way, one kind of market failure will happen. Another uncertainty is market competition. The competitions within the air cargo supply chain are price battle, service competition, speed competition and government resource competition. For example, some carriers can get lucrative lines which are always monopoly.

Air cargo market is not a perfect competition market because of the government participation, and the government must control the tax, smuggling,

and national benefit. So in this special market, market competition behavior, government control and IATA guidance are mixed.

3.5.6 System Risk

The system risks are the risks decided by the air cargo system itself because of the system inefficiency. The systemic uncertainties are management, technology within system, capital need. Based on the human resource management, lacking of talents, talents unfit or inefficient human resource policy can be the potential uncertainties for human management systemic risk. Air transportation is a capital intensive industry, which need large amount of capital to keep the moving, if the capital is not enough, the capital uncertainty will be the high potential risk for the whole supply chain. In the process, the airlines need large amount of capital to buy oil and aircraft, to hire people, to pay for the airport. Forwarders have to pay airlines for the aircraft space and guaranty.

3.5.7 Risk Transmission

From the structure analysis of air cargo supply chain and risk literature review, the air cargo supply chain risk can be transferred and spread by information, society, organization and individual. The transfer process can have Ripple Effect and social amplification theory (Nick Pidgeon et al, 2010). The small risk from risk source can have big social and economic influence through the transfer and amplification, as figure 3.13 showed.

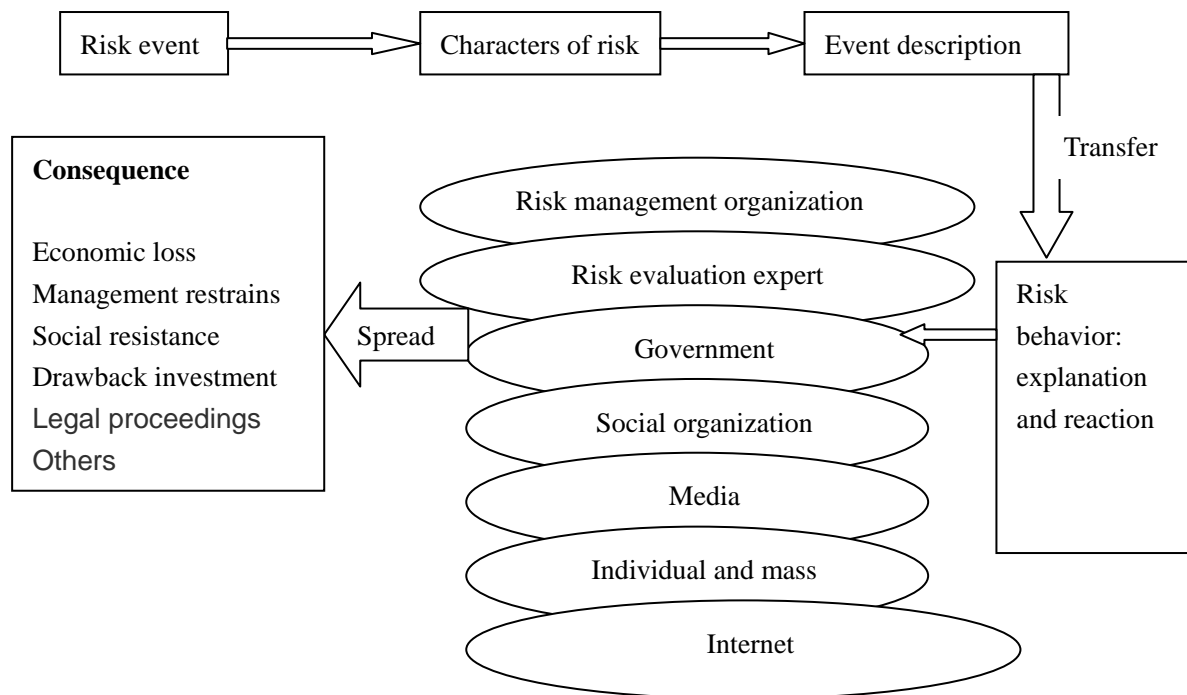


Figure 3. 13 Risk transfer process

3.5.8 Subjectivity of Risk

According to concept of risk, it is about the loss maybe caused by the uncertainty. When talking about the loss, it will have a strong sense of subjectivity. In the case of nature disaster, the risk maybe cause heavy loss for the carrier and shipper, while for the custom or bank, the loss can be neglected. In a macro point, the risk in the air cargo supply chain maybe nothing for the sea transportation participants. The subjectivity means that there must be someone who will bear the consequence of risk, and within the air cargo supply chain, the consequences are different according to different stakeholders or participants. The source of risk can be regarded as the subjectivity risk within the air cargo supply chain, and the key three subjects are shipper, forwarder and carrier.

Organizational factors can affect system risk in the aviation environment, according to Parke et al. (2004), there are three levels of risk source, organization-wide, teams/work groups and individual.

3.6 Conclusions

Chapter 3 includes two parts, basic definitions of risk and the risk formulation mechanism. In the first part, the basic source, different concepts, risk origination, classification and elements are clearly stated. It is summarized that risk is the uncertainty of the objective. Risk can not be researched isolated from risk management and control. Started from risk per se, some other concepts are analyzed, such as enterprise risk management, supply chain risk, risk in air cargo industry. For the enterprise, two typical frameworks are introduced as COSO framework and CAS framework, and both are popular in enterprise all over the world. Risk can be happened because of stakeholder relationship, information asymmetry, force majeure, technology, market failure, system risk and the process of risk transmission. This analysis will be helpful for the later risk identification.

Chapter 4 Air Cargo Supply Chain Risk Identification

4.1 Introduction

Based on the review of literatures on risk, air cargo industry of chapter2, and background of industry, economy and the author, this chapter takes the following step to identify the risks in Chinese air cargo industry.

Risk identification is the first and important step of enterprise risk management, only after the risk factors identification, the following assessment, control and decision can be made. In theory, there are many methods and tools for risk identification in different fields, such as expert interview, safety check list, work breakdown structure (WBS) risk breakdown structure (RBS) (WBS-RBS), scenario, fault tree analysis(FTA), financial statements, event tree analysis (ETA) and hazard and operability study(HAZOP). We can identify the risks through the analysis of the past events using "Five Why", Cause and Effect Diagram, Pareto report, lists (Donald Waters,2007), and we can get the suggestion from others using interview, survey, Delphi method, brain storm and so on. Every risk identification method has its own characters and applied fields, for example, in construction project; people often use WBS-RBS to identify the risks in the process of project process. Sometimes, people prefer combine two or three different methods together to identify the risks. In this research, brainstorm, expert interview, RBS and literature review methods will be used together to identify the risk in Chinese air cargo industry. From theory perspective, it will explain why it chooses these methods and implements the methods comparison.

While in reality, risk identification is a difficult, exhausting and complex task. There are so many risks we can not forecast and identify, it is impossible to identify every appreciable risk, but we must do it. In practice, identifying unknown risk is the most difficult work.

Surveys is one of the most often used method to identify the risk factors, and

NASA has developed one organizational risk model through the use of survey in order to identify the factors which contributed to many aircraft accidents(Parke et al., 2004). Chiou and Chen (2010) used a framework of SHEL (software, hardware, environment and live ware) to employ exploratory and confirmatory factor analysis, and then got 26 key risk factors in air traffic controllers.

The main process working of this chapter is to identify risks in Chinese air cargo industry using interviewing, brainstorm approach, risk breakdown structure (RBS) and literature review method, and then to analyze these identified risks. As a conclusion, figure 4.1 can describe the framework of this chapter.

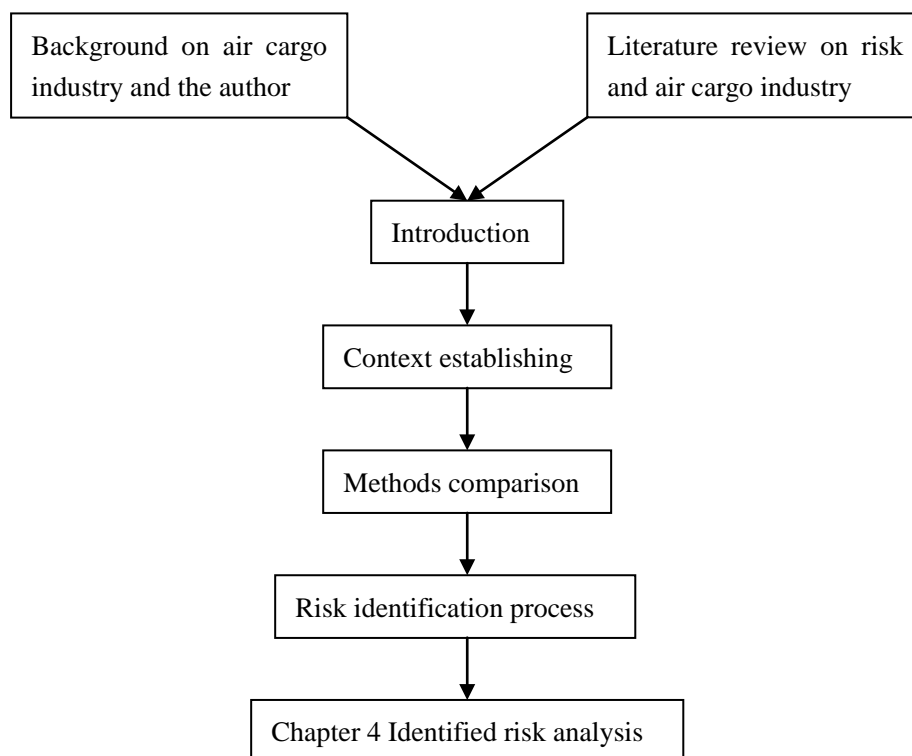


Figure 4. 1 Working framework of chapter 4

4.2 Context Establishing: Business Process Structure and stakeholder Analysis

Before the risk identification, the first step is to make clear the process of forwarder, carrier and customer.

Multi-product services portfolio is the core business for forwarders, they supply more services than cargo space alone. Their added value is reflected by their extensive market knowledge, their ability to arrange pick-up in country of origin and delivery in country of destination, their ability to consolidate and de-consolidate shipments, their ability to deal with customs procedures and other administrative and financial tasks and increasingly, their global coverage. What is more, forwarders also advise their customers about the most recommendable transport solution in a particular situation, about required packaging and may intermediate in recommended transport insurances. On the airlines side, they negotiate on the contract terms of carriage and generally supervise the transportation process. Their value adding services are documents handling, picking and packing, sorting, kitting, labeling, minor product repair, warehousing, storing, inventory control, customs clearance, order processing, ground distribution and taking care of the compliance with foreign regulations on trade and financing instruments(Fennes, 1997)

Forwarders are non-asset-based service providers with a more variable cost structure than other air cargo service providers which explains why they are less sensitive to fluctuations in supply and demand (Jones, 2000). Forwarders are flexible as they can easily tailor different transport modes and logistics services like warehouse management and value added logistics to meet customer requirements (Willem-Jan Zondag, 2006).

Generally, according to the author's working experience and business mode in China, figure 4.2 summaries the basic business model of air cargo transaction. In figure 4.2, there are six parties involved in the transaction, shipper or consignor, bank, custom, forwarder and carrier(airlines). During the transaction, capital (cash) flow, cargo flow and information flow connect six parties together. In practical working, bank A and bank B can be the same bank; forwarder A and forwarder B can be the same; sometimes, the consignee and the bank B can be the same. With the development of economy, globalization and informatization, the forwarder becomes stronger and stronger, and then, the

integrator comes into being, as the figure 4.3 showed. In the simplified process, the shipper or consignee only need sign the contract with the integrator and pay for it, the integrator can do the custom clearance, capital transfer, ground handling, packaging, warehouse and transportation by aircraft. Some integrators have their own aircraft for cargo or signed airlines; others have a long term contract with airlines. Because of this fact, the interview experts of brainstorm in this research are from shipper, forwarder, carrier and researchers.

With the coming into being of UPS, FedEx or other integrators who specialized on express delivery, the air cargo industry changes, while the express focus on small parcels, documents or letters. In this research, the express airlines were excluded out of the framework.

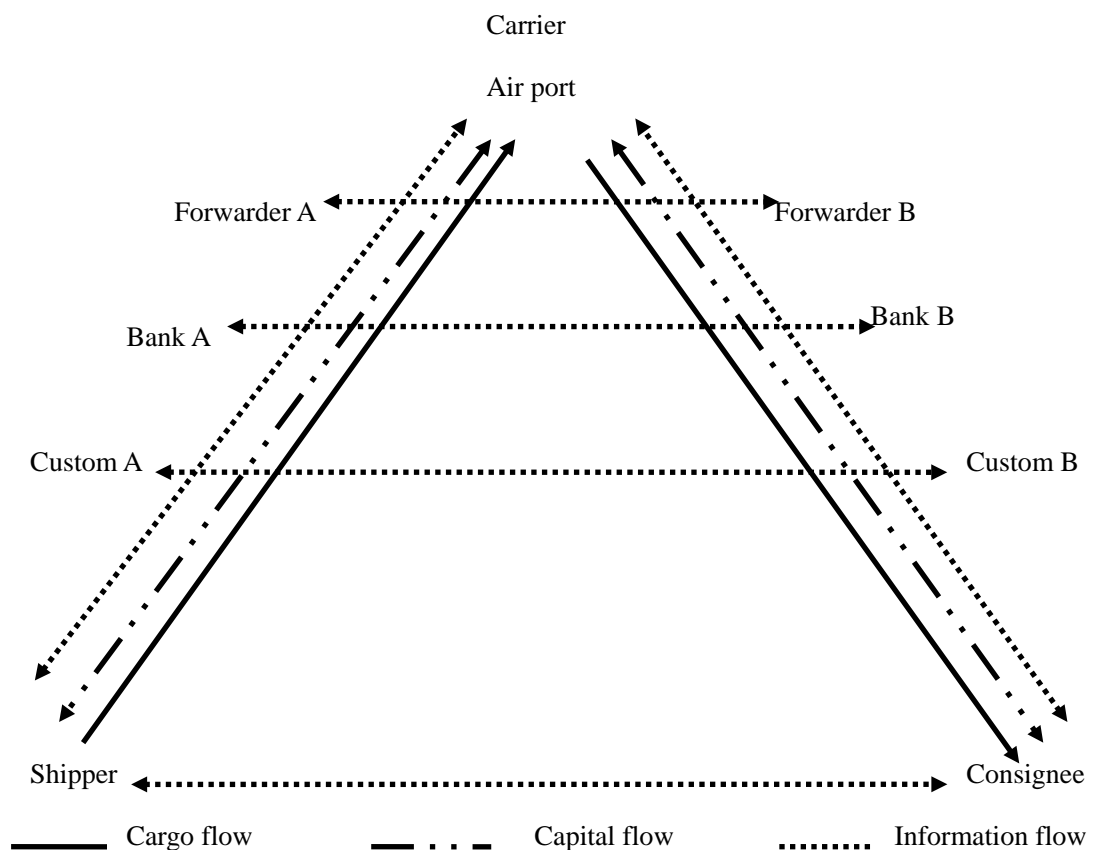


Figure 4. 2 Air cargo process and parties

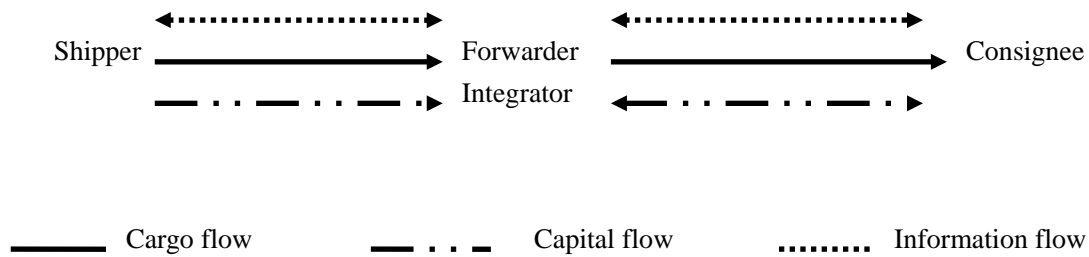


Figure 4. 3 Simplified air cargo process and parties

4.3 Alternative Risk Identification Methods and Methods Comparison

As the saying goes, every coin has two sides. Every risk identification method absolutely has its strong points and weakness. In this research, in the stage of risk identification, expert interview and literature review methods will be used to identify the risks in Chinese air cargo industry. Now the question is why these two methods are suitable for this research. Although some researchers have done the risk identification comparison (Forbes et al, 2008), and it is conclude that more than two methods should be implemented in the risk identification process, for air cargo industry, none risk identification methods comparison has been founded until now according to the author's literature reviews. Most of the risk identification methods comparisons are based on the context analysis and industry environment. Some methods are very suitable for the specific industry, while maybe they are useless for other industries. In reality and practice, it is impossible to take many methods to identify risks in the given program or industry, it will take too much cost and long time.

4.3.1 Literatures on the Risk Identification Comparison

For the construction and built environment, brainstorming is the most commonly used by practitioners (Bajaj et al. 1997), and the risk breakdown structure (BRS) is the second commonly used method. Forbes et al(2008) used brainstorm and BRS individually within the same built environment, and different risks were identified. The result showed that firstly, both methods are

useful for risk identification within construction industry; secondly, RBS can output more generalized risks and brainstorm can produce more specific risks; Thirdly, using brainstorm method, more unconventional and surprising risk will be identified than using RBS; fourthly, brainstorm method is more comprehensive than RBS, while more time consuming. Finally, Forbes et al suggested that a combination of both approach maybe the best way.

Mikko Kurttilaa et al (2000) combined SWOT method and AHP method together in forest-certification case. In this case, they did not criticized the risk identification and assessment methods, and try to use the advantages of both.

4.3.2 Risk Identification Methods Analysis and Explanation

A. Brainstorm

Osborn (2001) argued that brainstorm is an approach to generate many ideas from a group of people, and Wood and Ellis (2003) conclude that it is the most widely used approach in practice. Generally, brainstorm approach is divided into structured process or informal process, and the aim of structured process is to get as many as possible risk factors within limited time. In theory and practice, the process of brainstorm is very clear and popular, and many researchers and practitioners can use it efficiently.

Brainstorm approach has three stages normally, before the meeting, during the meeting and after the meeting. Following the key notes in the three stages can guarantee the smoothly brainstorm meeting.

Before the meeting

Key notes: select experts; declare the expectation to experts and participants; announce the process of the meeting; explain the questions; prepare a comprehensive list of risks for reference.

During the meeting

Catch as many as possible risks which appear in the meeting; use any recorder tools to avoid any missing; stimulate everyone to speak out their

opinions; use the prepared list to encourage participants; ask” why it does not work” and other inspiring questions.

After the meeting

Categorize the risks; well preserve the documents for check; clear the connection channel with participants to be sure that if there are some new emerging risks, they can inform the organizer; calls or email to the participants after several days, and to be sure there is no missing risks.

B. RBS

In case of a project or business with much data, in fact, it is true in this information age for every organization, structuring is regarded to be the essential strategy to make sure the success. That is the reason why Work Breakdown Structure (WBS) is so important and useful for project managers. The Project Management Institute defines a WBS as “A deliverable-oriented grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work” (Project Management Institute, 2000, 2001). The purpose of the WBS function is mainly for project work in hierarchical, manageable and definable packages to provide a basis for project planning, communication, reporting, and accountability.

According to Doctor David Hillson “A hierarchical Risk Breakdown Structure (RBS) framework similar to the WBS provides a number of benefits, by decomposing potential sources of risk into layers of increasing detail. The RBS is a powerful aid to risk identification, assessment and reporting, and the ability to roll-up or drill-down to the appropriate level provides new insights into over all risk exposure on the project.”

The working principle of RBS is coming from work breakdown structure (WBS), according to the working process of WBS; the risks are classified into hierarchical layers which are manageable, definable and clearly limited. One typical hierarchical structure is showed by Chapman (2001) as the figure 4.4. based on the structure of working process and format, the risks are divided into

several risk factors, within each risk factors, there will be some sub-layer risk factors, and then the sub-sub-layer risks.

RBS LEVEL 0	RBS LEVEL 1	RBS LEVEL 2
0. PROJECT RISK	1. TECHNICAL RISK	1.1 Scope definition
		1.2 Requirements definition
		1.3 Estimates, assumptions & constraints
		1.4 Technical processes
		1.5 Technology
		1.6 Technical interfaces
		1.7 Design
		1.8 Performance
		1.9 Reliability & maintainability
		1.10 Safety
		1.11 Security
		1.12 Test & acceptance
	2. MANAGEMENT RISK	2.1 Project management
		2.2 Programme/portfolio management
		2.3 Operations management
		2.4 Organisation
		2.5 Resourcing
		2.6 Communication
		2.7 Information
		2.8 HS&E
		2.9 Quality
		2.10 Reputation
	3. COMMERCIAL RISK	3.1 Contractual terms & conditions
		3.2 Internal procurement
		3.3 Suppliers & vendors
		3.4 Subcontracts
		3.5 Client/customer stability
		3.6 Partnerships & joint ventures
	4. EXTERNAL RISK	4.1 Legislation
		4.2 Exchange rates
		4.3 Site/facilities
		4.4 Environmental/weather
		4.5 Competition
		4.6 Regulatory
		4.7 Political
		4.8 Country
		4.9 Social/demographic
		4.10 Pressure groups
		4.11 Force majeure

Source: Sample Risk Breakdown Structure - ATOM-Risk

<http://www.atom-risk.com/templates/Sample%20Risk%20Breakdown%20Structure.pdf>

Figure 4. 4 Typical RBS hierarchical model

Because of the character of structure, this method is mainly useful for project management and well-structured organization. In air cargo industry, the business model can be well-structured as a simplified model which includes clients, forwarders and carriers. So RBS is one useful and easily managed method for this research.

C. Reviewing the past document

Document review is an effective guidance for most people if they can get the documents on the similar project or business. Through the past document,

they can identify many useful risks according to the experience recorded. This method is really useful for the construction industry or project management, because the projects always have some similarities.

For the other side of the coin, there are some preconditions for effective risk identification through past document reviewing. Firstly, there must have integral documents for review, that is to say, during the past working process, all the important documents were well-preserved. In case of risk management, one formal and good risk register system is supportive for this method. Secondly, because of the time change, you can not jump into the same river twice. There are always new-emerging risks under new condition. Thirdly, even if there are well-preserved document, normally it is difficult to get in. maybe it is confidential for the document keepers; maybe they just do not want to share.

According to the real condition of risk identification, the documents can be insurance policy, compliance recorder, and contract with clients, financial statement, regulations and public policy.

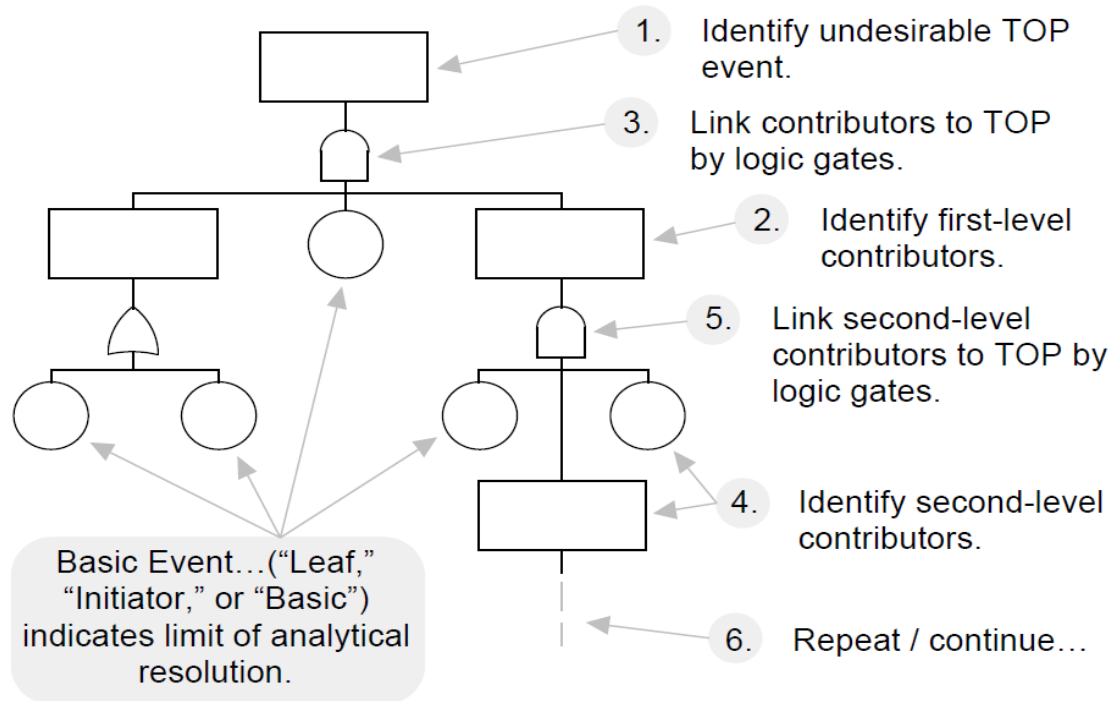
D. Questionnaire and survey

In the field of marketing and sociology research and practice, this method is one good method to get information from clients, consumers and stakeholders based on the mathematical statistics. For example, questionnaire and survey can be effective to get the client satisfaction degree through their complaints. The advantages are easy to carry out, better for special fields such as marketing, can benefit from software and statistics. For this research, air cargo industry is one limited and special industry, it is better to use experts, not ordinary consumers.

E. Outputs from Risk-oriented analysis

Fault tree analysis (FTA) and event tree analysis (ETA) are two typical techniques of risk-oriented analysis. They are intending to find out what events, conditions, faults could cause an undesirable problem from top to down. Fault tree analysis (FTA) was proposed for US Air Force by Bell Telephone Laboratories through the using of Minuteman System. Because of the success

of FTA, Boeing Company began to use it extensively. From the theory perspective, it is one symbolic logic analytical technique in the operation research field, and now is widely used in many fields, including risk management. According to P.L. Clemens (1993), normally FTA includes 6 steps as the figure 4.5 showed.



Source: Clemens (1993)

Figure 4. 5 FTA 6 steps

Event tree analysis is a bottom-up, deductive and system safety analytical technique which can be a good complementary to fault tree analysis and other techniques. One typical simplified Bernoulli Model is demonstrated as the figure 4.6.

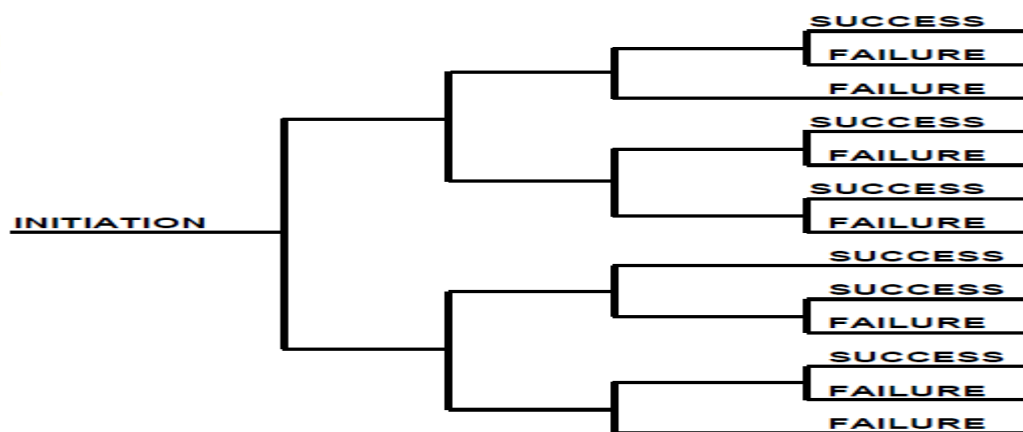
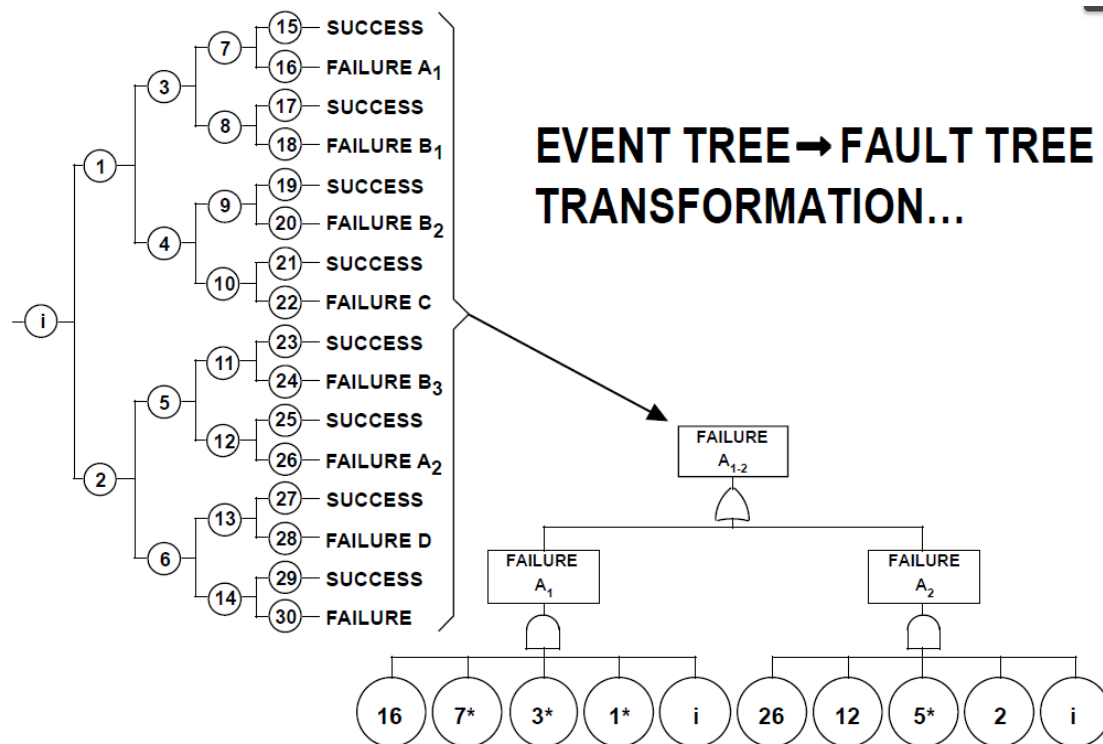


Figure 4. 6 One Bernoulli Model of event tree analysis

Normally, based on the analysis of event tree analysis, it can be changed into a fault tree analysis, and both methods can be interactive each other.



Source: P.L. Clemens(1990)

Figure 4. 7 From Event Tree analyses to fault tree analysis

In figure 4.7, through the analysis of one project, the success and failure are identified through ETA, and then FTA can be further analyzed to get the real and final result. For the disadvantages, the operating pathways must be anticipated; sometimes, the success and failure are not clearly distinguished; the initiating events are treated singly. For the advantages, multiple failures can be analyzed; the system weaknesses can be identified. Generally, the following table will show clearly the both sides of a coin for every method.

F. Strength, weakness, opportunity and Threat (SWOT) analysis

Based on the literatures, there are so many topics on SWOT, and there are many origination of SWOT too, while the origination is not important contrasted with its widespread use. According to Albert (2005), SWOT analysis is a structured planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or in a business venture. A SWOT analysis can be carried out for a product, place, industry or person. It

involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective. The technique is credited to Albert Humphrey, who led a convention at the Stanford Research Institute (now SRI International) in the 1960s and 1970s using data from Fortune 500 companies.

SWOT method is one easy and simple method which is used in every corner within the research and practical fields. Through simple analysis with the name of SWOT, many conclusions can be gotten and many decisions are made. In fact, it is dangerous in practical business decision making. Firstly, most SWOT analysis is static which can not have the function of foreseeing and forecasting. Secondly, it is too subjective and more depend on the ability and knowledge of the reporter. For the opportunity in business, only few people can anticipate in advance, and for the threat, most of the risks normally are ignored. Thirdly, it is too dangerous to make decision only base on the SWOT analysis, it is better to combine several methods together.

G. Risk Check Table

Risk check table is a tool from the past risk factors and predicable risk factors, and with the listed risk factors in the Risk Check Table, we can check every risk factor, then to give an analysis for every one. Table 4.1 is an example of Risk Check Table for a virtual enterprise (Feng Weidong and Chen jian,2001)

Table 4. 1 Risk Check Table of virtual enterprise

Risk	Time	Cost	quality	technology	human
Partner1						
Partner2						
.....						

Risk Check Table is one systematical method using a list on table to dig out all the exposures, perils and hazards. It is welcomed by risk managers and other non-well trained people because of the character of standardization. While for the other side of easy carrying out, this method has its obvious limitations. It is one stable fixed list for check, so it is normal to miss many new risks. In fact,

the world is changing; the only constant thing is changing.

H. Cause-and-effect diagram

Cause and effect diagram, sometimes called fishbone, is one common icon tool in management and also is one quality control method. Through the reasoning process of this method, we can get the risks and show them in figures. It can show the relationship between its effects (problem) and its potential cause, and figure 4.8 shows the typical model for the analysis.

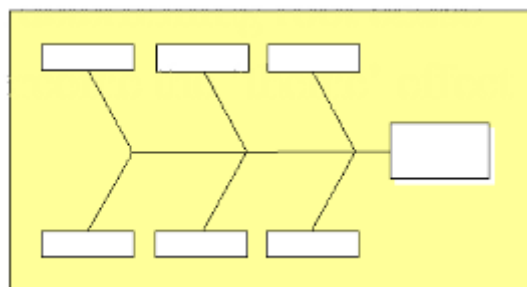


Figure 4. 8 Typical fishbone models

Using a cause and effect diagram, it can insure a balanced list of ideas which have been explored during brainstorm meeting; it can sort and related the effecting factors in case of little quantitative data is available; It can help to dig out the root case to overcome the “theme” effect. In the practical use, 6 M’s is the typical and useful technique to find the main causes, manpower, machines, materials, methods, measurements and mother nature(environment).

I. Risk-oriented Software

In order to identify risks systemically and easily, with the development of information technology, many research and development departments are focusing on the software design to identify risks automatically. Microsoft Project TM and Primavera TM are two well-designed software for risk managers. Boehm’s Top Ten Software Risks is 10-top-level software which can be helpful for risk identification. This software can have some basic functions especially on the computer science or information projects. Risk identification is one difficult work which needs cost, time and lots of investment, it is impossible to identify automatically.

4.3.3 Risk Identification methods classification

Reviewing and talking

Risk identification methods can be divided into two categories, identifying through talking with people and reviewing the documents according to the information collecting measures, as in table 4.2. In some cases, it is better to combine both measures, for instance, after or before brainstorming, taking a preparation of literatures reviewing.

Table 4. 2 Reviewing and talking identification methods

Talking with people	Meeting; brainstorm; Delphi; interview;
Reviewing document	Contract; regulation; policy; insurance document; history recorder; archives;

From the perspective of documents, information and analysis, risk identification methods can be divided into three categories, as table 4.3 shows, gathering information, reviewing documents and analysis.

Table 4. 3 Three risk identification methods

Document review	Plans; historical documents; and so on
Information gathering	Brainstorm; Delphi; Normal Group Technique; interviewing; root cause identification; SWOT
Checklist analysis	Based on historical information and previous experience
Assumptions analysis	Analyze all the assumption in the planning
Diagramming techniques	Cause and effect; process flowcharts; influence diagrams;

Based on the risk identification methods reviewing, one comparison table is summarized as table 4.4.

Table 4. 4 Risk identification method comparison summary

Identifying method	advantages	disadvantages
interview	Face to face; call or email. easy for	Need much time; need high

	the sensitive question;	quality of questions; a well-trained interviewer;
Brainstorm	As many as possible risks in short time Participants can share all the risks immediately	Some people do not want to speak in front of other people; group think; it is difficult to organize one smooth meeting
Check list	Easy and quick; Easy to get the list for reference	Risks maybe too general; possible missing;
Survey	Easy to carry out; written proof;	People do not want to fill; people can not provide accurate information; difficult to check the risks.
SWOT	Easily carry out; practical; main for strategy management and conference.	Static; too subjective; depend on the ability, attitude and knowledge of the reporter;
Risk-oriented Software	Risks can be get automatically; save time and resource;	Useful for the basic analysis; not for complex risk identification. Need more human talents.
Event tree analysis	End events need not be foreseen; multiple failures can be analyzed; system weakness can be identified; zero-payoff system elements/options can be discarded; potential single-point failure can be identified.	Sequence-dependent scenario is not modeled well; initiating event is treated singly; some success/failure are not distinguishable; operating pathway must be anticipated

Every method has its advantages and disadvantages, the best way is to combine all the possible methods together to identify the risks in air cargo industry, in reality, it will cost too long and large investment. Base on the character of air cargo industry and risk identification method comparison, in this research, interviewing, brainstorm approach, risk breakdown structure

(RBS) and literature review method can be used united. Firstly, literatures review can help to describe the air cargo industry and understand all the methods. Secondly, RBS can help to break down the industry model and business process. Thirdly, brainstorm methods can pool the important experts within air cargo industry in China, the intelligence of expert help to dig out the potential risks. Because of the weakness of group decision of brainstorm, after the brainstorming meeting, the interviewing through face to face, call and email can be very complementary for brainstorm. In this way, the new ideas and risks can not be missed from the experts. Brainstorm is regarded as one group decision; some members perhaps are easily affected by others. Through the after meeting interview, some people can speak out their different ideas individually.

4.4 Alternative Risk Models

Based on the literatures on air cargo supply chain risk, three available models can be used to propose the risk list of this research, model of Kichisaburo Nomura(2003)(figure 4.9), model of Peng Yan(2006) and air cargo industry environment model(figure 4.10). In 2009, Huangjin and Chengheng(2009) suggested 5 kinds of risks for airlines, market risk, strategy risk, finance risk, operation risk and Catastrophic unexpected risk. And Donald Waters(2007)'s summary also helped me to get some references, the supply chain risks are as the following: Strategy; nature; politics; economy; material; supply; market; product; operation; finance; information; organization; management; planning; human resource; criminal; safety; environment and local government authorization.

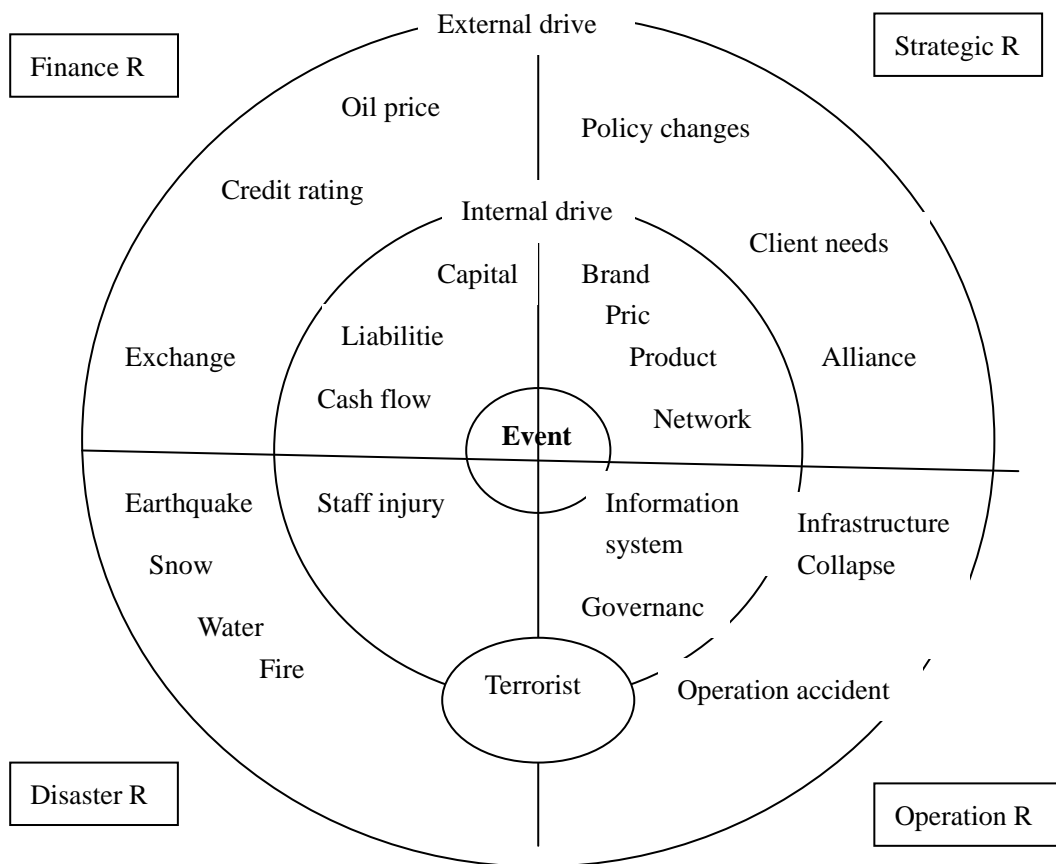


Figure 4. 9 Air cargo risk factors model of Kichisaburo Nomura

In figure 4.9, totally the air cargo industry risks were divided into four kinds, fiancé risk, strategic risk, disaster risk and operation risk. At the same time, there are two layers for the four kinds of risks, external and internal. So it is called two-dimension model. From the figure, we can see, the difference or limit among risks sometimes is not very clear, terrorist can be external and internal; also it can be regarded as disaster risk and operation risk.

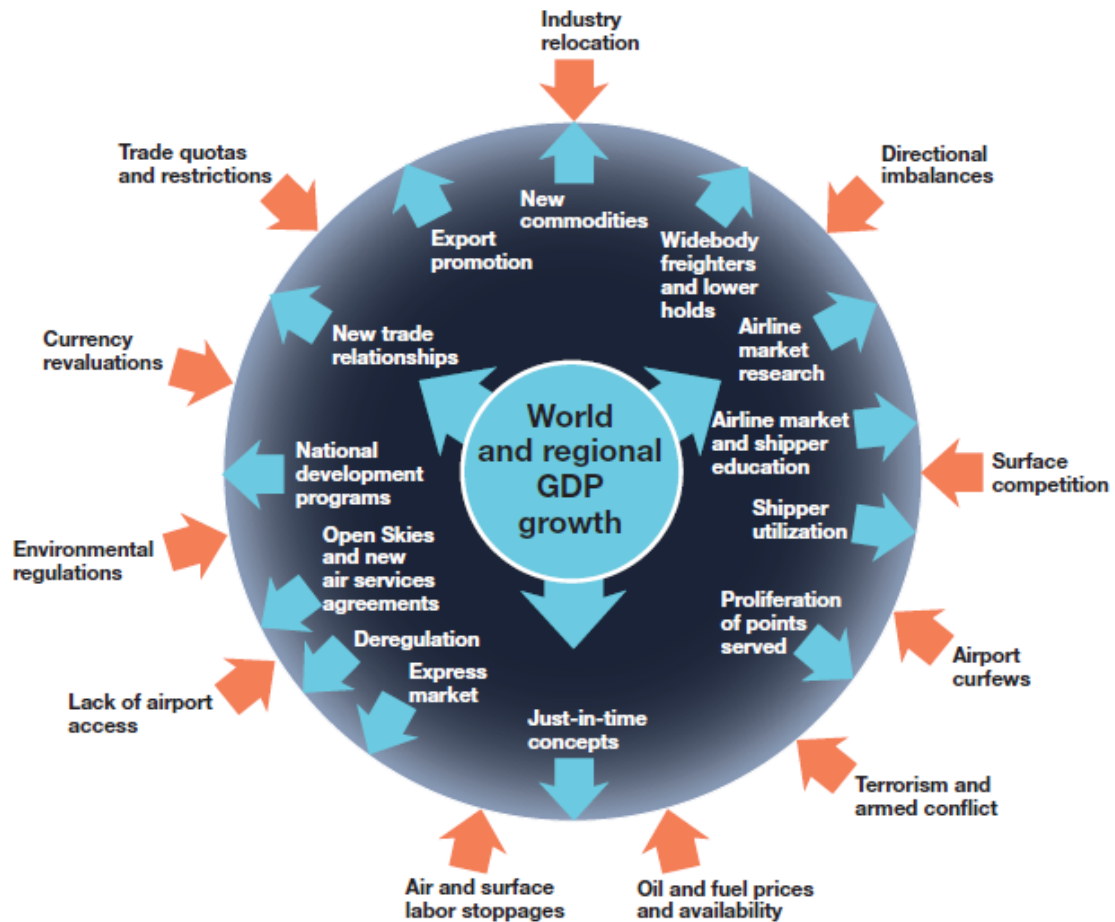


Figure 4. 10 Air cargo industry environment model

From the macro industry aspect, air cargo industry develops with stimulating factors and disadvantages. From Figure 4.10, we can know, the factors outside will restrain the air cargo industry development, while the inside factors support strongly its development.

Table 4. 5 Air cargo external and internal risk model of Peng Yan(2006)

External risk	Nature risk	Disaster from storm, flood
	Society risk	Political and war
	Economy risk	Economic crisis, exchange rate
	Technology risk	New technology
	Market risk	Market need and competition uncertainty
Internal risk	System risk	Efficiency, management, capital
	Organization risk	Not coordination, Moral hazard
	Information risk	Delay, asymmetric

Table 4.5 is one-dimension simple classification of air cargo industry. In this

table, air cargo risks can be judged from external and internal, and it is easy to understand.

4.5 The process and implementation of air cargo supply chain risk identification

Combined with personal cognitive and working experience, and based on the literatures on alternative risk model, air cargo industry breakdown structure and business process, one risk list as table is proposed, as table 4.6. The risk identification process and methods are showed in figure 4.11.

As in figure 4.11, the main risk identification method is brainstorm. Before the brainstorm meeting, I have done the preparation, such as experts inviting, meeting process organizing, document print and preparation and other activities. The brainstorm meeting was holding on October 2012 in the office of Malaysia Maskago airlines in Shanghai and totally 12 experts were invited from university, consignee or consignor, forwarder and carriers. Based on my prepared risk list and questions, it took experts three hours to discuss every possible risk factor and risk classification within Chinese air cargo industry. In the brainstorm meeting, most experts agreed that it is scientific and reasonable to divide four first layer risk factors, financial risk, strategic risk, operational risk and catastrophic risk. While when discussing the second layer risks, different ideas began appear. Through detailed negotiating and brainstorming, product, investment, human resource are regarded no need to be in the list.

After the brainstorm, I interviewed all the 12 experts through face to face talking, call and email, the main purpose is to be sure that there are some new ideas and changes for their opinions on the risks. Finally table 4.8 shows the final identified risk list. In financial risk, capital risk, liability risk and cash flow risk are all about the financial operations of the industry, with the suggestion from experts; there three risks are integrated into one risk, named financial accounting risk. In strategic risk, price can be one part of service, and the

forwarder service is including the price, security, speed and so on. Besides, brand is suggested to be merged into service. In the final list price risk and brand risk are canceled and integrated into service.

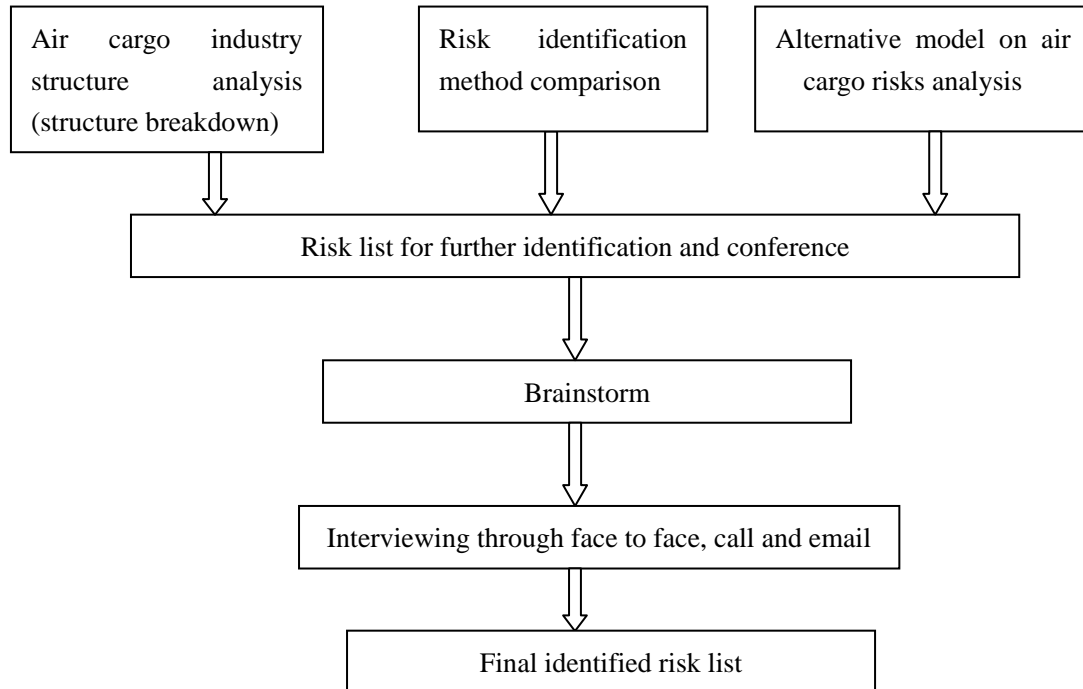


Figure 4. 11 Risk identification process

From the table 4.6, we can see there are three layers; the first layer includes four main risks, finance risk, strategy risk, operation risk and catastrophic accident risk. The third layer includes many risk factors which describe the second layer risk in detail. As agreed by many researchers, we can not identify all the potential risks because of objective reasons.

Table 4. 6 Identified three-layer risk factor list

First Layer	Second layer	Third layer
R ₁ Finance risk	Oil price	National price; international price
	Credit rating	Credit of forwarder, of carrier, credit system
	Exchange	Exchange rate between RMB and others
	Capital	Capital flow
	Liability	Financial balance of the stakeholders
	Cash flow	Security; cash preparing
	Policy changes	National policy; international; regulations
R ₂ Strategic risk	Client needs	Express; low cost; speed; security;
	Alliance	Alliance among stakeholders; alliance break;
	Brand	Brand of forwarder and carrier
	Price	Stable price; fluctuation;
	Service	Forwarder service; carrier service
	Business network	Network of carrier; relationship and income
	Government resource competition	Relationship with government Competition among carriers, forwarders
R ₃ Operation risk	Information system	Information system of industry; of enterprise
	Governance	Governance structure; business model
	Operation accident	Logistics accident; emergencies
	Infrastructure collapse	Logistics infrastructures;
R ₄ Catastrophic accident	Nature	Snow, flood, fire earthquake
	Economy	Economy Crisis
	Society	Political collapse, war
	Terrorist activities	Hijacking; goods robbery; explosion

Table 4. 7 The identified risk factor list

R ₁ Finance risk	Oil price R ₁₁
	Credit rating R ₁₂
	Exchange R ₁₃
	Capital R ₁₄
	Liability R ₁₅
	Cash flow R ₁₆
R ₂ Strategic risk	Policy changes R ₂₁
	Client needs R ₂₂
	Alliance R ₂₃
	Brand R ₂₄
	Price R ₂₅
	Service R ₂₆
	Business network R ₂₇
	Government resource R ₂₈
	competition R ₂₉
R ₃ Operation risk	Information system R ₃₁
	Governance R ₃₂
	Operation accident R ₃₃
	Infrastructure collapse R ₃₄
R ₄ Catastrophic accident	Nature R ₄₁
	Economy R ₄₂
	Society R ₄₃
	Terrorist activities R ₄₄

Table 4. 8 The final identified risks after interviewing

R ₁ Finance risk	Oil price R ₁₁
	Credit rating R ₁₂
	Exchange R ₁₃
	Capital R ₁₄ accounting
	Liability R ₁₅ R ₁₄
	Cash flow R ₁₆
R ₂ Strategic risk	Policy changes R ₂₁
	Client needs R ₂₂
	Alliance R ₂₃
	Brand R ₂₄

	Price R ₂₅	Service risk R ₂₄
	Service R ₂₆	
	Business network R ₂₅	
	Government resource R ₂₆	
	competition R ₂₇	
R ₃ Operation risk	Information system R ₃₁	
	Governance R ₃₂	
	Operation accident R ₃₃	
	Infrastructure collapse R ₃₄	
R ₄ Catastrophic accident	Nature R ₄₁	
	Economy R ₄₂	
	Society R ₄₃	
	Terrorist activities R ₄₄	

4.6 Conclusion

4.6.1 Limitations for the identified risks

From the literatures, there are many risk identification methods, while there is no universal and best method, and every method or tool has its strong points and short ones. In this charter, the identification process was based on the experts' subjective judging, literature review and interview. It tries to use as many as possible methods. On the other side, it will take too long and cost too much if use every method.

Air cargo industry is one dynamic industry which can be influenced by many factors, such as political moves and economic crisis. That is to say, the risks faced by the participants in air cargo supply chain are dynamic. The better way to cover longer time is to do the identification frequently, while in this research, the identification was done once for the time being.

Any risks will have the character of geography; the risks can change as in different places or cities. This research focus on the air cargo industry in Shanghai, and the interviews were done in Shanghai.

The more experts were interviewed, the better the result will be. While in reality

and implementation, it is difficult to find proper experts who would be interviewed and at the same qualified for the name of expert. This research has done the interview with 12 experts in different field to get the ideas from more comprehensive background.

4.6.2 Result

Through risk identification methods comparison, literature review, RBS, brainstorm and interview methods are used in this part, and they can be beneficial and complementary each other. Some methods, such as cause and effect diagram, are proper for risk identification and risk assessment also. The two-layer risk model was summarized base on the combined four risk identification methods for the further risk assessment and analysis.

Chapter 5 Identified Risk Factors Analysis

5.1 Introduction

Identified risk factors analysis is the connection step between the risk identification and risk assessment. Before risk assessment, the risk consequence, risk occurrence probability (sometimes called likelihood), controllability and its influence for stakeholders should be analyzed to prepare for the risk assessment. In this part, the risk analysis process is carried out through literature review and author's working experience

5.2 Financial risk analysis

There are two kinds of risks in financial risk in air cargo industry, external factors and internal factors. The external financial risks are the risks which cannot be controlled by the carriers or forwarders, such as petrol oil price fluctuation, credit rating lower and international currency exchange rate. The internal risk is about the accounting statement in air cargo industry, such as the capital situation, the liability, cash flow and balance sheet.

Financial risks can be induced by world economy crisis, international resource shortage, market change, enterprise management and so on. As many world air cargo carriers are listed company, and they will inevitably face the challenge of financial problems or crisis. Financial risks in air cargo industry can influence air cargo industry directly and indirectly. As from 2008, world financial crisis in European and American has damaged world economy and many manufacturing enterprises have to reduce volume or stop the making process, correspondingly, the demand for air cargo has decreased. For the direct influences, the share price of list air cargo companies will come down, and the balance sheet of accounting will be in red. In the following, four identified financial risks will be analyzed, oil price, crediting rating, exchange

rate and accounting risk.

Mckinsey & Company examined the investor's returns in aviation industry in the period of 1996 to 2004 under the instruction of IATA, and found that the highest risk does not equate to the highest returns, quite the opposite for airlines. As for air cargo industry, the forwarders are in fact counter-cyclical, getting higher average returns in the bad time than in the upturn industry development.

Generally, the key financial indicators for air cargo carriers are financial revenue and financial costs, share of profits and losses of associates, assets structure, assets mortgage, capital expenditure, equity investment, debt structure, commitments and contingent liabilities, gearing ratio, working capital and its sources. Oil price fluctuation is one obvious financial risk for most carriers. Air China Limited aims at controlling the oil price risk through the engaging in fuel hedging transactions since 2001. The hedging instruments used were mainly derivatives of Singapore kerosene together with Brent crude oil and New York crude oil.

Taking Air China Limited as an example, as figure 5.1, the financial revenue consists of exchange gains, gain on interest rate derivative contracts and interest income. And the financial cost consists of interest on interest-bearing bank loans and other borrowing, interest on finance leases, loss on interest rate derivative contract and forward foreign exchange and exchange loss. These indicators can describe clearly the financial situation of a carriers or forwarder.

Finance revenue		For the six months ended	
		30 June 2012	30 June 2011
		RMB'000	RMB'000
		(Unaudited)	(Unaudited)
Exchange gains, net		—	1,508,288
Gain on interest rate derivative contracts		2,025	—
Interest income		144,210	87,610
		146,235	1,595,898
Finance costs		For the six months ended	
		30 June 2012	30 June 2011
		RMB'000	RMB'000
		(Unaudited)	(Unaudited)
Interest on interest-bearing bank loans and other borrowings		1,115,186	866,193
Interest on finance leases		256,383	167,710
Loss on interest rate derivative contracts and forward foreign exchange contracts, net		—	37,499
Exchange loss, net		339,259	—
		1,710,828	1,071,402
Less: Interest capitalized		(351,243)	(300,302)
		1,359,585	771,100

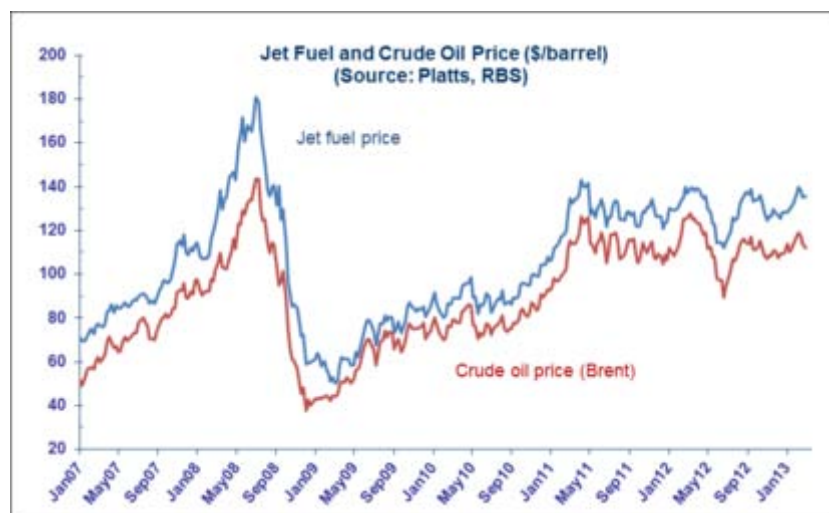
The interest capitalisation rates during the period ranges from 1.19% to 7.92% (six months ended 30 June 2011: 0.8% to 5.9%) per annum relating to the costs of related borrowings during the period.

Source: 2012 interim report, Air China Limited.

Figure 5. 1 Financial revenue and costs of Air China Limited on June 30, 2011

5.2.1 Oil Price

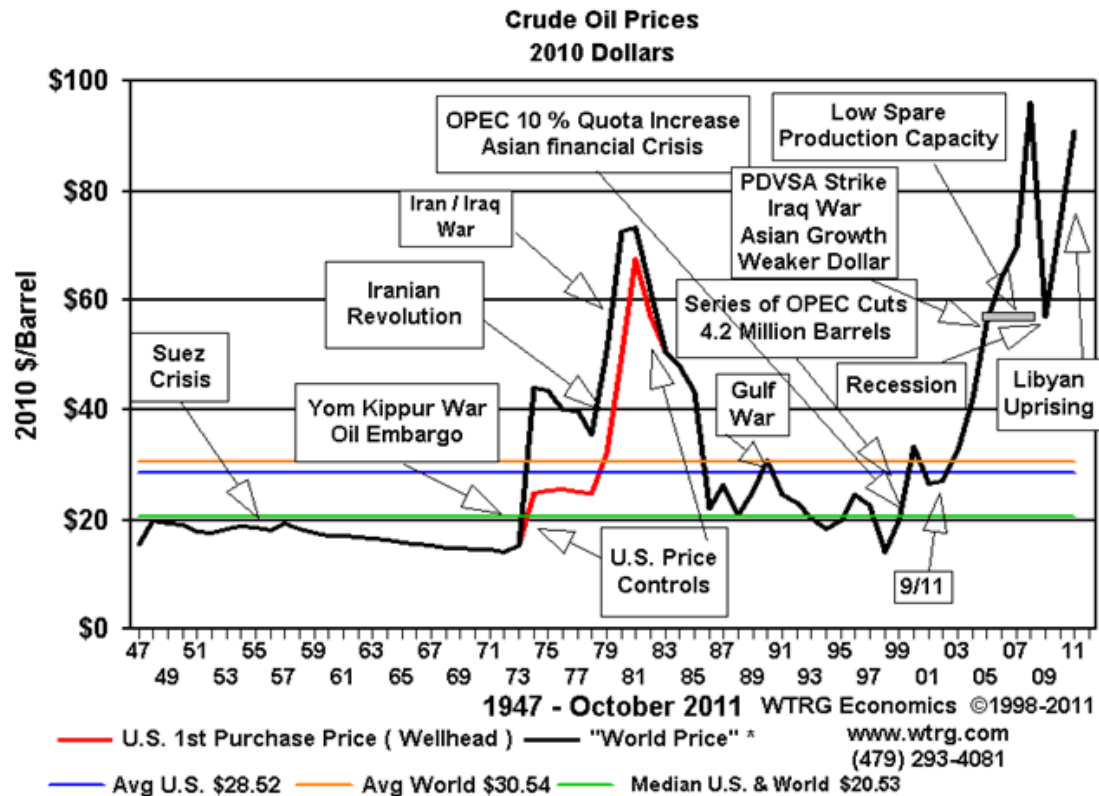
Global oil history can be described as a statement of turmoil and instability in the past fifty years. As in figure 5.2, According to the statistics from IATA website, we take the period from January 2007 to January 2013 as an example, the price of oil fluctuated greatly and jumped.



Source: <http://www.iata.org/publications/economics/fuel-monitor/Pages/price-development.aspx>

Figure 5. 2 Fuel oil price from 2007 to 2013

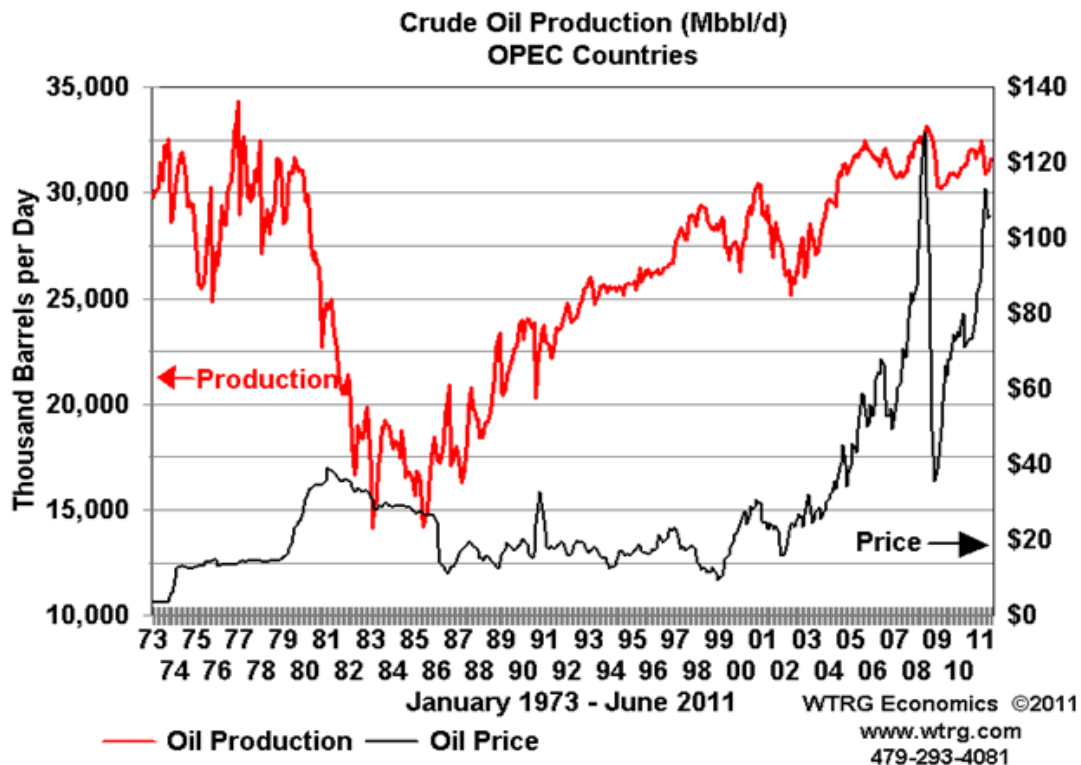
While the period of five years is too short, based on the historical price data, long term perspective is reasonable for the analysis.



Source: http://www.wtrg.com/oil_graphs/PAPRPOP.gif

Figure 5. 3 Oil price from 1947 to 2011

Taking more than 60 years as the research period, in figure 5.3, the standard comparison currency is dollar in 2010. In the past 60 years, the crude oil price is fluctuating and rising. From the figure, we can draw out the events and reasons for the price fluctuating, they are Yom Kippur War Oil Embargo, Iranian Revolution, war between Iranian and Iraq, U.S Price Controls, OPEC10% Quota increase Asian Financial Crisis, Series of OPEC Cuts 4.2 Million Barrels, 9.11 events, PDVSGA Strike/Iraq War, Asian Growth, Weaker Dollar, Low Spare Production Capacity and Libyan Uprising. As the conclusion of the figure, the oil price fluctuation and high price are pushed by world important events, including war and economy crisis.

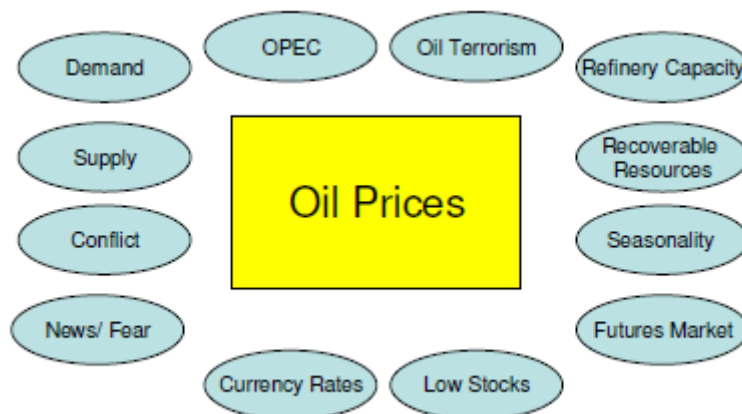


Source: <http://www.wtrg.com/prices.htm>

Figure 5. 4 Crude oil production and price

The general economy principle for ordinary goods is not suitable for oil demand and price. From figure, the world oil production has no direct and close relationship with oil price. From the point of national security, many countries prefer to consume oil through international market and reserve their own oil underground.

According to Gal Luft(2006), the oil price is decided by many factors, like demand, supply, conflict and so on, as showed in figure 5.5 .



Source: Gal Luft (2006), p.11

Figure 5. 5 Oil price deciding factors

Oil price is important and critical for air cargo industry and it will impact impose a special burden on energy-intensive-consuming sector like the air cargo industry. According to Gal Luft(2006), by value, 40 percent of goods traded internationally are transported as air cargo; cargo traffic is a leading indicator of any economic slowdown. The air cargo industry itself, in which fuel accounts for 20-30% of the operational cost, is poised to be the prime casualty of the new era of expensive oil.

Airlines have responded by fuel hedging—locking in the rate of fuel some years in advance. However, in times of price increases that exceeded most of the expectations, many carriers have found themselves very vulnerable to cost increases. Andreea Popescu, Pinar Keskinocak, Issam al Mutawaly(2010)

In practice, most carriers carry out the measure of surcharge calculation, which connects with per kilogram of cargo and the fuel price level. Whenever the oil price increases above or decreases below a certain threshold, the surcharge is adjusted upward or downward.

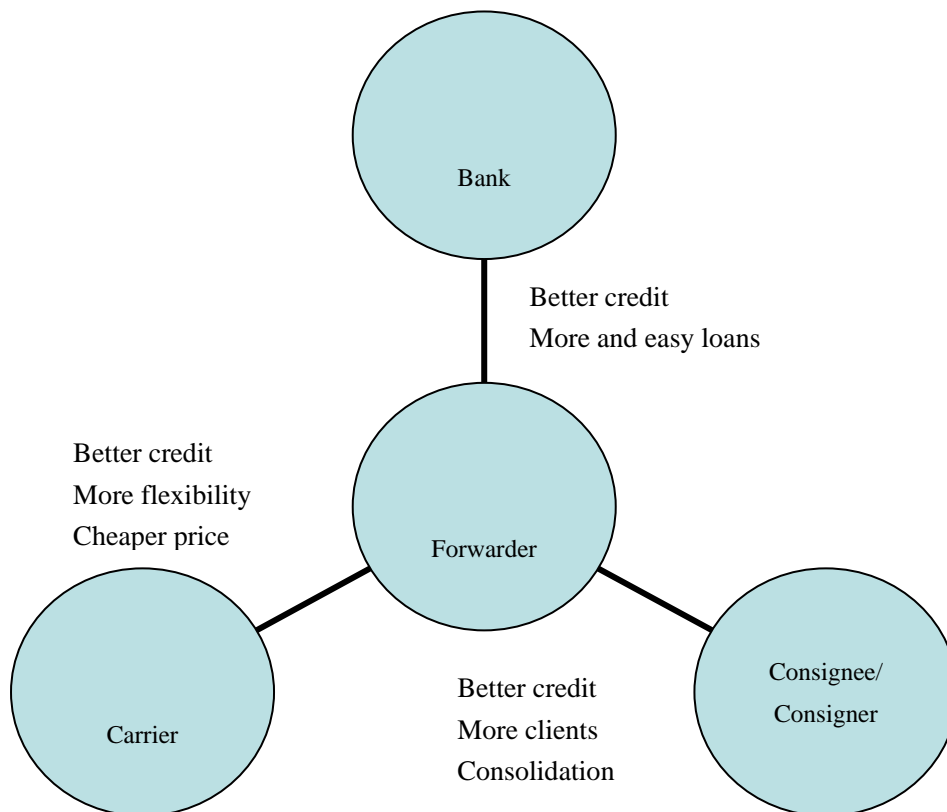
Facing high oil price, air cargo industry has to bear the higher cost. If we can forecast certainty that the oil price will increase stably and continuously, the carrier airlines can make oil futures and stock oil. Unfortunately, oil price is keeping a situation of fluctuating; it is difficult to do the oil futures. In 2009, China East Airlines has lost millions of dollars because of the failure in oil futures. From the risk point, oil price is one potential risk for the financial performance, both on external economy environment and on internal accounting cost.

5.2.2 Credit Rating

Based on the definition of kronwald and Christian (2009), A credit rating evaluates the credit worthiness of a debtor, especially a business (company) or a government. It is an evaluation made by a credit rating agency of the debtor's ability to pay back the debt and the likelihood of default. The world famous

agencies are A. M. Best, DBRS, Dun & Bradstreet, Standard & Poor's, Moody's and Fitch Ratings, and they will publish their rating result on credit for company, country and other organizations. In air cargo industry, it is useful and important because of the credit system which has relationship with banks, bounds, investing companies and clients. During the economy crisis, the banks will take a conservative attitude for its clients, such as forwarders and carriers. With a better and good credit recorder and rating, the forwarder can have the loan from banks in difficult times. Especially for the forwarders in air cargo business, credit rating is really important and critical. According to the industry description in the former chapters, forwarder will supply service for its clients, and in turn get benefit. Normally, forwarder is one kind of asset-light company, who collects goods and serves the clearance, customs check and ground handling. In order to gather more goods and supply better service, more and more forwarders prefer to buy the goods and take back the money from the consigner or real buyer, as a consequence, the forwarders have to borrow the enough money from the bank and return the loan after getting back from the consignees. Because of the light asset, the forwarders have no fix asset or equipment to impawn in the bank, so the credit rating is one critical and useful asset for forwarders.

Between forwarders and carriers, it will be very helpful if one forwarder has a good credit record to negotiate the price and discount. The credit rating among stakeholders in air cargo business can be described as in figure 5.6.



Source: author's summary

Figure 5. 6 Credit relationship among stakeholders

5.2.3 Exchange Rate

Air cargo business is one of the important international logistics measures which will transfer the goods across the nations; correspondingly, it will refer to the deal currency. As the international trade rule, the dealers will settle the transaction currency, normally U.S dollar, Euro or other important currency. With the development of China, Chinese RMB has being becoming more and more important in international trade. Within the recent 10 years, because of the strong economy growth, RMB become stronger and stronger contrasted with U.S dollar, Euro and other currency. Rising exchange rate of RMB has damaged Chinese export and in turn has influenced the air cargo industry need. Ten years ago, exchange rate between euro and RMB is more than 10,

and now it decreases to about 7. In the same principle it has influenced the international trade between China and European countries

Exchange rate will cause the potential risk for the stakeholders in air cargo industry through the following business model. Generally, the highest speed of air cargo transaction between China and America is 24 hours, as the integrator FedEx processed. But the main goods of FedEx are documents, letters and other small parcels, for the general air cargo goods, the transaction period between China and American is from 3 days to 10 days which will depend on the efficiency of clearance and ground handling. International exchange rate between any two currencies is changing anytime. The exchange rate volatility will cause loss and benefit for the dealers, including shippers, forwarders, carriers and consignee. In reality, the practitioners always fix the transaction currency, normally hard currency as Euro, U.S dollar, RMB recently, and take currency hedging options to control the loss.

5.2.4 Accounting

From the nature of air cargo industry, it is one energy exhausting, high technology and heavy asset industry. For the carriers, the aircraft will consume much fuel, and the aircraft itself is very expensive. For these reasons, carriers must get benefits through scale effect and long term share cost. For the accounting of carriers, it is complex and difficult to generate out one good balance sheet. For the forwarders, it seems easily for their accounting, in fact, the small and simple forwarders cannot survive in the competition because of the risk of liability and cash flow. In the business, the new business model will take much of capital for the forwarders to pay for the client, and the forwarders should pay much for carriers in advance and as guarantee. Many forwarders go into bankrupts because of the cash shortage and liability.

5.3 Strategic Risk Analysis

Strategic risks are those that arise from the fundamental decisions that directors take concerning an organization's objectives. Essentially, strategic risks are the risks of failing to achieve these business objectives. Strategic risks are often risks that organizations may have to take in order (certainly) to expand, and even to continue in the long term. Here in this research, the main strategic risk factors are industry policy, client needs, stakeholder alliance, service, business network, government resource and competition.

5.3.1 Policy Change

Air cargo industry must obey the policy of IATA on security, safety, fairness and open sky regulations. From the IATA point, more and more policy will be implemented to assure the health development of air cargo industry. Under IATA layer, there are many regional and national policies. Normally every country and region will try to protect their own benefit through local policies, and these policies are always conflict each other. Through the negotiating and communication of IATA, most countries agree to sign cooperation contract to be reciprocal each other. For example, the Bilateral World Trade Agreement of 1999 led to China's entrance to the World Trade Organization (WTO); EU-US Open Skies Agreement allows any airline of the European Union and any airline of the United States to fly between any point in the European Union and any point in the United States.

For the forwarders in China mainland, they are facing more and more complex local policies which intent to assure the security of Chinese air cargo development. The main policies are about the custom clearance and insurance. For example, in recent years, Chinese government proposes to carry out national information platform to connect all customs and different data. This policy will produce big changes in air cargo industry.

For the government policy, every country has many policies to protect their

own benefit. While IATA general director Giovanni Bisignani argues that the government must get out of the airlines industry. (<http://www.iata.org/whatwedo/Documents/economics/Value-Chain-Profitability-full.pdf>)

A better direction of policy change for air cargo industry is to be more liberalization and deregulation. Local nations must allow air cargo carriers to have more freedom in the operational and ownership decisions. National self-protected policy can be a major barrier for the development of air cargo industry. More liberalization and deregulation will facilitate the restructure of air cargo industry to bring more benefit for shippers and clients.

One important changing policy is about environment. Because of the world worsen environment, many countries and organizations pay more attention on environment protection. Because of the much fuel consumption of air cargo industry, it is regarded as one important source of air pollution. In 2010, European Union carried out the taxation on all the airlines that have business in European Union, named European Union's Emissions Trading Scheme (ETS). ETS is regarded as the most pressing regulation which was first mentioned in the relocation industry in a Graebel Relo TRENDSsm in 2010.

5.3.2 Client Needs

In the world air cargo industry, the client means the shipper who need the air cargo service. The first client need change is on the geography zone because of the economy development in the new developing countries, such as in China and Brazil. The stable and high economy growth brings more clients to the industry, and the new client needs are mainly focusing on China to US line, China to Europe line, and China to Pacific regions. So we can say that the client need is high sensitivity of demand regarding economic growth.

With the development of information technology and economy growth, contrasted with the traditional client need, the present client need is focusing

more on short time, more security and better one stop service. In the most cases, the forwarder can do everything on behalf of the shipper, including ground handling, custom clearance, negotiating with carriers, and delivery for the consigner.

Another client need is on the goods category. For example, because of the food security problems in the mainland of China, more and more air cargos are foods from other countries. With the popular of Apple I-Phone, most of the telecom equipments are produced in China and then transported to other countries.

5.3.3 Alliance

Star Alliance, One World and Sky Team are three main airlines alliance which have been founded since the 1990s. Hsu and Shih (2008) defined; an international airline alliance is an agreement between all member airlines to cooperate in a commercial relationship. Basic alliances objective is to create a comprehensive, high quality and online network, to strengthen customer loyalty by widespread frequent-flyer-programs, to access new markets and extend the own network under air traffic rights and resource limitations (Oum et al., 2001).

Zhang and Zhang (2002) argued that there is no successful cargo alliance because of the following reasons.

The air cargo market is internationally extremely concentrated on few profitable routes (e.g. China→US, China→Europe, US – Europe). Hence, airlines tend to use their own capacities and optimize their load factors instead of cooperating with the alliance partners (Doganis, 2010).

Indirect services with en-route stops are very common in the cargo business. Thus, total transport times are much higher than in passenger transport. Additional waiting times were accepted by the airlines to ship freight with the corporate aircrafts instead of saving some hours and cooperating within the

alliance especially on profitable routes.

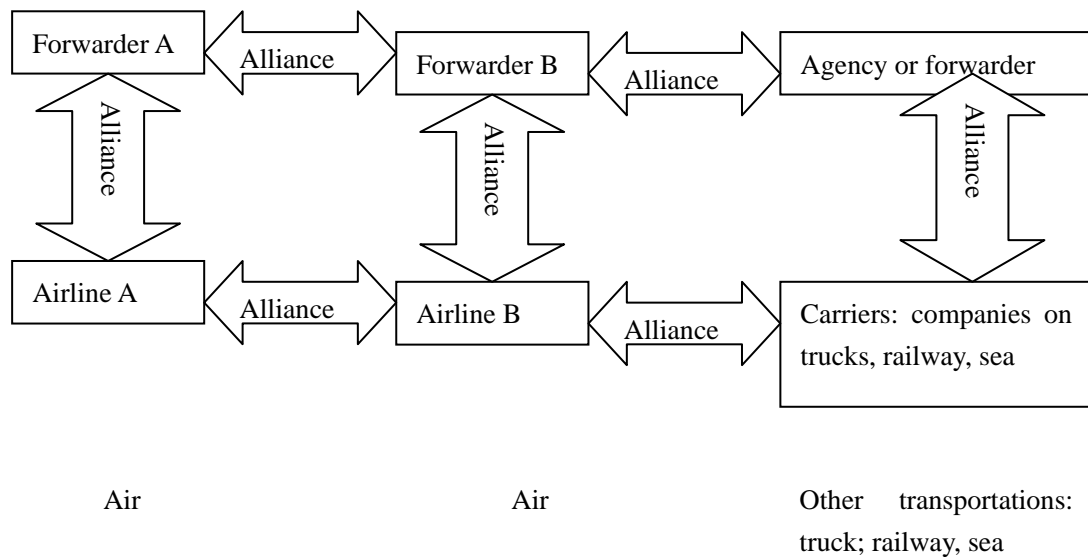
Cooperation between the alliance partners only occurred at secondary markets which usually bear high extra cost (e.g. handling, re-packing) for the carrier and might finally be less profitable.

A uniform appearance was missing, such as internet, contact person, marketing, etc. A common and standardized system has never been promoted by the partners and bookings, inquiries, complaints, etc. have to be communicated directly with the airline and cannot be directed via an alliance administrative office (Vahrenkamp, 2007). The focus of each cargo airline is on its own business. Hence, alliances do not play a significant role in the air cargo market.

A comprehensive need for coordination and cooperation exist for cargo alliances (e.g. empty container management, software/hardware adaptations) which is far higher than for passenger alliances (cargo needs to be electronically monitored at all time).

In the air cargo market products, services and transported goods differ extremely from another (e.g. perishables, standardized freight, refrigerated goods, frozen goods, oversized goods). Therefore, creating, steering and administrating a cargo alliance is more challenging and difficult than for passenger alliances (Grandjot et al., 2007).

There are two main alliances for air cargo industry, one alliance is within the air cargo industry and another one is among air cargo participators with road transportation, railway logistics and marine shipment.



Source: author's analysis

Figure 5. 7 Alliance among stakeholders within logistics

In figure 5.7, forwarders can build alliance to bring more clients, and the forwarders can build alliance with airlines to get long term relationship on better price and more flexible space in aircraft. At the same time, there are alliances between air cargo transportation and truck, rail and marine transportation. The objective of alliance is to finish the door to door delivery on time and benefit maximization.

GLOBAL charter broker Chapman Freeborn Airchartering (CFA) has secured a unique strategic cooperation agreement with Lufthansa Cargo. It means that CFA will handle Lufthansa Cargo's third-party chartering requirements – allowing the German airline to focus on marketing charter capacity on its own fleet of 18 MD-11Fs. The agreement will give Lufthansa Cargo's international sales force and client base access to the full range of charter aircraft through Chapman Freeborn's global network of 35 offices – from helicopters and light aircraft for time-critical freight, up to giant An-225 aircraft for heavy and outsize cargo lift requirements. CFA's clients will benefit from enhanced access to Lufthansa Cargo's freighter fleet, but will maintain its position of neutrality in the marketplace and continue to work in partnership with other cargo aircraft suppliers worldwide.

5.3.4 Service

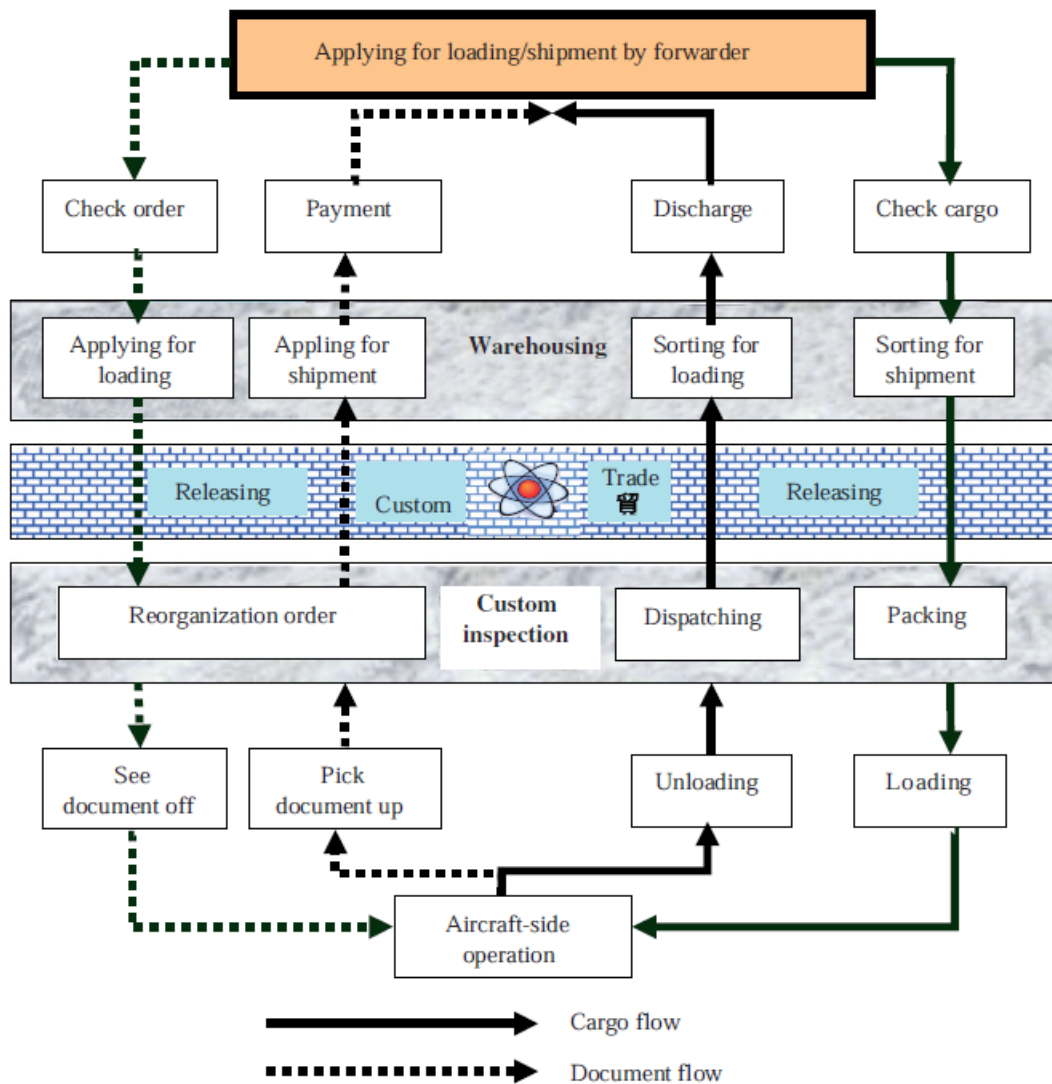
To deliver a good service to client, the benefits and relationship among the stakeholders within air cargo industry should be arranged properly. In the aviation industry, air cargo terminal (ACT) function as relay stations in between land-to-air transportation. Due to the lagging development and growth of domestic cargo volume in recent years, ACT operators have resorted to price warfare in order to maintain stable growth in business. Many conflicts are from the relationship between ACT and forwarders and carriers. Kai Chieh Hu and Mei Chieh Huang (2011) proposed one service quality model to explore the effects of service quality, innovation capability and corporate image on customer's satisfaction and loyalty of ACTs.

As C.-H. Chen et al (2008) researched, air cargo transportation should focus on service process design and management that transcend organizational boundaries to satisfy all the stakeholders, including shippers, distribution centers, cargo agents, forwarders, local transporters, brokers, air cargo terminals, customs, ground services and carriers. Because of the international interfaces in the air cargo industry, the global air cargo transportation system is influenced if the service process of the air cargo terminal or ground service or carrier is delayed or inaccurate.

Rong-Tsu Wang (2007) has examined the performance of China Airlines using quality function deployment to integrate inside quality technology and the voice of outside consumers, and using House of Quality charts, to illustrate the company's performance in terms of service and offer suggestions for improvement. The conclusion shows, in terms of outside consumer voice, the three main factors demanding improvement and the three in greatest need of improvement regarding quality technology.

Because of the one stop service offered by forwarders, client only needs to get service from forwarders. While in reality, the business of forwarder is becoming more and more comprehensive and complex. As figure 5.8 showed, forwarder

should deal with check order, payment, discharge, loading, shipment, warehousing, sorting, releasing, dispatching, and packing and so on. In all, the service of air cargo industry is really depending on the ability and efficiency of forwarders.



Source: Rong-Tsu Wang (2007), p.223

Figure 5. 8 Business of forwarders in air cargo

5.3.5 Business Network

Generally, for the point to point line, the carrier should focus on the lower cost which may happen on fuel, labor and operation. For the bigger and stronger carriers, they always have network structure to benefit from the economy of scale and comprehensive revenue from the network. As explained in the

former chapters, air transportation has two main measures, belly capacity and freight aircraft. In total amount half of the worldwide air cargo is transported by aircrafts and the other half is transported by belly capacity (Bowen, 2004). While in recent years, the share has been shifted to pure freight aircraft because of the following reasons: more air cargo demand than air passenger, more and more requirements for air cargo, new cargo airlines stepped into the market which only operate freighter aircrafts, combined airlines increasingly ordered pure freighter aircrafts(AARON B.SCHOLZ, 2011)

Generally there are two kinds of networks, spatial network and temporal network. The spatial configuration can be defined as the level of concentration of an airline network around one or a few central hub airports (concentration in space). The temporal concentration analyses how departure and arrival flights are coordinated at the main airport of the airline (usually its hub airport). Airlines operate synchronized waves of flights from their hub(s) with the aim to optimize the quantity and quality of connections offered and to increase aircraft utilization (Reynolds–Feighan, 2000).

Figure 5.9 shows some typical example of spatial network for airlines. These networks are the very simple and easy ones, in the reality, the networks are more complex and comprehensive which need more complex model to design and calculate, like AirTrafficSim model. Figure shows the complex network of Lufthansa. The benefit and revenue maximization is the objective of this network, and it need Operational Research theory, computer science and many intelligential designs to make benefit.

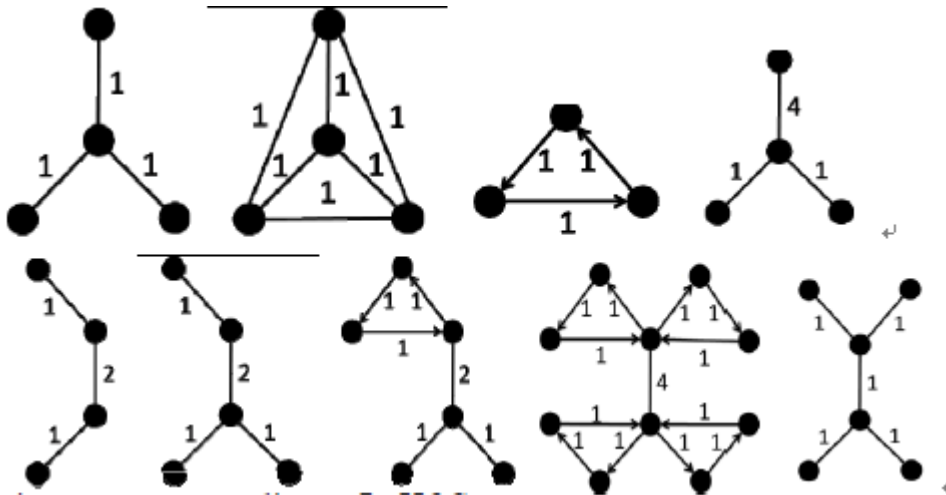


Figure 5.9 Example of spatial network types



Source:

http://www.google.com.hk/imgres?q=Network+structure+of+Lufthansa&hl=zh-CN&newwindow=1&safe=strict&biw=1351&bih=689&tbn=isch&tbnid=KZ0Xk2NDM29vIM:&imgrefurl=http://www.lufthansa.com/ca/en/Lufthansa-Route-Map&docid=2aJ0oWfqX0eUrM&imgurl=http://www.lufthansa.com/mediapool/jpg/42/media_992042.jpg&w=536&h=228&ei=Bb5PUdr1J43mkgXT0YGgCQ&zoom=1&iact=hc&vpx=960&vpy=331&dur=313&hovh=146&hovw=344&tx=241&ty=72&page=1&tbnh=124&tbnw=248&start=0&ndsp=18&ved=1t:429,r:11,s:0,i:122

Figure 5.10 Network structure of Lufthansa

5.3.6 Government Resource

From IATA's point, heavy-handed government intervention, whether financially or through unnecessary regulations, damages profitability. Further liberalization of out-dated government operational and ownership restrictions

on airlines is vital.

(<http://www.iata.org/whatwedo/Documents/economics/Value-Chain-Profitability-full.pdf>). At the same time, there are all kinds of taxation in domestic air cargo industry and market. From this point, it is agreed that the government intervention has damaged the efficiency of air cargo industry because of the monopolistic power and inefficiencies from government. On the other side of the coin, the development of air cargo industry cannot across over or pass away the national government or regional government. Because of the national security and benefit, no goods can be transferred across the national border without custom check and supervision, except smuggling. China's entrance into WTO is a good example that nation can facilitate world trade and development. According to recent world air cargo industry development, several developing countries, such as China and Brazil, have contribute much for the world trade, in turn contribute much for the air cargo development. Most of the world air cargo logistics are from country to another country.

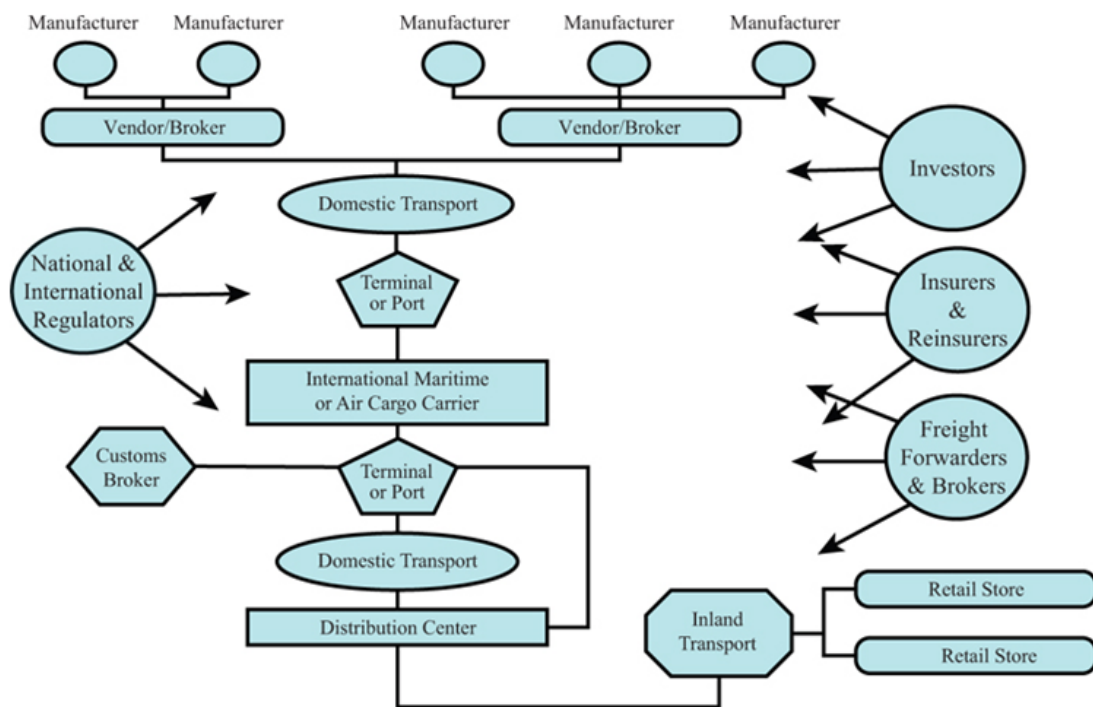
For most air cargo stakeholders, government relationship is one kind of important resource. Close relationship with local government can have core competition advantage, sometime, exclusive advantage. We all know that FedEx has developed based on hundreds of aircrafts which were from American military. It will take much of money for one company to buy or rent that amount of aircrafts. Government resource can promote the working efficiency for the ground handling, custom clearance, and loan from Chinese national bank which are the main business of forwarders. At the same time, for carriers, they can get infrastructure building help, aircraft flight lines and schedule, airport stay and maintenance, and so on.

Without government resource, it is impossible and difficult to carry out air cargo business. Government resource is one potential vital risk factor for air cargo participators. In China, most of the stakeholders within air cargo industry are state-owned organizations, such as banks, airports, airlines. It is impossible to do successful business without the relationship with government.

5.3.7 Competition

For the trucks transportation, there are two kinds of trucks transportation which can be contrasted with aircraft transportation. One kind of truck transportation is operated under an air waybill and is officially regarded as air freight. Within Germany, Europe and China mainland, on short and medium distances road transportation is more efficient for aircrafts, and truck is more flexibility, low cost and less complexity. (Aberle, 2009)

As figure 5.11 showed, there is competition between air cargo and other measures of cargo, such as railway, maritime and trucks.



Source:<http://my.safaribooksonline.com/getfile?item=cjlxMDE3ODJIOGQvYXNjcC8vMGdpOW1nNmEzcnQ3aWcuYWdscGYwaGMyLzJ0aV8zanNw>

Figure 5. 11 Stakeholders within air cargo industry

The competition among different cargo transportation measures is depend on the following considerations: very short transport times, low damage or loss risk, very high security criteria, a high geographical coverage, small warehousing cost because of its reliability, punctuality, flexibility and its very short transport times(Grandjot et al., 2007).

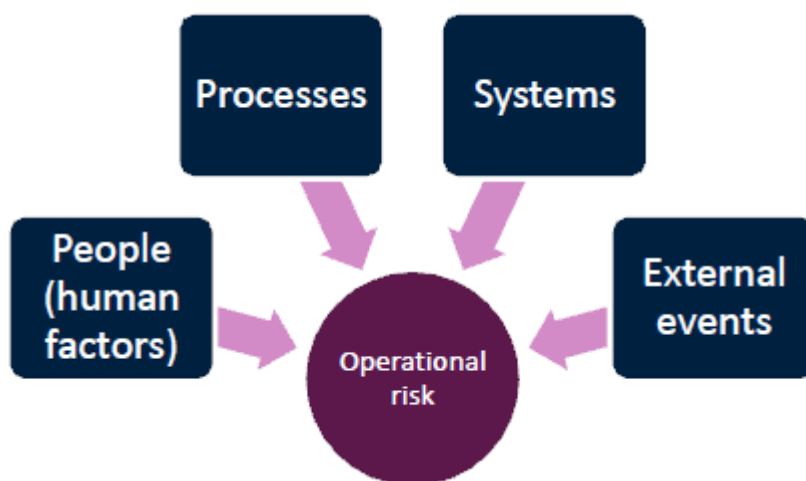
The second competition is within the air cargo industry, such as competition among forwarders and among carriers. With the high cost of labor and oil consumption, the competition is becoming more fierce and intense. The remaining directions for forwarders because of the competition are building alliance, and trying to be more comprehensive and complex. For the airlines, they have to take quality and cost control to get margin and survive.

5.4 Operational Risk Analysis

Operational risk is defined as the risk of loss resulting from inadequate or failed processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputation risk.

JP Morgan Chase defines operational risk as the risk of loss resulting from inadequate or failed processes or systems, human factors or external events.

The operation process includes three main steps which commence after transport capacities have been sold to the (end) customer either via the airline or in general via the freight forwarder.



Source: operational risk management, Global Association of Risk Professionals GARP.

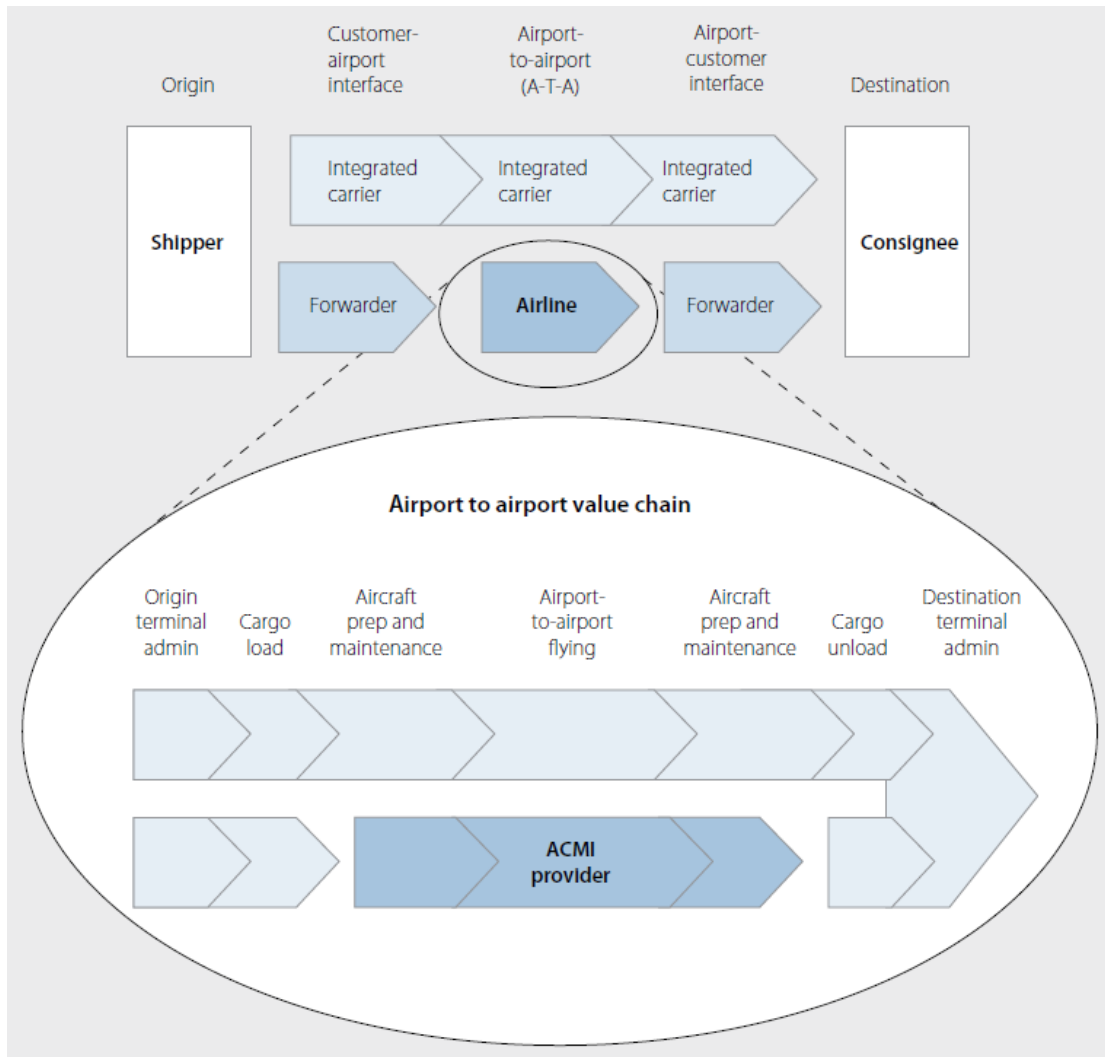
Figure 5. 12 Operational risk model

A forwarder collects goods from the customer or a dedicated assembly point and transports (usually by truck) to a trans-shipment centre. Goods are sorted, classified, consolidated and pooled in the trans-shipment centre. Most air

freight forwarders operate trans-shipment centre directly at the airport to minimize transport cost and to be more flexible concerning available aircraft capacities. However, also the direct delivery from a non-airport trans-shipment centre to the airline is possible. In case that the end customer books capacities directly via the airline a delivery to the airport is common, and the airline carries out sorting, consolidating and pooling of the goods. This first step of the air freight logistics chain usually takes 26% of total transport time (Helmig, 2005). Ground handling agents load the aircraft and assure that all specific requirements of the transported goods are fulfilled. Afterwards, the core of the air freight logistics chain proceeds, the flight from origin to destination airport². In average air freight is in the air for only 17% of total transport time (Helmig, 2005). This core step of the air freight logistics chain is the object of investigation for the present dissertation.

At the destination airport freight is unloaded by ground handling agents and cleared by customs. The transported units (e.g. pallets, containers) are departed, unconsolidated and shipped to their final destination usually by freight forwarders. The last step takes around 57% of total transport time (Helmig, 2005).

The process of operation in air cargo industry can be showed in figure 5.13 by the perspective of value chain. In figure 5.13, the value can be created in different stages in the chain, as forwarder stage and airline stage. Inside the airline stage, the value can be produced through the process of terminal administration, cargo load, ground handling, and aircraft service and so on.



Source: Merge Global Value Creation Initiative. End of an Era? American Shipper, Aug. 2008; 33-47.

Figure 5. 13 Air cargo freight value chain

5.4.1 Information System

Information technology has also brought new challenges and opportunities to the air cargo industry. An important component is a third-party e-commerce community network. Leung et al (2000) present a framework for such a network, which extends the traditional business-to-business e-commerce exchanges to a more broadly based e-commerce approach at the industry level. The proposed infrastructure differs from traditional portals in that it features the online integration of business transactions. It provides a virtual

market for agents of the air cargo industry, enabling them to develop and engage in logistics integration. It also facilitates tracking and tracing, and minimizes unnecessary travel and inventory costs, thus achieving supply chain management at the industry level. Planning and cooperation among industry agents using e-commerce as an enabler could transform the air cargo industry into one that can provide customized services to individual shippers at the cost level of mass production.

Information system has been applied into all the fields in air cargo industry, including ground handling, scanning, custom clearance and electronic document. Firstly, the information system has saved human labor and improved the efficiency of business. Secondly, it facilitates the whole industry development. Thirdly, it has brought more margin and revenue for all the stakeholders. Now, more and more information system platforms have come into being in the worldwide air cargo industry. Because of the information system, the alliance among air cargo transportation and other railway, marine transportations can be possible. With the development of information system, the data can be risky if they are not protected confidentially.

5.4.2 Governance

Consolidation of freight forwarders can have more investment return through economies of scale, so the governance structure of forwarder is to be more comprehensive to become more competitive.

For the carriers or airlines, aircraft choosing is one difficult and important question. Antonov, Airbus, Boeing, and Illushin are four main manufacturers of dedicated cargo aircraft. From the operation governance, there are some reasons and indicator for choosing different aircrafts as the following.

Dedicated air cargo services use dedicated freighters, as do integrated express carriers. Here one can find many aircraft that have been removed from passenger services and converted to cargo services after having lived out

their economically useful lives as airliners.

Scheduled airlines: Typically scheduled airlines use passenger airline belly capacity, though Lufthansa, Alitalia, Malaysian Airlines, and others also have dedicated freighters. In addition, some scheduled airlines may use "combis" - aircraft that are part passenger and part cargo configured.

Special operations: The widest variety of aircraft can be found in this category, including the Antonov AN-255 Mriya, which is the largest fixed-wing aircraft flying today. (Heinrich Bofinger, 2009)

5.4.3 Operation Accident

The operation accident can be happen because of the cost sudden rising, such as the oil price rising and labor shortage. According to table 5.1, operation cost consists of flying operation cost, crew cost, aircraft fuel cost and others. Labor and fuel are both most important cost for the operation.

Table 5. 1 Example direct operation cost of major US carriers

Direct operation cost	Year 2000[%]	Year 2007[%]
Flying operation cost	68.4	76.3
Flight crew	25.1	15.2
Aircraft fuel and oil	30	53.2
Insurance	0.2	0.2
Rentals	11	6
Others	2.1	1.7
Flight equipment maintenance	22.9	17.5
Flight equipment depreciation	8.7	6.2

Source: AARON B.SCHOLZ. 2011

The other operation accidents can be aircraft crash or crazing and strike of staff. In 2012, one operation accident happened in Pudong airport between aircraft of China East Airline and Malaysia airline, which caused great damage and great loss for both airlines. Table showed the fire accidents happened in

recent several years.

Table 5. 2 Aircraft accidents in recent years

Airlines	Place	Damage	Time
Asiana Airlines	Jeju Island	2 died	2011
Lufthansa Airline	Saudi Arabia	2 injured	2010
Zimbabwe	Shanghai pudong	3 died, 1 injured	2012
Pakistan	Karachi Airport	8 died	2010
Italian	Sofia Airport		2011
UPS	Saudi Arabia	2 died	2010
Russia	Mumbai International Airport	Close 3 hours	2013

Source: author's review

Staff strikes maybe happen in western countries like France and US. In China, the strike probability is very low.

5.4.4 Infrastructure Collapse

As Oliver Wyman (2012) pointed, airfreight could triple and port handling of maritime containers worldwide could quadruple by 2030. with the highest transport growth expected in Asia, and between China and India and Europe and North America. Unfortunately, the current infrastructure could not handle anywhere near this kinds of increase, and more than 53 trillion dollar will need to be spent on infrastructure.

The lack of overall infrastructure is a common complaint amongst air cargo operators in developing countries. This is not related as much to airports per se, where the main complaint is often lack of apron space (cargo aircraft sit on the tarmac for loading much longer than passenger aircraft), but particularly a country's road network. By necessity, air transport is multi-modal, since whatever is being shipped has to come to the airport somehow. Except for the very rare exception of true cargo cities like the one being built in Dubai today,

the dominant mode of access to an airport is by road, meaning that all cargo has to be brought by truck.

The challenge, however, is not only the road access to the airport itself, though this is critical, but all the other logistics that complements this. For integrated express carriers (such as FedEx or UPS), the overall road network in a country is of essence. Arriving packages and letters need to be brought to their final destination quickly, and cargo has to be able to get to the airport in an efficient manner.(Heinrich Bofinger, 2009)

It is said within industry that air cargo's competition for increased volume and market share could be decided more by how well it performs on the ground than in the air. So the infrastructure in the ground is more and more important. Generally classifying, there are two kinds of ground support systems: airport terminal operations and pickup and delivery services. The support ground system should be mechanization and containerization for the future competition.

5.5 Catastrophic Accident Risk Analysis

5.5.1 Nature

In recent year, the frequency of disasters is higher and higher, and the damage is more and more heavy. The main natural disasters are avalanches, earthquakes, volcanic eruptions, hydrological disasters, floods, limbic, tsunami, meteorological disasters blizzards, cyclonic storms, droughts, hailstorms, heat waves, tornadoes and wildfires. And most of them can affect aircraft directly or indirectly.

Taking Hurricane Sandy in 2012 October as an example as in figure 5.14. The passage of Hurricane Sandy across the US east coast at the end of October caused disruption to air transport operations at major gateway airports over the course of a week. In total nearly 17,000 inbound or outbound flights¹ were

cancelled, affecting an estimated US\$0.5 billion in airline revenues. At the peak of the impact on Monday 29th and Tuesday 30th October, the closure of New York airports and severe disruption in Philadelphia and Washington, resulted in over 5,000 flights per day being cancelled, grounding 8-9% of worldwide scheduled passenger capacity or over 1,600 million available seat kilometers.(IATA Economic Briefing, November 2012).

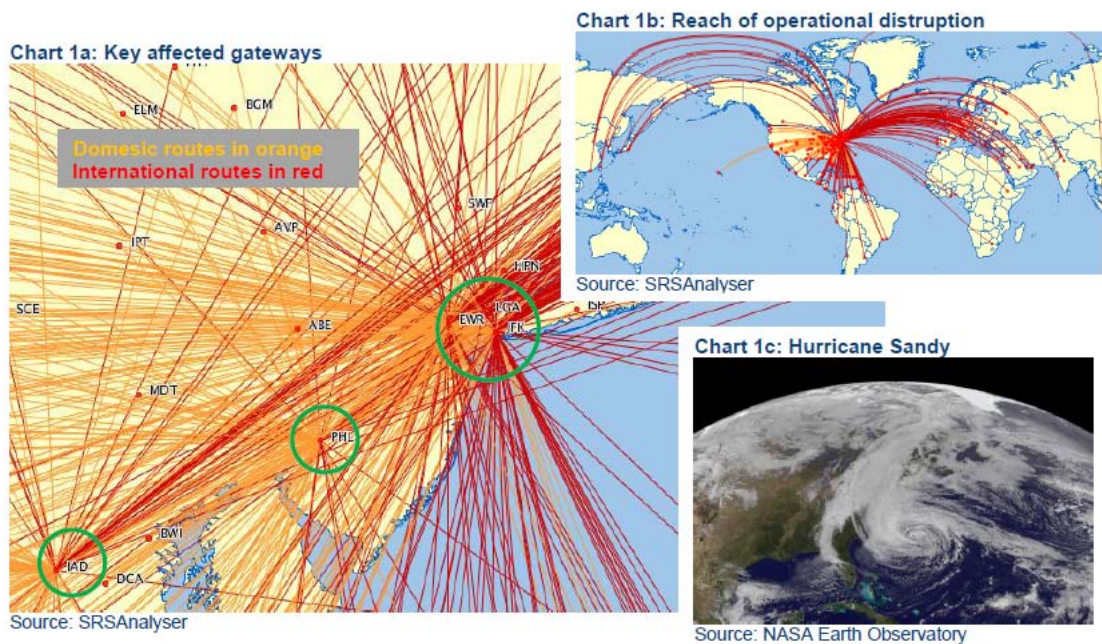
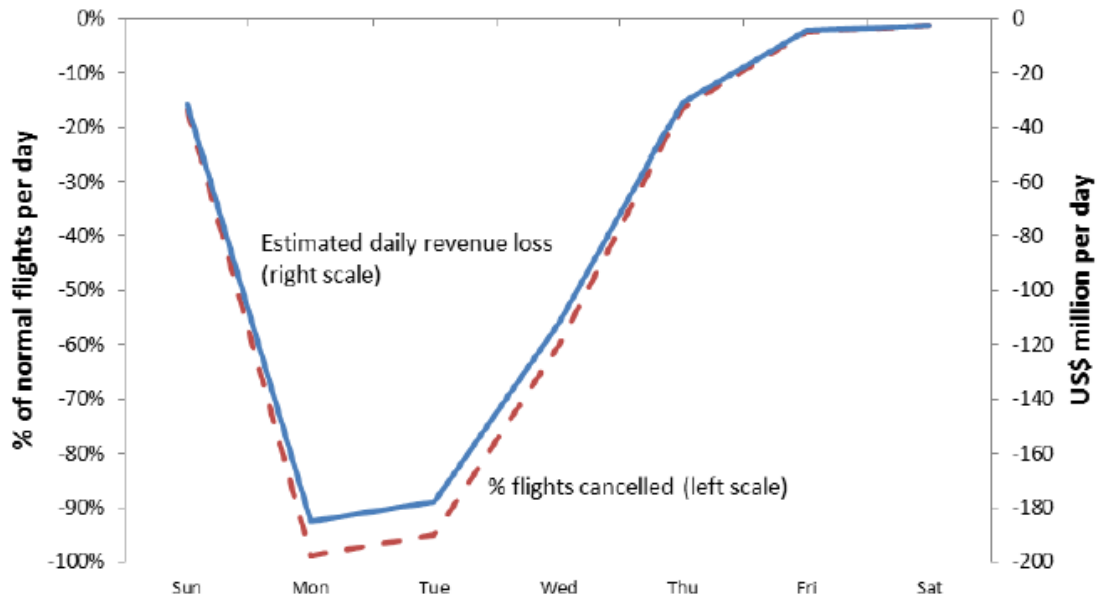


Figure 5. 14 Hurricane Sandy's influence on world airlines.

The influence can be assessed through the indicator of revenue loss as in figure. In the figure 5.15, we can see there are big amount of money lost within two days, one conservative loss is US\$0.5 billion.



Source: IATA Economics, FAA Opsnet

Figure 5. 15 Impact on airline revenue per day

5.5.2 Economy

Here economy is regarded as one disaster factor because of the negative aspect of economic crisis. In many airports around the world, air cargo indicator can be regarded as the economy development indicator. Under the background of globalization, economy crisis will decrease the world trade, and the demand for air cargo will be weak. Without strong demand, the forwarders can not collect enough goods to consolidate, and can not get revenue. Without goods transported, the aircrafts will be idle and cost much with no income. From 2008, the financial crisis had spread most of the world, and the air cargo volume had decreased greatly. This is the real example of the economy crisis risk.

In recent years, Chinese economy has been in the process of structure changing, many electronic equipment manufacturing factories has been moved to other countries such as Vietnam and Thailand. Most of the finished electronics are transported by airlines. This economy structure shift will change the air cargo lines and structures. In China, the factory of Intel had moved to Chengdu from Shanghai, and the Malaysia airline Maskargo had

added new line from Chengdu to Shanghai, or added new chartered trucks under supervision of custom.

5.5.3 Social Events

Society is one abstract concept, and there are many events anytime anywhere in the world. Some of the social events will affect air cargo industry greatly, and we regard these social events as the risk factors influencing air cargo developments.

Here in this part, severe acute respiratory syndrome (SARS) is taken as the example to show the social event's influence on air cargo industry. SARS is a viral respiratory disease in humans which is caused by the SARS coronavirus. Between November 2002 and July 2003, an outbreak of SARS in Hong Kong nearly became a pandemic[citation needed], with 8,273 cases and 775 deaths worldwide (9.6% fatality) according to the World Health Organization (WHO). Within weeks, SARS spread from Hong Kong to infect individuals in 37 countries in early 2003. (Smith, R. D. 2006). Because of the SARS, all the airports had taken the strictest action to check the virus in all the exported and imported goods. The same for the airlines, they have to disinfect all the goods. These actions have slowed the process of air cargo, and it makes air cargo longer time and cost much.

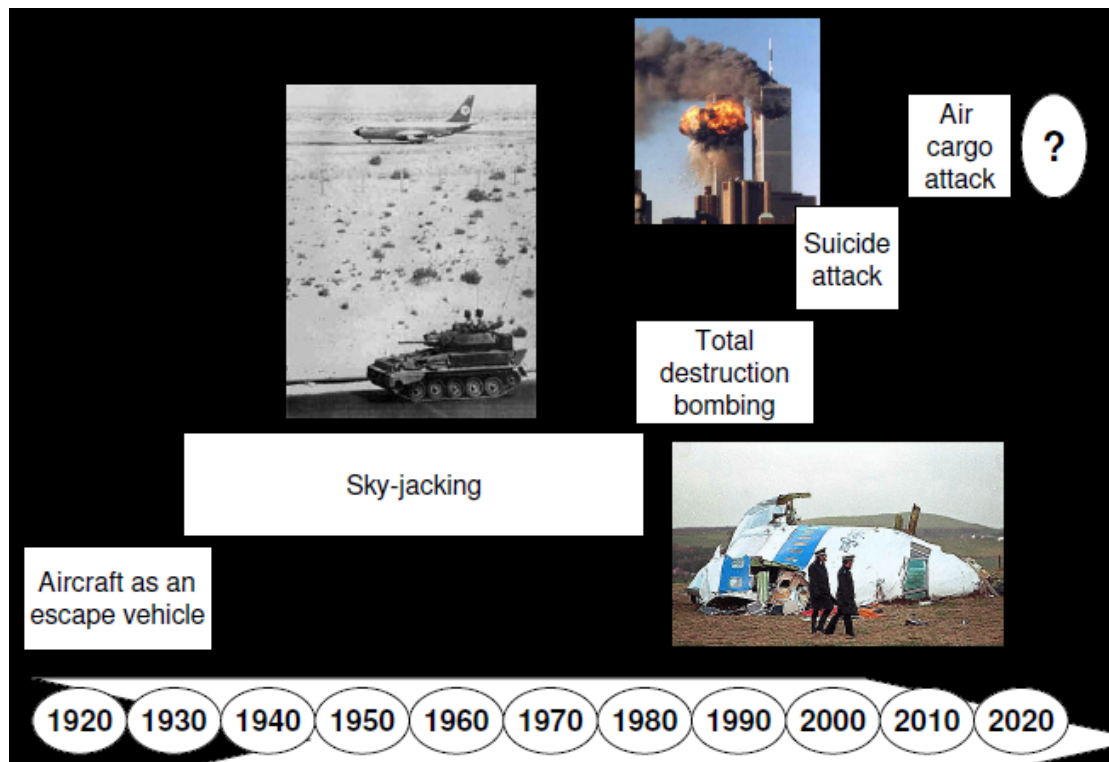
Political events and national conflicts are main social events also. In 2013, because of the Diaoyu island event between China and Japan, the air cargo between two nations has decreased more than half. In mainland of China, there is a social activity to boycott Japanese goods, and in turn the trade between two nations has been damaged. Another important social event is war and it never disappears since birth of human being.

5.5.4 Terrorist Activity

Terrorist activities as Yemeni-launched parcel bombs and 9.11 are typical and

influential for the air cargo transportation. The Transportation Security Administration (and its predecessors) has been attempting to deal with this vulnerability long before September 11, 2001, in the form of the "known shipper" program (KSP). This program is one in which air carriers and freight forwarders are allowed to accept shipments only from those companies designated by Customs and Border Protection (CBP) as "known" shippers. In order to become a known shipper, a company must have an established and documented business history with a U.S. or international air carrier or freight forwarder, as well as customer records that clearly verify the validity of a company (providing a proven address, phone number, and sources of payment or credit history). X-rays technology has been used worldwide for the check of security of goods.

As the figure 5.16 showed, Thomas Biermann pointed that in the future of 2020, air cargo will be the target of terrorist after the sky-jacking, total deconstruction bombing and suicide attacks.



Source: <http://www.garsonline.de/Downloads/111020/BiermannAirCargo.pdf>

Figure 5. 16 Terrorist activates with the time going

.5.6 Conclusion

In this chapter, four first-layer risk factors and 19 second-layer risk factors have been analyzed, the analysis is based on the literature review and the author's working experience. The main contents of analysis are the influence of risk on air cargo industry, on stakeholders, risk occurrence probability and so on. After the analysis, the next step is to assess the identified risk factors using scientific, reasonable and practical method.

Chapter 6 Risk Assessment Approach Choosing

6.1 Introduction

In the Chapter 4 and chapter 5, risks factors in Chinese air cargo industry are identified and analyzed, the following step is to know how about the risks in Chinese air cargo industry. How about the probability, consequence and controllability of these identified risks are? The answer to this question is the process of risk assessment. Risk assessment and risk evaluation are two similar academic terms to describe this process, and some researchers make a clear difference between them, while in the most cases, both have the same meaning. In this research, both terms are used with the same understanding and meaning. As reviewed previously, there are many kinds of risks in the world and society, and all the risk should be assessed in order to support the decision making and understand profoundly. Facing thousands of risks, people use different approaches in different fields to assess them, and every approach has its advantages and disadvantages. In this research, before the risk assessment, one suitable, scientific and practical approach should be chosen, founded or created. While creating tools or method is one really difficult and academic task. In this chapter, the objective is to choose one excellent approach. The main content of this chapter is risk assessment approach review and comparison.

6.2 Risk Assessment Concept and Theory

Risk assessment is used for estimating the likelihood and the outcome of risks to human health, safety and the environment and for enlightening decisions about how to deal with those risks. (Silvianita, 2011). According to Jacqueline et al (2004), a risk assessment is a systematic process for identifying potential hazards and the likelihood that those hazards will cause harm. The National

Research Council of the National Academy of Sciences of USA defined risk assessment as “the use of the factual base to define the health effects of exposure of individuals or populations to hazardous materials and situations” (National Research Council, 1983). Although there are other many concepts, generally the nature of risk assessment consists four basic steps, as hazards identification, analysis of the relationship between cause and the result, assess the exposure and characterize the risk. While not all of the four steps are necessary for every risk assessment, and the details of how these steps are carried out will vary with the nature of the risks involved and the information available to analyze them Jacqueline et al (2004).

For all the risks, the step of assessment is the most important and critical one. Only after the risk assessment, we can see a clear picture of these risks and make decisions based on the risk assessment. As there are many risk assessment approaches, the characteristic of the hazard, the existing data, the industry or field requirement and decision maker’s request are some important considering factors which can influence the approach choosing (Haimes, 2001).

As early as 3200 B.C., the Babylonians consulted a priest-like sect known as the Asipu to analyze alternative actions for coping with risky situations (Covello and Mumpower, 1985). Later, in about 1800 B.C., Hammurabi, King of Babylon, formalized the concept of buying insurance to protect against risks. The earliest insurance policies covered losses of cargo at sea in exchange for payment of interest to moneylenders (Bernstein, 1996). Life insurance was another early form of risk management, instituted by Roman collegia (Bernstein, 1996). Concern about contaminants in the environment also dates to ancient times. The Greeks and Romans recognized the toxicity of lead, mercury, and fumes from burning charcoal (Graham, 1995). The effort to quantify the likelihood that a risky event will occur dates to the development of probability theory nearly 400 years ago. The earliest use of probability for evaluating risks was in the establishment of life insurance premiums, in which

insurance adjusters would determine the minimum premium necessary to cover the costs of a death benefit (Bernstein, 1996). In the seventeenth century, the French monk Antoine Arnauld observed, “Fear of harm ought to be proportional not merely to the gravity of the harm, but also to the probability of the event” (Bernstein, 1996).

Risk assessment can be either quantitative, i.e. providing a numeric estimate of the probability of risk and the magnitude of the consequences, or qualitative, using a descriptive approach. The French Agency for Food, Environmental and Occupational Health and Safety (ANSES), formerly the French Food Safety Agency (AFSSA), bases its assessments on the opinions of scientific panels, such as the ANSES Animal Health Scientific Panel (AH-SP). Owing to the lack of relevant data and the very short period of time usually allowed to assess animal health risks on particular topics, this panel has been using a qualitative risk method for evaluating animal health risks or crises for the past few years B. (Dufour et al, 2011).

6.3 Risk Assessment Approaches

Because of the attention to risk and the diversification of risk, with the development of information technology and scientific research, there are thousands of risk assessment approaches. As in table 6.1 showed, for the federal government of USA, there are many methods for different risk assessment. Different agencies prefer their interest in different programs using different risk assessment methods. In this research, some popular and universal approaches will be reviewed.

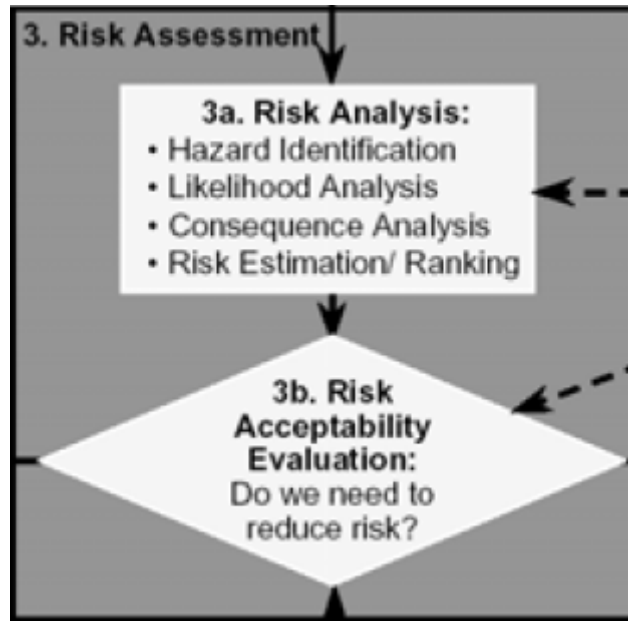
Table 6. 1 Federal Risk Assessment Methods Reviewed

Agency	Program	Risk Assessment Application Reviewed
DoD	Defense Environmental Restoration Program (DERP)	Relative Risk Site Evaluation (RRSE) Primer
	Department of Defense Explosives Safety Board (DDESB)	Safety Assessment for Explosive Risk (SAFER)
	Army Chemical Stockpile Disposal Program (CSDP)	Quantitative Risk Assessment (QRA)
DOE	Office of Environmental Management	Environmental Restoration Priority System (ERPS)
	Office of Civilian Radioactive Waste Management	Total System Performance Assessment (TSPA)
EPA	Office of Solid Waste and Emergency Response	Hazard Ranking System (HRS)
	Office of Solid Waste and Emergency Response	Risk Assessment Guidance for Superfund (RAGS)
	Office of Solid Waste and Emergency Response	Ecological Risk Assessment Guidance for Superfund (ERAGS)
FAA	Office of System Safety	<i>System Safety Handbook</i>
NASA	Space Program	<i>Risk Management Procedures and Guidelines and Continuous Risk Management Guidebook</i>
	Office of Nuclear Reactor Regulation	Probabilistic risk assessment
Occupational Safety and Health Administration (OSHA)	Workplace Safety	General workplace safety standards for carcinogens

Source: Jacqueline et al(2004), p.82

6.3.1 Matrix Method for Risk Assessment

Matrix method is one popular and frequently used risk assessment method which is coming from the nature of risk. In the literature of risk and the definition, risk has two basic elements, probability and consequence, through the evaluation of both elements; one decision-making support matrix can be made. The basic guidance for matrix method is as the figure 6.1.



Source: John Shortreed et al, 2003

Figure 6. 1 Matrix model process

In figure, the risk analysis which includes hazard identification, likelihood analysis, consequence analysis and risk estimation ranking should be made before the decision making. The matrix consists of two elements, probability (likelihood) and consequence. Usually, matrix method is one semi-quantitative method which can induce to more quantitative methods. Take the outcome of John Kicks and Helle Tosine(John Shortreed et al, 2003) as a example, the matrix method can produce one matrix as the figure 6.2.

	Higher			
<i>Likelihood (probability)</i>		Medium	High	High
		Low	Medium □ Event 2 Receptor 2 □ Event 2 Receptor 4	High □ Event 1 Receptor 3 □ Event 1 Receptor 2
	Lower	Low □ Event 1 Receptor 1	Low □ Event 2 Receptor 1 □ Event 2 Receptor 3 □ Event 1 Receptor 4	Medium
		Lower	<i>Consequence</i>	Higher

Figure 6. 2 Example of matrix method outcome

In figure 6.2, through the quantitative evaluation of probability and consequence of risk, all the risks can be classified into nine categories, based on the nine categories, the decision making can be made to avoid, reduce, eliminate, and ignore the concerned risks.

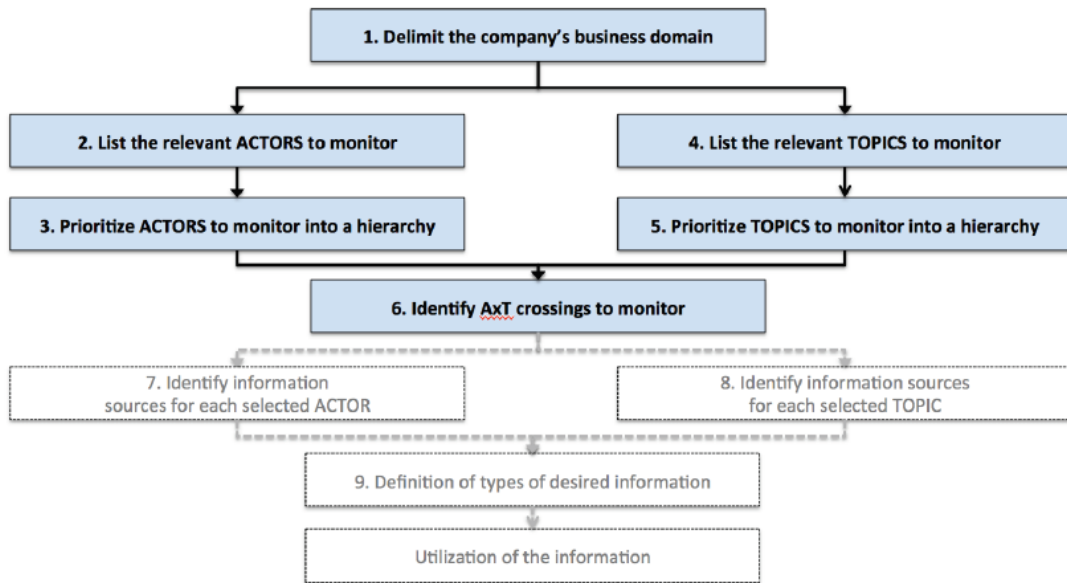
Normally there are two elements within the matrix method assessment, when taking into other elements in consideration, such as the controllability, transparency, uncertainty and scale, the matrix method will lose its advantages; it is difficult and impossible to classify the risks based on more than two standards.

6.3.2 Strategic Scanning

Strategic scanning method is created by Professor Humbert Lesca and Professor Nicolas Lesca who are from Grenoble university of France. Humbert and Nicolas(2011) argues that forecasting method is one traditional method based on the historical data, and strategic weak signal scanning method is creative method which can anticipate the future based on imaging and hypothesis. In the process of risk assessment, it can create some scenarios for the risk decision maker to considerate. Strategic scanning refers to the collective, proactive, continuous and transversal process through which members of the enterprise/organization deliberately track down, interpret and use relevant anticipative information items relating to their outside(sometimes internal as well) environment and the changes(among which risks) that may occur in it. (Humbert and Nicolas,2011).

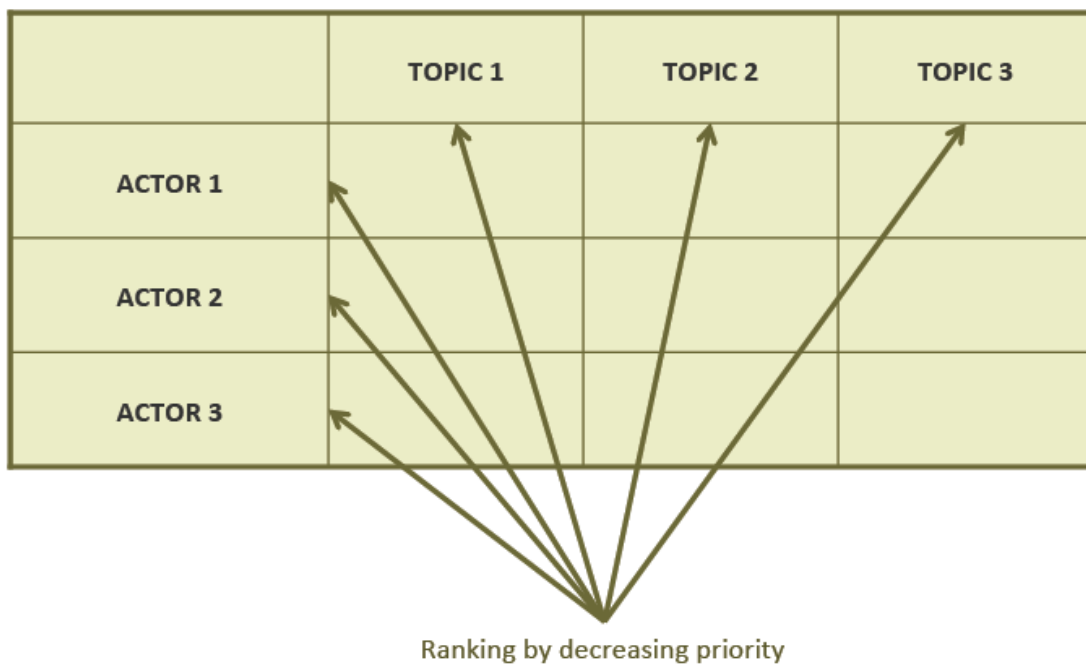
As in figure 6.3, firstly the domain or field should be focused. Then actors and topics should be listed based on the collective intellectual meeting and prioritized in ranking. After the matrix consisting of prioritized actors and topics, the sources of actors and topics can be digging out. The sources can be classified into desired information which can be the reference for decision makers. The matrix can be illustrated as in figure 6.4 which consists of actors

and topics.



Source: from the lecture of Professor Nicolas Lesca in Shanghai university

Figure 6. 3 Strategic scanning model



Source: from the lecture of Professor Nicolas Lesca in Shanghai university

Figure 6. 4 Axt Matrix

Strategic scanning method can creatively create risk warning system through the scanning of risks in the process, and the scanning process can be quantitative and qualitative.

6.3.3 Bayesian Methods

A basic introduction to Bayesian statistics is given by Lee (2004), while a guide to Bayesian data analysis is given by Gelman et al. (1995). Bayesian method is very universal and can be applied in many fields, such as in meat quality analysis (Blasco, 2005) and cost-effectiveness analysis in clinical trial data (O'Hagan and Stevens, 2001). A comprehensive overview of Bayesian methodology and applications was presented by Berger (2000) and O'Hagan and Forster (2004). Two case studies illustrating Bayesian inference in practice are given by O'Hagan and Forster (2004) and many applications of Bayesian statistics are illustrated by Congdon (2001).

Bayesian method involves choosing a parametric model, $M(X|\theta)$, where M represents the model; X is the random quantity of interest and θ represents the parameters. Here a prior distribution, $p(\theta)$, should be selected for each parameter. The likelihood function, $L(\theta|x)$, is $p(x|\theta)$ where $p(x|\theta)$ is a function of θ for given X . Then Bayes Theorem can be used to multiply the prior distribution(s) with the likelihood function for this chosen model to give a better posterior distribution. This makes any prior information, that we have for a random quantity, which needs to be included in the analysis through the prior distribution. It at the same time naturally models the given joint distribution of the parameters. One of the advantages of Bayesian methods is that the additional observations could be applied to update the output. Once one joint probability distribution for both observable and unobservable quantitative has been chosen, all posterior distributions and Bayesian posterior predictive distributions can be computed.

The Bayesian posterior predictive distributions for Normal and Lognormal distributions are well known for specific priors (Gelman et al., 1995). When distributions do not have closed-form solutions, Markov Chain Monte Carlo (MCMC) methods can be implemented using software like WinBUGS (1990), so we can make inferences by sampling from the posterior distribution. (Blasco,

2005)

6.3.4 Frequentist Confidence Methods

The frequentist alternative of credible region is a confidence region. This has the interpretation function that for a large number of repeated trials m , ($m \rightarrow \infty$), the real values of the parameters can fall in the $p\%$ confidence region $mp/100$ times. Using the Bayesian methods, it is difficult to visualize and plot the confidence regions when using more than three parameters. Burmaster and Thompson (1998) used the maximum likelihood estimation to fit parametric distributions of data. Parameters point estimates are carried and used to make joint confidence regions with standard methods. The χ^2 approximation and the standard Taylor series approximation both are used to show approximate confidence regions. The confidence regions verified depending on which approximation was used but as $n \rightarrow \infty$, here n is the sample size, the confidence regions will be converge. This is a little similar to the Bayesian credible region method which could vary depending on the prior distribution which can be chosen through the parameters. When $n \rightarrow \infty$, the data likelihood function will dominate, and this prior distribution can produce less influence. The maximum likelihood method could be illustrated for all the Normal and Beta distributions, at the same time; an assumption for the parameters of the Normal distribution and Beta distribution will be distributed, as a Multivariate Normal distribution could be made. The Bayesian framework lets the options for other distributions in the parameters through the prior distribution, also the likelihood function. Bryan et al. (2007) has given other available methods, and Bryan et al construct confidence regions through expected optimal size. Evans et al. (2003) regards a hybrid Bayesian frequentist method confidence region using the frequentist coverage properties. The Bayesian outlines allow more flexibility, because it can turn in prior information with the prior distribution which the frequentist methods. The frequentist method here has the point that

it is no need to take a prior distribution, while in case of no information available for a priori. Different p-boxes can be constructed with the same way as in the Bayesian p-box using different regions, this was illustrated by Burmaster and Thompson (1998), Evans et al. (2003) and Bryan et al. (2007). These can produce frequentist p-boxes with the explanation that p% for the time, here p is for some chosen confidence level, the real distribution could fall within the p-box.

6.3.5 Nonparametric Predictive Inference (NPI)

Nonparametric Predictive Inference (NPI) is a good tool, which could provide lower and upper likelihood to the predicted value for one or more future observation in random quantities. The base of NPI is Hill's assumption, and it can use interval probability to show uncertainty in quantity (Coolen, 2006). It can be a option for robust Bayes, similar with imprecise probability methods. NPI has been showed for lots of applications, such as adaptive age replacement strategies, comparison of proportions and right-censored data. Because of the use of $A_{(n)}$ for deriving both lower and upper probabilities, NPI matches the frequentist framework of statistics, while could also be interpreted using a Bayesian perspective. Another NPI advantage is the consistence within interval probability theory (Augustin and Coolen, 2004), with agreement for empirical probabilities, and it study the effect of distribution assumptions using other methods. NPI only has few assumptions; one is the exchangeable data, therefore, inferences could not depend on the data ordering. Another underlying assumption can be showed like this. a intervals uniform distribution between these data points while no further specification, as how the probabilities are distributed using intervals. NPI can not been implemented before the exposure assessment area, while it can give predictive probability bounds to all these exposures of an individual. With no an assumption on the distribution where the data are coming from, it seems helpful to make it.

6.3.6 Probability Boxes (p-boxes)

In the process of ecotoxicological risk assessment, information available is often lack to quantify random quantities and to the use uncertainty around them. Probability bounds analysis is not on line with established results on the bounding distributions and these random quantities by Chebyshev (1874) and Markov (1886), using modern computational methods, it can solve many common problems, such as lack of the exact input distributions, and lack of dependencies between the inputs. The meaning of p-boxes is that this output p-box can produce all possible output distributions, which could get using the input distributions, expecting the random quantities distributions lie in the respective p-boxes (Ferson and Tucker, 2003). They can be nonparametric or parametric.

Some p-boxes perhaps do not need much information; for instance, some can be constructed through the maximum, minimum, mean or variance of data or the combination of both. Nonparametric p-boxes can have confidence levels connected with them, for example, the 95% Kolmogorov-Smirnov (KS) confidence limits; also they can be structured assuming 100% confidence. Ferson et al. (2003) has showed more information on nonparametric p-boxes. In parametric models, the distribution is clear, while the parameter estimate is only described using intervals, and the probability bounds could be calculated (Ferson et al., 2003). It works perfectly in single parameter distributions, assuming that there should be some justification in choosing interval for the parameter. But for distributions using more than one parameter, this method can not have the dependence between these parameters.

6.3.7 Monte Carlo Simulation

Monte Carlo simulation (MCS) is one popular and useful tool currently employed to implement risk assessment., MCS was originated at Los Alamos in the 1940s based on the work of Ulam, von Neumann and Fermi. It is a

random sampling tool to solve difficult deterministic equations (Ulam, 1976). Rugen and Callahan (1996) has given an history overview of Monte Carlo Simulation. since then based on advances in computing, Monte Carlo methods has been continuously evolved, and it can be used in many applications. Two-dimensional Monte Carlo simulation (2D MCS) is one new used and developed in wide applications, such as in human health risk assessment (Pouillot et al., 2007), environmental flood risk assessment(Lindenschmidt et al., 2008), avian risk assessment, (Hart et al., 2007) and microbial risk assessment (Vicari et al., 2007).

One-Dimensional Monte Carlo simulation (1D MCS) gives predictive outcome for a random individual on a given population. It has different implementations and Frey (1993) states that, every input random quantity has assigned a distribution according to the observed data values. Using maximum likelihood methods can help to assign a distribution. The model is operating for much iteration with the sampled values based on the input distributions for every random quantity. Typically anyone between 100 and 10,000 iterations is formed with some sample values for a given random quantity of interest. The number of iterations implied was generally determined through the analyst with the trial and error with the reference of the output after each turn and each checking its consistence with the previous runs. If it is true, the iterations number is regarded as sufficient. The required iterations number can decide the model complexity and the used sampling technique.

Two-dimensional Monte Carlo simulation (2D MCS) is an extra useful extension of Monte Carlo simulation. For 2D MCS, there are two loops for the allowing variability and uncertainty which are modeled separately. The uncertainty is modeled in the outer loop and the variability is in the inner loop. Burmaster and Wilson (1996) has given an clear introduction to model both variability and uncertainty separately in the process of setting up a 2D MCS. 2D MCS can be completed in the Bayesian framework as discussed previously, because it hypothesis that all the distribution parameters given are uncertain.

While, there is no common recognize about the advantage of Bayesian 2D MCS and still there is no non-Bayesian versions has been implemented.

In the non-Bayesian versions, parameters distributions are selected by analysts and dependencies, and the parameters are often ignored. In the Bayesian method, prior distribution is assigned for random quantities parameters and then to update with the data. This can explain parameter uncertainty and also can show the dependencies between parameters. Bayesian 2D MCS can generate bounds on the result for any model at any credible level, and it also takes parameter uncertainty as for each random quantity in the given model. Vose (2001) has given some advantages of Monte Carlo methods. The process includes the availability of software, procedure implement and also it can be applied as the sensitivity analysis through making adjustments and interval to this model. It includes the results comparing for each adjustment to show the effect of changes. The model uncertainty could be decided through the setting up of different models and the comparing and enveloping the results. What is more, 2D MCS can be carried with copulas to consider any known correlations among the random quantities for the model. Ferson (1996) has given out the problems of 2D MCS, for example, it is difficult to assign input distributions and to deal with the unknown correlations.

6.3.8 Bootstrapping

Vose (2001) presents the introduction of bootstrapping. Bootstrapping is regarded as a computationally intensive approach from the point of statistical inference. Commonly it is used often in order to find confidence intervals among particular parameters, like the mean. Empirical distribution of data group is commonly used in case of sampling from the point of an approximate distribution. Normally, sample can be taken many times with replacement according to the observed data set, then the new data sets as the same size can be got and the statistic of interest can be calculated for each sample. With

or without replacement, smaller and larger size of data sets can be sampled from all the data set. Bootstrapping can be one useful alternative or replacement to parametric methods, but it requires strong assumptions on the data distribution. While, in case of exposure risk assessment, the distributions tails and re-sampling is more interesting from the data set. Finally, we have can not provide any information about more extreme values than the observed ones. In order to deal with it, one kind of parametric model could be matched to the data, on the other side, we can draw the random samples from this distribution. While it can not explain the uncertainty of the parameter values. Zhao and Frey (2004) take one example to show that. Bootstrap methods can be useful for dealing with censored data.

Grist et al. (2002) illustrated that it can be good method for species sensitivity distributions (SSDs), in the article, it illustrates the bootstrap regression about the estimation of SSDs in the aquatic environment. Using empirical distribution function (EDF), The probability of each observation is of $1/n$. Choosing EDF, it is necessary at least $n = 20$. but for toxicity of mammals and birds, it is common that the data sets is not more than 20. Even taking a sample of 20, the 5th percentile of confidence limits can not be capture. From this point, bootstrapping perhaps should not be taken for the small samples. But the confidence interval can be accelerated and use a bias, the coverage of bootstrap confidence intervals can be supported.

6.3.9 Worst-case Analysis

Worst-case analysis is a common method for ecotoxicological risk assessment. Through recognizing that it is uncertainty for the random quantities values, it can not model the uncertainty explicitly. The uncertainty is illustrated by selecting values using the way of believing that the overall risk estimate is conservative.

In the EU guidance targeted at for birds and mammals (European Commission,

2002b), there is one example of using worst-case analysis. But Frey (1993) criticized this method; using conservative estimates of compounding effect can not be understood. Ferson (2002) also ceiticizes this method, the conservatism is unqualified, at the same time, it is inconsistent among different assessments. As we do not know the conservatism levels for different analyses, in the purpose of decision making, it is impossible to compare them. Worst-case analysis also can be regarded as one screening assessment, using it, we know further refinement is required no not. Vermeire et al. (2001) proposed one comprehensive comparison of worst-case analysis and the probabilistic assessment.

6.3.10 Interval Analysis

This interval analysis method takes intervals to illustrate the possible values where the random quantity can take. These used intervals could then be manipulated with the regulations of interval arithmetic. Ferson et al. (2007) argues the data with interval uncertainty, such as the descriptions on basic operations, multiplication, subtraction, addition and division. The bounds about all elementary mathematical operations could be computed. In case a random quantity repeated again in the process of analysis, the random quantity uncertainty could be added to every repetition which can lead to suboptimal bounds. Here all the optimal bounds could be the tightest possible bounds under the given inputs. On the contrary, when random quantities do not repeat in this model, we can guarantee that the interval analysis can yield the optimal bounds under the given inputs (Moore, 1966). Therefore under proper condition, we could manipulate the model, in this way, the random quantities could occur only once. Interval analysis can deal with all or any kind of uncertainty and produce bounds under given data, this is the advantage. In other case, under the wrong random quantities input within these intervals, the intervals could be combined using good way. So we can judge that the real

result is in the output interval. But because of the more mathematical operations, the intervals are becoming more and more conservative. At the same time, the result is becoming wider and no enough information. We can see interval analysis method is criticized to be hyper conservatism. There are also no indications, which value is likely in the given interval. In this case, interval analysis could mean the only information, and can not show more meaningful result. Some times we can use software like RiskCalc to perform the Interval analysis in the process of risk assessments. Ferson et al. (2007) proposed many details of methodology, examples and some applications. Moller and Beer (2008) also give some applications in the field of engineering.

6.3.11 Fuzzy Arithmetic

Fuzzy numbers can be regarded as the generalization of given interval analysis. In the interval, using a membership function to describes one person's beliefs on interval value where the random quantity falls. Arithmetic operations could be computed on fuzzy numbers through using interval arithmetic for every possibility level interval between 0 and 1. Kentel and Aral (2005) has done a detailed and clear comparison between the frequentist 2D MCS method and the fuzzy 2D MCS method. In the method of 2D fuzzy Monte Carlo, it can support membership functions using the mean and standard deviation. The membership functions normally are decided by group of analysts or expert, at the same time, the fuzzy method does not consider the parameters dependencies. It can automatically produce the dependence between parameters under a posterior distribution, so we can say the 2D MCS method of Bayesian framework is more preferable than the 2D fuzzy MCS.

6.3.12 Sensitivity Analysis

As the most straightforward method, sensitivity analysis is always regarded as

the useful approach to decide the random quantities of the given model which will have the most influential effect on the output. Of course there are criticisms targeted on it, and the core criticism is that the more the number of random quantities increasing, the more complex cumbersome and computationally intensive for all the possible scenarios.

Although there are many methods that can vary correlation coefficients, while Ferson and Hajagos (2006) show in their research that varying correlation coefficients only is not enough or sufficient to contain all the possible dependencies in the method of sensitivity analysis. Ferson and Tucker (2003) has explored sensitivity analysis for p-boxes. Through their research, they found how p-boxes can be matched into with a precise and detailed distribution to know what effect that will has on the result.

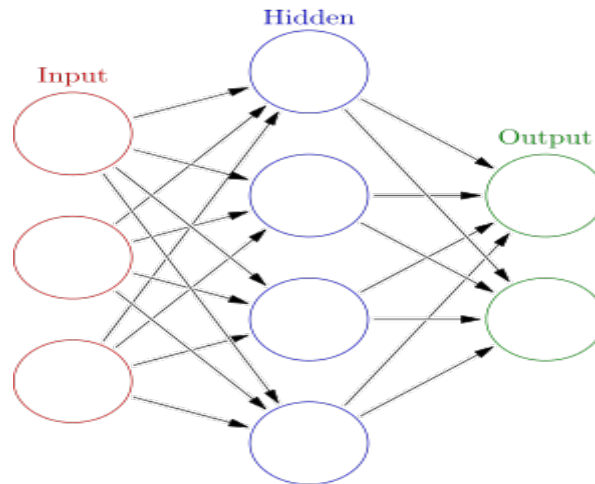
6.3.13 Artificial Neural Network

Artificial neural network (ANN), some times called neural network, is oriented or inspired from biological neural networks, in more general language, it is a mathematical model. A typical neural network has one set of interconnected groups of artificial neurons, using neurons it can process information with a connectionist approach to calculate. In most cases or normally, it is an adaptive system which can change its structure in the period of learning phase. The main aim of calculating is to find patterns in data, and then to model the complex relationships among inputs and outputs. With neural networks, this system can be comprehensive and perfect.

The main function of an artificial neural network models is that in the practice they can deduce a more useful and meaningful function from the outside observations. In the practice and real world applications, there is much and complex data, and normally it is impossible to calculate by hand, so an artificial neural network can be a useful and practical method or replacement.

As in the research of Roman M. Balabin, Ekaterina I. Lomakina (2009), there are many

application fields, such as system identification, process control, natural resources management control, vehicle control, game-playing, decision making, sequence recognition, quantum chemistry, financial applications, pattern recognition, medical diagnosis, data mining, e-mail spam filtering and visualization..



Source: http://en.wikipedia.org/wiki/File:Colored_neural_network.svg

Figure 6. 5 ANN model

As in figure 6.5 from wiki website, there are three key elements within one typical ANN model, hidden and internal intelligent process, input, and output. This is also the most typical one simulation model.

One typical practice of this method is from two Italy researchers, Salvatore Alessandro Sarcià and Giovanni Cantone. In order to assess the risks, they use ANN to show the prior and posterior probabilities which are automatically from derive from historical data.

In real applications, especially in robotics science, using it requires much of diversity training to make the operation smoothly. This is one typical drawback. in 1997, as a famous Scientific American columnist, A. K. Dewdney, wrote, "Although neural nets do solve a few toy problems, their powers of computation are so limited that I am surprised anyone takes them seriously as a general problem-solving tool." (Dewdney, p. 82)

For the integrated and hybrid models researchers, they insist that this method is not perfect or so useful. In most cases, they prefer to combine neural networks with symbolic approaches, or these two methods can intermix

together. In this way, they think, this method can master the real nature of the mechanisms of human being. (Sun and Bookman 1994).

6.4 Integrated Assessment Approaches

6.4.1 Some Hybrid Approaches

Considering the practical condition, cost, energy, ability of organization and other many factors, in most cases, one risk assessment process normally chooses unique suitable approach. While Silvanita(2011) argued that the integrated risk assessment tools can carry out the assessment better than the single tool. The integrated assessment approach means that more than one approach will be used to assess the same risks within the same organization or project. Based on the summary of Silvanita(2011), one table was summarized as the table

Table 6. 2 Integrated risk assessment approaches summary

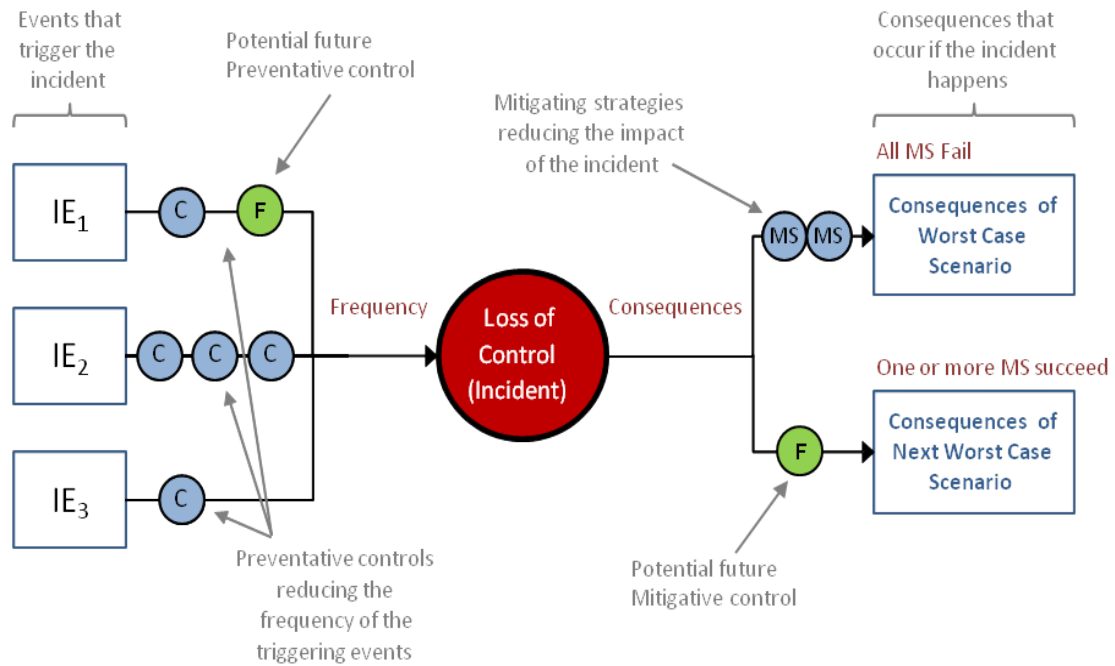
Approach	authors	Application field
FMEA – FTA	Moss et al (1983)	Offshore Reliability Analysis of TLP
HAZID – Structural Reliability Analysis	Stiff et atl (2003)	Offshore Comparative Risk Analysis of Mooring
FETI-HAZOP-FTA	Roy et al (2003)	Material Quantitative Risk Assessment in Production Facility
FTA – ETA(Bow Tie Analysis)	Jacinto & Silva (2009)	Offshore Ship Building Industry
	Dianous & Fievez (2005)	Industry Methodology for Risk Assessment
	Targoutzidis (2009)	Safety Methodological tool in risk assessment
HAZID - ETA	Petruska et al (2009)	Offshore: Mooring MODU Risk Assessments
HAZOP – FTA – ETA	Deacon et al (2010)	Offshore: Risk Analysis in Offshore Emergencies
	Cockshott (2005)	Chemical risk management

Source: Silvanita(2011), p.84

In order to calculate the reliability analysis of a platform, Moss and Kurty(1983) used FMEA and FTA to identify and examine all the possible failures and the impacts. The FTA method can describe all the causes of undesired factors which can lead to the failure mode. The problem is this integrated method is the subjectivity which is from the practitioner.

FETI, HAZOP and FTA were used in the process of quantitative risk assessment for storage and purification section from titanium sponge production facility (Roy et al, 2003). In order to find the most dangerous section in the entire plan, they used FETI and HAZOP methods, and FTA is used as probabilistic analysis to describe the root cause of an events.

Bow-Tie approach is one typical integrated approach which combines the thoughts from control thinking, causal factors charting, ETA and FTA. As for the origination of this method, there is no agreed author and documents in record. Based on the thinking of Bow-Tie approach, the famous Bow-tie diagrams is showed in figure 6.6. It is a simple and effective tool for the risk assessment and it clearly display the links between the potential causes, preventative and meditative controls and consequences of a major accident. Bow-tie diagrams may be used to display the results of various types of risk assessments and are useful training aids. Bow-tie diagrams may also be integrated with semi-quantitative analysis techniques such as Layers of Protections Analysis (LOPA) depending on the level of complexity required. The general structure of a bow-tie diagram is represented in the diagram below.



Source: <http://www.r4risk.com.au/Bow-tie-Analysis.php>

Figure 6. 6 Bow-Tie approach example

6.4.2 NPI-Bayes Hybrid Approach

In the real practice, there are different level of information available, based on these information, we can make different assumptions. in order to capture and combine random quantities, Victoria Montgomery (2009) creatively integrated nonparametric predictive inference (NPI) with Bayesian methods. The research combined NPI and the Bayesian posterior predictive distribution by using the NPI-Bayes hybrid method and the NPI-Bayes robust hybrid method. It is possible to combine NPI with 2D Bayesian methods such as 2D MCS. This method is useful where there are different levels of information available for random quantities. NPI can be used for random quantities for which we do not have enough information available to assume a distribution and the Bayesian posterior predictive distribution or 2D Bayesian MCS can be used for random quantities about which we have more information. It is common in practice that this situation, where we have lots of information about some random quantities and less information about other random quantities, will occur. For example, there is often little information about concentration of chemicals in different

food types but lots of information available about the bodyweights of the population.

6.5 Critical Commentary on Risk Assessment Approaches

6.5.1 Quantitative Method and Qualitative Method

It is agreed that both quantitative and qualitative methods are important and necessary for risk assessment. In the case of enough data and information, quantitative method can show clearly the data or result in number. In most public affairs and decision making, we can not get direct data in number, and qualitative method can also help to make decision. Quantitative method always need computer science, mathematics and biology knowledge, and qualitative method needs more on psychological and social knowledge.

6.5.2 Critics on Scoring Method with Ordinal Scale Method

Many risk management methods promoted by management consultants and international standard organizations involve calculating a numerical value for risk based on simple point scales (defined below) combined in some way.

Such scales are subjective and are usually based on some kind of ordinal comparisons or classifications.

On an ordinal scale, factors such as likelihoods are assigned numbers in such a way that the order of the numbers reflects the order of the factors on an underlying attribute scale.

Two broad categories of subjective ordinal risk assessment methods are widely used. We will refer to them as additive and multiplicative. Additive scores are those in which several independent factors are weighted and added together. For example, when evaluating the credit risk of an international customer, a manufacturer might identify factors for country stability, order size, currency volatility, and so on. Additive scores tend to be used to evaluate

overall risks of projects, investments, and policies, for example. Multiplicative scores are those that have just two or three factors that are multiplied together. When two factors are used, they are usually likelihood and impact (or probability and consequence), and they are generally not individually weighted as in additive schemes.

These scores are often used to represent the evaluation of the risk of individual events, such as theft of data by hackers (i.e., malicious users) or power outage in the factory. Some three-factor variations of multiplicative scores, particularly in security-related areas, use threat, vulnerability, and impact.

D.Hubbard and D.Evans(2010) found four weak point of this ordinal scale for scoring method. The first fallacy is the idea that without further aid or adjustment, subjective assessments of experts are an adequate assessment of risks. This is not true; the research in human judgment and decision making cited in the section BA partial review of literature on cognitive biases shows that various known errors and biases are highly significant in the subjective assessment of risks, even for in fact particularly for experts.

The second fallacy is the idea that if a scale is very rigorously defined, then it will be used in a predictable consistent manner. This is not true either; the research cited research regarding the variability of verbal labels shows that the verbal scales are used in a highly inconsistent manner, even when users are given a great deal of descriptive detail about the definitions of the values.

The third fallacy is the idea that the exact scales and scoring calculations chosen are arbitrary and will not ultimately have as much bearing on the outcomes as the input of the experts. This is patently false; the arbitrary choice of whether a scale is a three- or five-point scale, together with the choice of how the scales are to be combined, can affect the results or produce nonsensical results. Furthermore, the arbitrary application of operations such as addition and multiplication to these ordinal scales adds even more error.

The fourth and final fallacy is the idea that correlations and other interactions among events are not necessary to model a rough approximation. This is false:

In quantitative risk models, it is known that excluding correlations and relationships such as cascade failures or common mode failures can cause a model to greatly underestimate risks. There is no reason to believe this issue is somehow alleviated by using ordinal scales.

Scoring method is a commonly and often used method in a variety of different fields, and in most cases, it always arithmetically combining ordinal scales. With the ordinal scales, the risk probability and outcome be seen in the form of number. This is the purpose of many researchers and practitioners. While D.Hubbard and D.Evans(2010) think the contrary and pay more attention to the other side of this method. First, they do not usually take into account the findings of psychological research concerning the cognitive biases that impair most people's ability to assess risk. Second, the verbal labels used in ordinal scales are interpreted extremely inconsistently among different users and by the same user. Third, many users treat these scales as if they are ratio scales, with the result that they draw invalid inferences. Fourth, simple scoring methods rarely consider correlations that would change the relative risks. Taken together, these four problems indicate that scoring methods are likely to be poor tools for risk assessment.

6.6 Analytic Network Process and (ANP) Approach

6.6.1 Analytic Hierarchy Process (AHP)

(1) Basic Introduction

Analytic Hierarchy Process (AHP) was created in 1990's by Thomas L. Saaty (2008) in the 1970s and then was extensively researched and spread the entire world. As the definition of the author, The Analytic Hierarchy Process (AHP) is a theory of relative measurement with absolute scales of both tangible and intangible criteria based on the judgment of knowledgeable and expert people. How to measure intangibles is the main concern of the mathematics of the AHP. In the end we must fit our entire world experience into

our system of priorities if we are going to understand it. The AHP reduces a multidimensional problem into a one dimensional one. Decisions are determined by a single number for the best outcome or by a vector of priorities that gives an ordering of the different possible outcomes. It is a structured technique aiming to help complex decision making based on the mathematics and psychology. After the introduction, AHP has been applied into enterprise decision making and public affairs decisions in many fields, such as business, government, healthcare, education, environment and other domains.

In the helping process, it tries to find best suitable and reasonable proposal under the principle of goal, and provide a comprehensive and structured framework. The main logic is to involve the mathematical synthesis of numerous judgments on the decisions.

In practice, AHP can be helpful for the selection of alternatives under the given set of alternatives; AHP can be used in putting many alternatives in the desirable order; not only ranking them, it can determine the relative merit of members of alternatives. In all, it has been applied widely in resource allocation, benchmarking, quality management, and forecasting, balanced scorecard and conflict resolution.

In the world, AHP has an important influence in China, as more than one hundred universities have offer AHP courses. Over 900 journal paper has been published on AHP and many doctor dissertations and research project use AHP as the main method (Sun Hongkai, 2005).

According to Saaty, Thomas L. (2008), the main procedure of AHP application is summarized as the following:

- Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, and the criteria for evaluating the alternatives.
- Establish priorities among the elements of the hierarchy by making a series of judgments based on pair wise comparisons of the elements. For

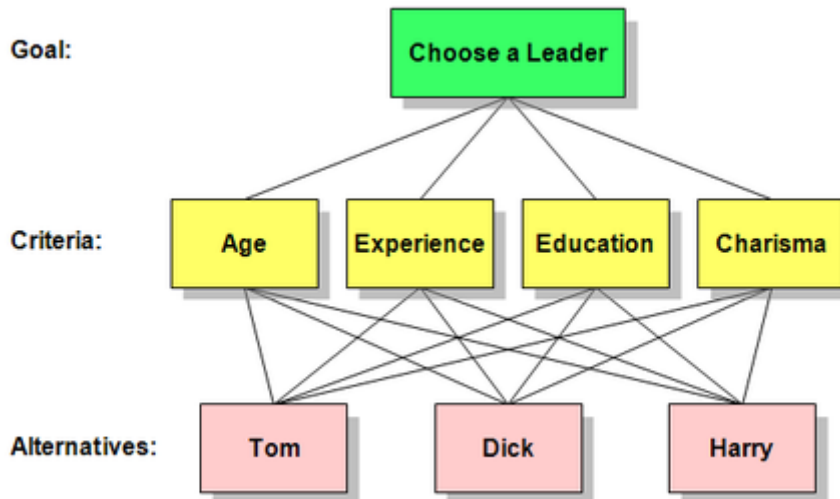
example, when comparing potential real-estate purchases, the investors might say they prefer location over price and price over timing.

- Synthesize these judgments to yield a set of overall priorities for the hierarchy. This would combine the investors' judgments about location, price and timing for properties A, B, C, and D into overall priorities for each property.
- Check the consistency of the judgments.
- Come to a final decision based on the results of this process.

(2)Hierarchy Building

As the name showing, the obvious character of AHP method is the hierarchy building. A hierarchy is a stratified system of ranking and organizing people, things, ideas, etc., where each element of the system, except for the top one, is subordinate to one or more other elements. Though the concept of hierarchy is easily grasped intuitively, it can also be described mathematically (Saaty, Thomas L. 2010).

As described in figure 6.7, a normal hierarchy consists of an overall goal (choosing a leader), a set of alternatives (candidates for leader) for reaching the goal, a group of factors or criteria (age, education, experience) that connected with goal. The hierarchy building depends on the participants' knowledge, values, opinions, attitudes, needs and judgments, and also depends on the nature of the problem itself. A scientific and reasonable hierarchy normally is built by experts' group discussion or brainstorm, and the alternative and criteria can be added or canceled according to the collective meeting result.



Source: http://en.wikipedia.org/wiki/Analytic_hierarchy_process

Figure 6. 7 Typical AHP hierarchy

(3) Priorities Establishing and Inconsistency Check

The Priorities are numbers associated with the nodes of an AHP hierarchy. They represent the relative weights of the nodes in any group. Like probabilities, priorities are absolute numbers between zero and one, without units or dimensions. A node with priority .200 has twice the weight in reaching the goal as one with priority .100, ten times the weight of one with priority .020, and so forth. Depending on the problem at hand, "weight" can refer to importance, or preference, or likelihood, or whatever factor is being considered by the decision makers.

Priorities are distributed over a hierarchy according to its architecture, and their values depend on the information entered by users of the process. Priorities of the Goal, the Criteria, and the Alternatives are intimately related, but need to be considered separately.

By definition, the priority of the Goal is 1.000. The priorities of the alternatives always add up to 1.000. Things can become complicated with multiple levels of Criteria, but if there is only one level, their priorities also add to 1.000. All this is illustrated by the priorities in the example below.

In order to get the priorities and weight of node and criteria, one useful number fuzzy evaluation method can be used to describe the attitude of experts. To

tradeoff the objectives and criteria, the expert judgment is usually in the form of number which can express the qualitative attitude. The experts should make reciprocal pair wise comparisons for the indicators and criteria, and the Fundamental Scale is the most used tool, as in table 6.3 showed.

Table 6. 3 Fundamental Scale and consistency index

Number		Meaning								
1		Equal importance								
3		Moderate importance of one over another								
5		Strong or essential importance								
7		Very strong or demonstrated importance								
9		Extreme importance								
2,4,6,8		Intermediate values								
Use reciprocals for inverse comparisons										
Order	1	2	3	4	5	6	7	8	9	10
<i>R.I.</i>	0	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

Source: www.SID.ir

Associated with the weights is an inconsistency. The consistency index of a matrix is given by $C.I. = (\lambda_{max} - n)/(n - 1)$. The consistency ratio (C.R.) is obtained by forming the ratio of C.I. and the appropriate one of the following set of numbers shown in Table , each of which is an average random consistency index computed for $n \leq 10$ for very large samples. They create randomly generated reciprocal matrices using the scale 1/9, 1/8....1/2, 1, 2...8, 9 and calculate the average of their eigenvalues. This average is used to form the Random Consistency Index R.I.

It is recommended that C.R. should be less than or equal to 0.10. Inconsistency may be thought of as an adjustment needed to improve the consistency of the comparisons. But the adjustment should not be as large as the judgment itself, nor so small that it would have no consequence. Thus inconsistency should be just one order of magnitude smaller. On a scale from zero to one, the overall inconsistency should be around 10 %. The requirement

of 10% cannot be made smaller such as 1% or 0.1% without trivializing the impact of inconsistency. But inconsistency itself is important because without it, new knowledge that changes preference cannot be admitted. Saaty, T. L. & Ozdemir, M. (2005).

6.6.2 From AHP to ANP

(1) AHP and ANP comparison

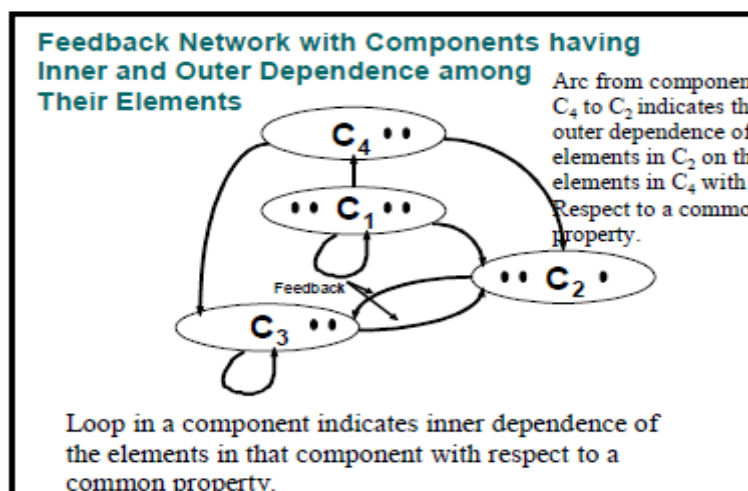
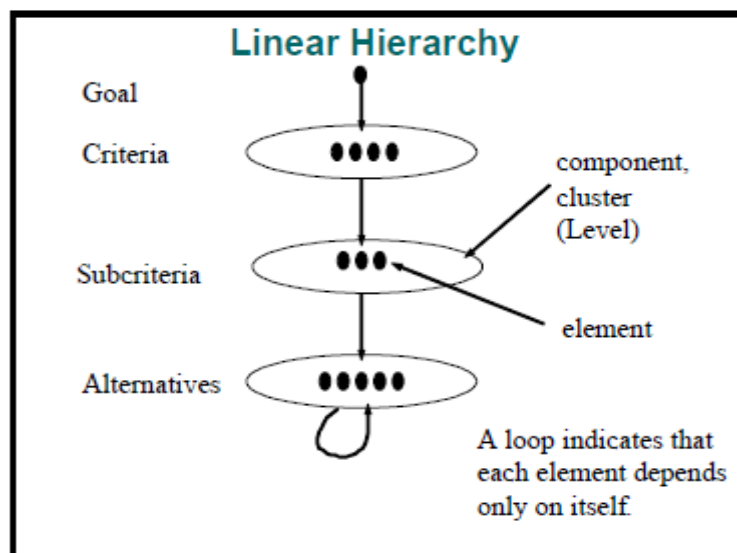
Originally, the analytic network process (ANP) is a more wide form of the analytic hierarchy process (AHP). The Analytic Network Process (ANP) is a generalization of the Analytic

Hierarchy Process (AHP), by considering the dependence between the elements of the hierarchy. Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in a hierarchy on lower level elements. Therefore, ANP is represented by a network, rather than a hierarchy.

The feedback structure does not have the top-to-bottom form of a hierarchy but looks more like a network, with cycles connecting its components of elements, which we can no longer call levels, and with loops that connect a component to itself. It also has sources and sinks. A source node is an origin of paths of influence (importance) and never a destination of such paths. A sink node is a destination of paths of influence and never an origin of such paths. A full network can include source nodes; intermediate nodes that fall on paths from source nodes, lie on cycles, or fall on paths to sink nodes; and finally sink nodes. Some networks can contain only source and sink nodes. Still others can include only source and cycle nodes or cycle and sink nodes or only cycle nodes. A decision problem involving feedback arises often in practice. It can take on the form of any of the networks just described. The challenge is to determine the priorities of the elements in the network and in particular the alternatives of the decision and even more to justify the validity of the outcome. Because feedback involves cycles, and cycling is an infinite process, the

operations needed to derive the priorities become more demanding than has been familiar with hierarchies.

In Figure 6.8, we exhibit a hierarchy and a network. A hierarchy is comprised of a goal, levels of elements and connections between the elements. These connections are oriented only to elements in lower levels. A network has clusters of elements, with the elements in one cluster being connected to elements in another cluster (outer dependence) or the same cluster (inner dependence). A hierarchy is a special case of a network with connections going only in one direction. The view of a hierarchy such as that shown in figure 6.8 the levels correspond to clusters in a network.



Source: www.SID.ir

Figure 6. 8 Comparison between hierarchy and network

(2) Supermatrix of ANP

The priorities derived from pair wise comparison matrices are entered as parts of the columns of a supermatrix. The supermatrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control criterion. A supermatrix along with an example of one of its general entry matrices is shown in Figure 6.9. The component C1 in the supermatrix includes all the priority vectors derived for nodes that are parent nodes in the C1 cluster.

$$W = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_N \end{matrix} \\ \begin{matrix} C_1 \\ \vdots \\ C_2 \\ \vdots \\ C_N \end{matrix} & \begin{bmatrix} e_{11}e_{12} \dots e_{1n_1} & e_{21}e_{22} \dots e_{2n_2} & \dots & e_{N1}e_{N2} \dots e_{Nn_N} \\ W_{11} & W_{12} & \dots & W_{1N} \\ W_{21} & W_{22} & \dots & W_{2N} \\ \vdots & \vdots & \dots & \vdots \\ W_{N1} & W_{N2} & \dots & W_{NN} \end{bmatrix} \end{matrix}$$

W_{ij} Component of Supermatrix

$$W_{ij} = \begin{bmatrix} W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \dots & W_{i1}^{(j_{n_j})} \\ W_{i2}^{(j_1)} & W_{i2}^{(j_2)} & \dots & W_{i2}^{(j_{n_j})} \\ \vdots & \vdots & \dots & \vdots \\ W_{in_i}^{(j_1)} & W_{in_i}^{(j_2)} & \dots & W_{in_i}^{(j_{n_j})} \end{bmatrix}$$

Figure 6. 9 ANP supermarix

(3) ANP Steps

AHP structures a decision problem into a hierarchy with a goal, decision

criteria, and alternatives, while the ANP structures it as a network. Both then use a system of pair wise comparisons to measure the weights of the components of the structure, and finally to rank the alternatives in the decision. (http://en.wikipedia.org/wiki/Analytic_network_process)

According to Saaty, Thomas L.; Brady Cillo (2009), there are some key steps for the implementation of ANP as following:

- Clearly understand the decision problem in detail, including its objectives, criteria and subcriteria, actors and their objectives and the possible outcomes of that decision.
- Determine the control criteria and subcriteria in the four control hierarchies one each for the benefits, opportunities, costs and risks of that decision and obtain their priorities from paired comparison matrices.
- For each control criterion, construct the supermatrix by laying out the clusters in the order they are numbered and all the elements in each cluster both vertically on the left and horizontally at the top. Enter in the appropriate position the priorities derived from the paired comparisons as subcolumns of the corresponding column of the supermatrix.
- Perform paired comparisons on the elements within the clusters themselves according to their influence on each element in another cluster they are connected to (outer dependence) or on elements in their own cluster (inner dependence).
- Compute the limit priorities of the stochastic supermatrix according to whether it is irreducible or it is reducible with one being a simple or a multiple root and whether the system is cyclic or not.
- Synthesize the limiting priorities by weighting each idealized limit vector by the weight of its control criterion and adding the resulting vectors for each of the four merits: Benefits (B), Opportunities (O), Costs (C) and Risks (R).
- Determine strategic criteria and their priorities to rate the top ranked (ideal) alternative for each of the four merits one at a time.
- Perform sensitivity analysis on the final outcome.

6.6.3 Critics on ANP method

AHP mathematically attempt to analyze verbal preferences. Since the AHP can be used to estimate the coefficients of ordinal scales, proponents of AHP point out that such scales will then directly yield a cardinal product that is potentially accurate and relevant.

However, this does not imply that AHP thereby avoids the problems during the use of ordinal scales in risk assessment, since these mathematical adjustments are only valid for converting ordinal utility measures to cardinal utility values. However, in risk assessment, subjective utility is only part of the concern; without objectively valid (i.e., well-calibrated) probability assessments and cost estimates, even the most finely tuned subjective utility values will be useless. The theory behind converting ordinal utility into cardinal utility (as developed by von Neumann and Morgenstern (1944)) is quite a different topic than the degree to which the predictive power of subjectively chosen scores is empirically validated.

The theoretical soundness of AHP (which has been disputed is a separate issue from the empirical description of whether the potential accuracy of AHP is ever realized in practice. Regardless of how much personal satisfaction that people may derive from using AHP, its objective value as a risk assessment tool depends on showing that experts using AHP outperform experts using their own unaided intuition in a controlled forecasting experiment.

There is, however, no such evidence. Instead, the research concerning the validity of AHP, as with other scoring models, has focused on other measures, such as how well the method predicts the stated preferences of users, and not how well it forecasts real-world events, such as costs, project failures, and industrial accidents (P. J. H. Schoemaker and C. C. Waid, Ban, 1982). Furthermore, AHP can not solve the problems, as erroneous input produces erroneous output. These problems exist for AHP if eliciting probabilities and risks by scales (pair wise comparisons) is flawed.

Again, care must be taken not to confuse the perception of a benefit with actual improvements in the accuracy of assessments. Studies have already shown that gathering more information and interacting with other individuals before making a decision can improve subjective confidence in the decision without improving its objective quality; indeed, it can even decrease the objective quality (C. Tsai, J. Klayman, and R. Hastie, 2008). One empirical study of decision quality does, in fact, show that the use of a well-known AHP tool improved confidence without an improvement or perhaps even a degradation in decision quality (M. L. Williams et al, 2007).

Decision making involves ranking alternatives in terms of criteria or attributes of those alternatives. It is an axiom of some decision theories that when new alternatives are added to a decision problem, the ranking of the old alternatives must not change — that "rank reversal" must not occur.

There are two schools of thought about rank reversal. One maintains that new alternatives that introduce no additional attributes should not cause rank reversal under any circumstances. The other maintains that there are some situations in which rank reversal can reasonably be expected. The original formulation of AHP allowed rank reversals. In 1993, Forman (1993) introduced a second AHP synthesis mode, called the ideal synthesis mode, to address choice situations in which the addition or removal of an 'irrelevant' alternative should not and will not cause a change in the ranks of existing alternatives. The current version of the AHP can accommodate both these schools—its ideal mode preserves rank, while its distributive mode allows the ranks to change. Either mode is selected according to the problem at hand.

Rank reversal and the AHP are extensively discussed in a 2001 paper in *Operations Research* Forman (2001), as well as a chapter entitled *Rank Preservation and Reversal*, in the current basic book on AHP (Saaty, Thomas L. 2001). The latter presents published examples of rank reversal due to adding copies and near copies of an alternative, due to intransitivity of decision rules, due to adding phantom and decoy alternatives, and due to the switching

phenomenon in utility functions. It also discusses the Distributive and Ideal Modes of the AHP.

6.7 Conclusion

In the former part of this chapter, mainly about 14 independent risk assessment methods are discussed, as strategic scanning, worst-case analysis, interval analysis, fuzzy arithmetic, sensitivity analysis, artificial neural network (ANN), bootstrapping, Monte Carlo simulation, probability boxes, NPI, Frequentis confidence method, Bayesian method, matrix model and many methods from federal government of USA.

In the second part, some hybrid methods are discussed. As someone argue that one single method maybe weak and too simple to assess the risk in complex and big projects or organizations. Some hybrid methods like FMEA – FTA, FETI-HAZOP-FTA , HAZID - ETA , HAZOP – FTA –ETA were summarized by Silvianita(2011); what is more, NPI-Bayes hybrid, SWOT-ANP and other integrated methods.

The third part focuses on the arguments and comments on different risk assessment method. It is sure that every method has two sides, like a coin. The main arguments in the choosing risk assessment method are as the following: explicit probabilities and magnitudes of losses expressed quantitatively Vs using surrogate verbal or ordinal scales, qualitative or quantitative, more subjective or more objective, more on individually or more on collectively.

In the fourth part, AHP and ANP were introduced in detail, from the history, concept operation process to the weak points. Because of the many theory researches and much practice in China, AHP and ANP method are very welcome and popular in China compared with other countries.

Through the discussion, some summaries can be drawn as the following points.

- There are thousands of risk assessment methods all over the world.
- There is no universal and all-agreed risk assessment for any projects or organization.
- Risk assessment method choosing may depend on the nature of the risks, character of the organization, attitude and ability of the participants, investment on risk assessment (including capital, time and energy invested) and other external or internal factors.
- Risk assessment is absolutely not an automatic and mechanical processes, judgment from experts are necessary anytime.

For the risk assessment of Chinese air cargo industry, ANP is a scientific, reasonable and practical method. Firstly because of the character of this research, it is a doctor candidate research which is based on my working experience. It is easy for me to find the experts within air cargo industry to be interviewed in the process of risk assessment. Secondly, it is impossible for me to invest much money and time on this research work, and using more complex and integrated methods is difficult. Thirdly, according to the nature of risk in Chinese air cargo industry, it is impossible to find the exact and accurate risk occurrence probability. From the point of consequence of risk, we can compare and image the consequence, but it is impossible to forecast the exact loss for any risks. ANP method can produce a ranking for the risks through the comparison from experts, it will be helpful for the decision making on how to deal with and control the risks.

Experts' judgment and suggestion are indispensable and complementary in risk assessment, including ANP method. Firstly, scientific data may not speak for themselves and the process requires careful interpretation. Secondly, scientific data may seem conflicting or inconsistent and it needs judgmental synthesis. Thirdly, in the absence of data, assumptions are necessary and it requires judgment about plausibility of assumptions; finally, choice of and/or construction of models may require judgments that are beyond the expertise of the risk assessor. (Ulf G..Ahlborg, 1996)

Chapter 7 Risk Assessment Implementation and Result Analysis

7.1 Introduction and Preparation

More than 10 risk assessment methods and several hybrid integrated methods have been studied and analyzed in chapter 6. Considering the research investment budget, individual working network and experience, time and energy, the nature of the risks and the other factors, ANP method is scientific and practical for this research. In this part, firstly it tries to build the network model using personal working experience and meeting with other experts. The most difficult and time and energy exhausting work of this research is the expert interview. Totally there are 20 experts from air cargo industry as the candidates for interview. There are two steps in the process of interview, risk factors explaining and risk factor comparison in questionnaire. The experts will try to give their value number according to the rule set in advance. Once the questionnaires are collected, the data will be input into the Superdecion software which was invented by the author of ANP method, Satty and Thomas. With the software, much time and computation can be saved. In case of the sound data and reasonable results, all the result will be analyzed in the final part. The purpose of this part is to support the decision making of chapter 8 through the risk assessment implementation.

The preparation consists three main parts, searching experts, designing questionnaires and downloading software. The experts are from managers within air cargo industry, professors from university and directors in government. Firstly I will list more than 30 experts candidates with contact information, then contact with everyone to be sure that they are interesting for this questionnaire interview and they have time to do it. The second preparation is to design the questionnaire which is based on the principle of

ANP method and identified risks. Superdecision is one practical and useful calculating tool for ANP method, while the download and use must under the agreement of the author. Once you get the permission to use it, normally the approved use period is one month.

7.2 Network Model Building

7.2.1 Goal Setting

Goal setting is the first step of hierarchy building in AHP method and network building in ANP method. The goal must be accurate and clear for the candidate experts. At the same time, there must be the common sense of the meaning of goal between author and experts. In this network building, the goal is Chinese air cargo industry risk assessment based on the identified risk factors.

7.2.2 Criteria Setting

In most risk assessment process, likelihood (probability) and impact (consequence) are two basic criteria. From the definition of risk in the former chapter, risk can be defined directly by the multiplying of likelihood and impact. While besides two criteria of likelihood and impact, controllability and transference (shift) are also important criteria. Some risks are easily transferred into other kinds of risks, and this is the character of transference or risk shift. In this research, likelihood and impact are obviously two key criteria. While for Chinese air cargo industry, the aim of risk management is not only to understand and assess the likelihood and impact, but also to control the risk and take some risk dealing with measures. Here based on my own working experience and collective discussion with experts, likelihood, impact and controllability are three criteria in the network building.

According to the risk criteria of Deakin University (<http://www.deakin.edu.au/fbsd/risk/criteria.pdf>), three criteria can be

summarized as in table 7.1. Likelihood and impact can be classified into five rating, and controllability can be classified into six rating. Normally in ANP method, there are 9 rating for each criterion under the comparison between any two criteria to show which one is more important.

Table 7. 1 Three risk criteria measuring

Likelihood(probability)	Impact(Consequence)	Controllability(control rating)
Almost certain	Catastrophic	Excellent
Likely	Major	Very good
Possible	Severe	Good
Rare	Modest	Medium
Almost impossible	Minor	poor
		No controls

Source: summarized according to Deakin University

To compare the importance among three criteria, the experts should compare any two criteria as in Appendix 2. And the data will be input into Superdecision software. According to the request of ANP method, the opinion of experts can be valued with number from 1 to 9, and 1 means that two factors are equal; 9 means that one factor is totally and absolutely important than another one.

7.2.3 Risks for Assessment and Network Building

Based on the identified risks in table 4.8, there are 4 first layer risks and 19 second layer risks. According to principle of ANP method, there are connections among these risks, and the risks can not be built into hierarchy model.

Considering the works in chapter 4 and chapter 5, the rule of ANP method, the network model is built as in figure 7.1. The control layer consists of the objective of this model and the criteria (likelihood, impact and uncontrollability), and the network layer consists of 4 first layer risks and 19 second layer risks. For the R_1 , R_2 , R_3 and R_4 , they are connected and interacted in the form of

network. Within R_1 , R_2 , R_3 and R_4 , the second layer risk are connected and interacted also in the form of network. Among the four risks, they are inter-influential each other, finance risk can influence other three risks, and be influenced by them too. And within each risk, for example for R_1 , four risk factors (R_{11} , R_{12} , R_{13} , and R_{14}) are inter-influenced. This is the difference between AHP and ANP, in AHP, the risks are independent, while in ANP, the risks are dependent each other. In reality, finance risk must have influence to strategic risk, so ANP is more general and universal compared to AHP. Because of the spreading character of risks, all the risks identified are in the form of network.

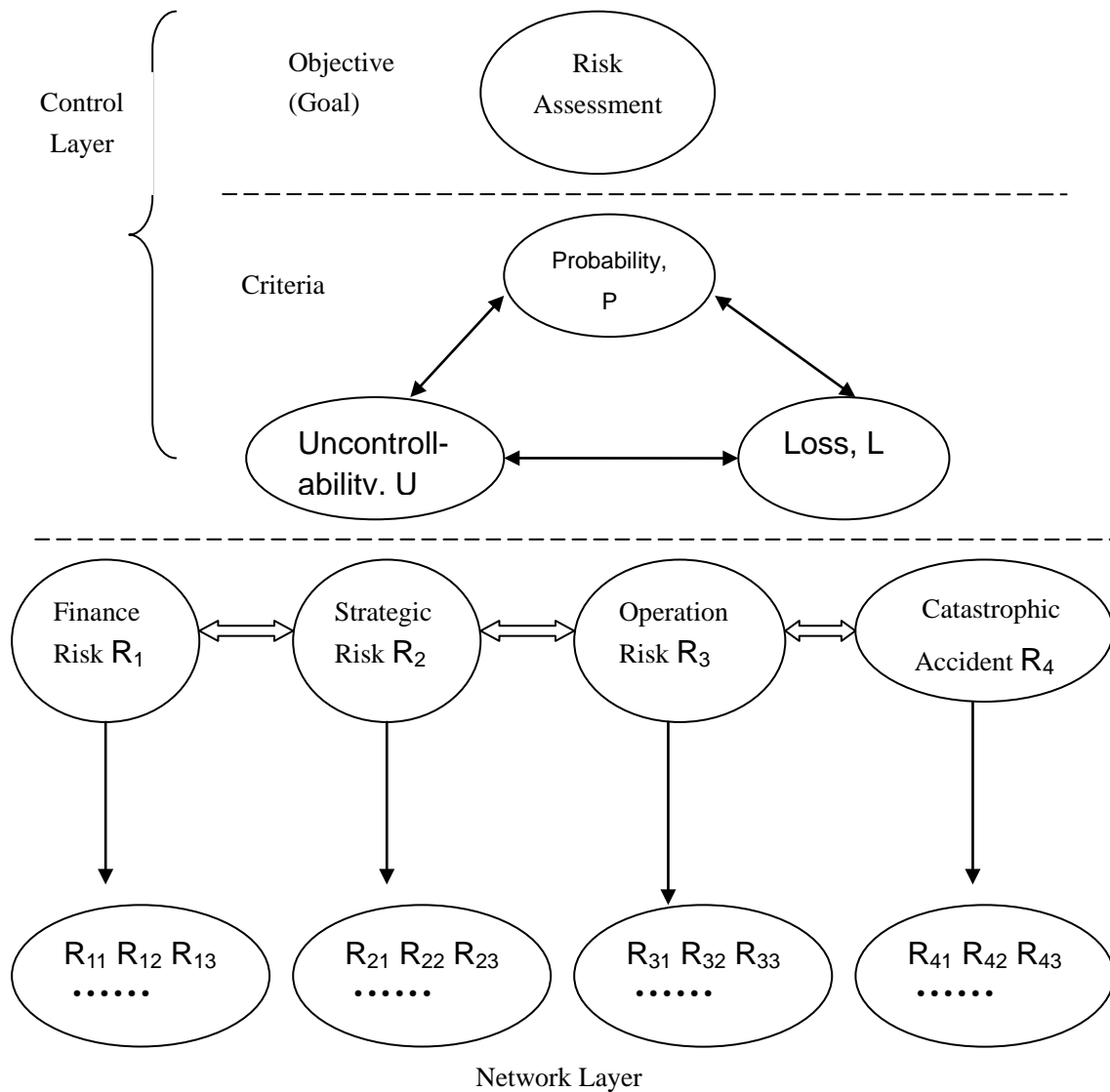


Figure 7. 1 ANP model of this research

7.3 Priorities Establishing and Inconsistency Check

7.3.1 Data Collection

Because of the experts brainstorm in the process of risk identification, I have created the close relationship with these experts. And these experts are family with the main content and topic of this research. In this assessment process, I have interviewed 20 experts and the interview consists of two parts. Firstly, I would explain the purpose of this interview, and then explain the questionnaires (as in Appendix 2) to be sure that they can understand all the details correctly. Finally the questionnaires were collected and the data were analyzed, 3 questionnaires are invalid. In all, there are 17 questionnaires from 17 experts for the data input. It assumes that the 17 experts have the same weight during the risk assessment process. All their judging numbers will be averaged, and then the averaged number will be put into the software.

Thanks to the efforts of Saaty, Thomas L and Brady Cillo (2009), they created the software to do this exhausting job. After registering in the website (<http://www.superdecisions.com/>), this research got the authorization to use this software Super Decision. Through the calculating of judging matrixes, one evaluating table was got to show the importance of different risks. Based on the importance of the 17 experts, each expert will be given a weight for his(her) evaluation, finally the five evaluation results will be weighted and averaged.

7.3.2 Superdecision Software

The Super Decisions software is used for decision-making with dependence and feedback. It implements the Analytic Hierarchy Process, AHP, and the Analytic Network Process, ANP. Both use the same fundamental prioritization process based on deriving priorities by making judgments on pairs of elements, or obtaining priorities by normalizing direct measurements. In the AHP the decision elements are arranged in a hierarchic decision structure from the goal

to the criteria to the alternatives of choice, while in the ANP the decision elements are grouped in clusters, one of which contains the alternatives, which the others contain the criteria, or stakeholders or other decision elements. In the ANP there is not a specific goal element, rather the priorities are determined in a relative framework of influences and the prioritization of the alternatives is implicitly understood to be with respect to whatever the network is about: the decision concern. The clusters are arranged into a network with links among the elements, or sometimes into multiple tiers of elements such as when a problem is decomposed into Benefits, Opportunities, Costs and Risks. Most decision-making methods including the AHP assume independence: between the criteria and the alternatives, or among the criteria or among the alternatives. The ANP is not limited by such assumptions. It allows for all possible and potential dependencies.

The ANP does not limit human understanding and experience to force decision-making into a highly technical model that is unnatural and contrived. It is in essence a formalization of how people usually think, and it helps the decision-maker keep track of the process as the complexity of the problem and the diversity of its factors increase. The best testimony of the power and success of the ANP are those applications that have been done that derived priorities that corresponded with known answers in the real world or that have predicted outcomes. From that perspective it is a reliable and objective approach for making decisions based on priorities and importance with which one has had experience. It is rather different than making guesses about the probabilities of occurrence as some decision-making methods would have you do. (<http://www.superdecisions.com/super-decisions-intro/>)

It can be downloaded after registration, and you will get one series number. After installation, and putting into the series number, we can use it based on the collected data. While the permission period for using is only one week or a little longer, once it is expired, we need to get new series number again.

As explained in ANP principle, for every judging matrix, the inconsistency

index must less than 0.1, other wise the judging matrix will be regarded as invalid. As showed in the result figure, the entire inconsistency indexes are less than 0.1. So the judging matrixes from experts are valid.

7.4 Risk Assessment Result Producing

7.4.1 ANP Model Building with Superdecision software

As in figure 7.2, the model is built as the guidance from superdecision software. Firstly the goal will be set as risk assessment, and here the cluster is goal and the node is risk assessment. Secondly, the criteria are risk probability, consequence and uncontrollability, and here the cluster is criteria and the notes are probability, consequence and uncontrollability. Thirdly, the alternatives are financial risk, strategic risk, operational risk and catastrophic risk. Fourthly, every node in cluster of alternative will have some sub-layer risks, as four risks within financial risk, 7 risks in strategic risk, 4 risks within operational risk and 4 risks within catastrophic risk.

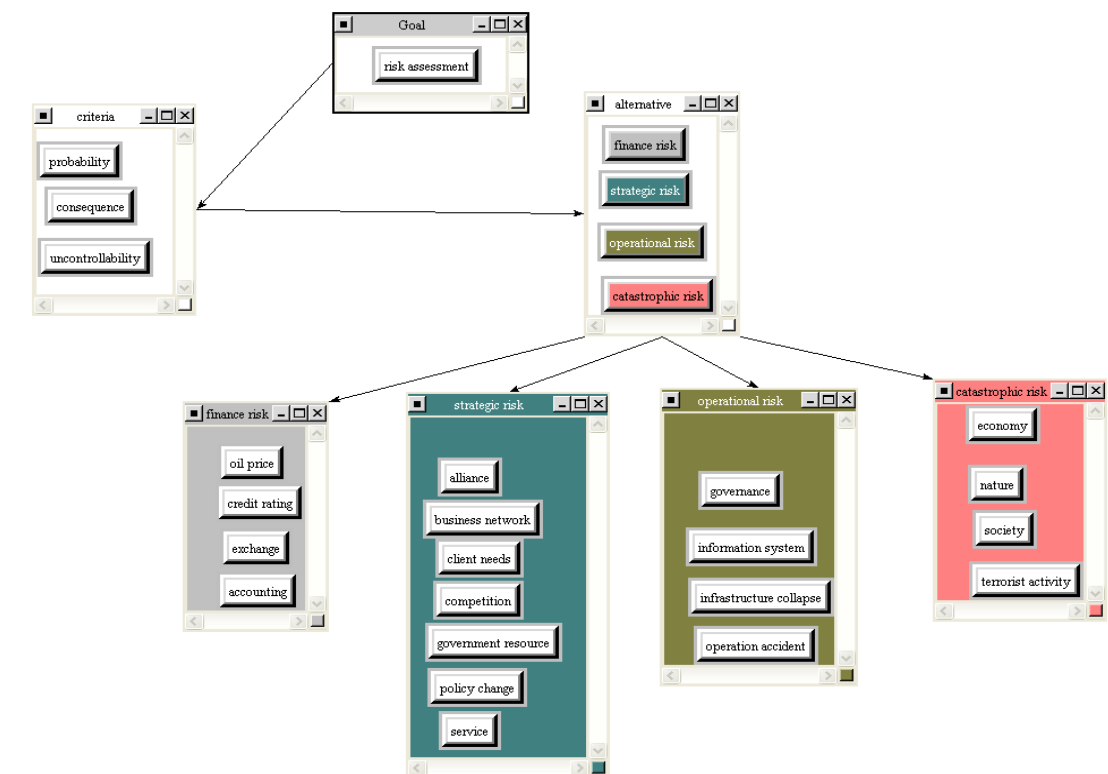


Figure 7. 2 Model Building in Superdecision software

7.4.2 Every Step Results

With respect to risk assessment, the experts averaged judging data are put into the software. As in figure 7.3, the inconsistency is 0.05155, less than 0.1. so the data are valid. The weight of consequence is 0.52784, and the weight of probability is 0.33252. This means that, most of the experts think the risk consequence is the most important factor compared with other two factors. In another words, the risk can happen often and although these risks can not be controlled, while the consequence is critical for the participants.

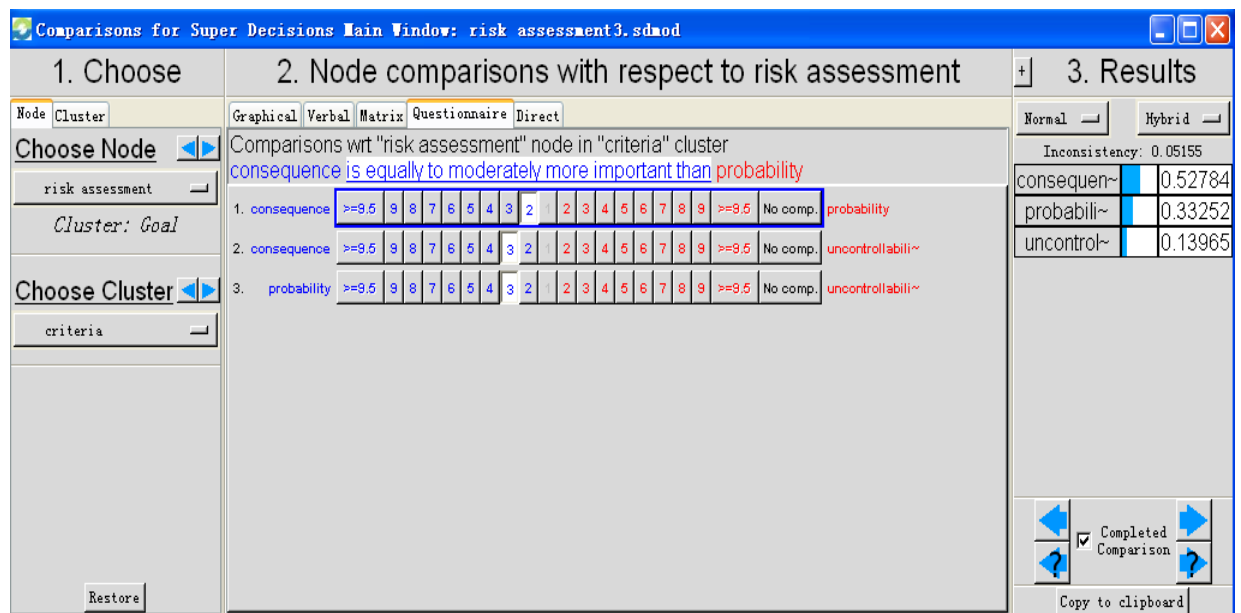


Figure 7. 3 Result and node comparisons under risk assessment

With respect to consequence, the judging matrix and the results are in figure 7.4; it means that strategic risk will have most heavy or influential consequence for Chinese air cargo industry. And financial risk also will have heavy influence on Chinese air cargo industry. Catastrophic risk no doubt can have huge consequence on all the whole society, while because of the comprehensive and perfect insurance in practice, the participants do not care too much for the loss caused by catastrophic risks, such as nature disasters. Taking the 7 risk factors within strategic risk into consideration, most of them are intangible. Intangible risk will be more risky for people.

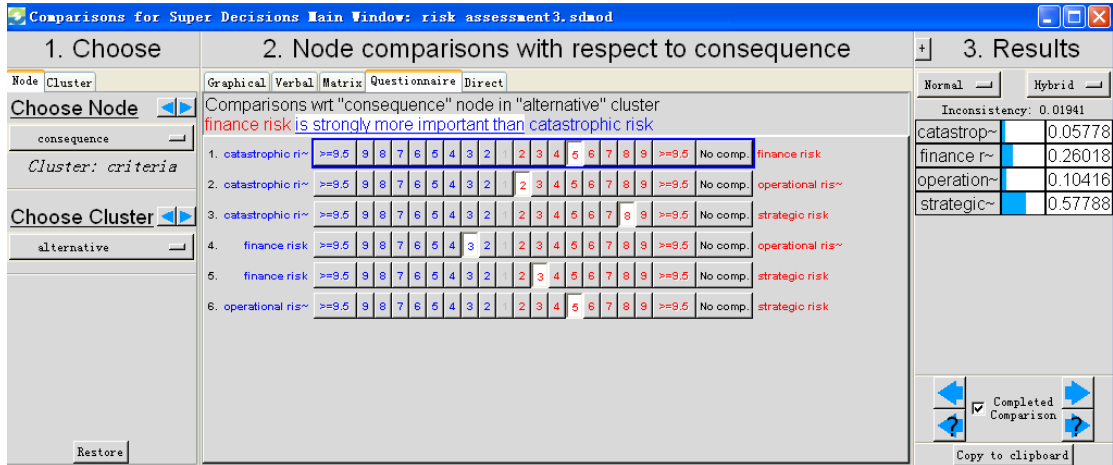


Figure 7. 4 Result and node comparisons under consequence

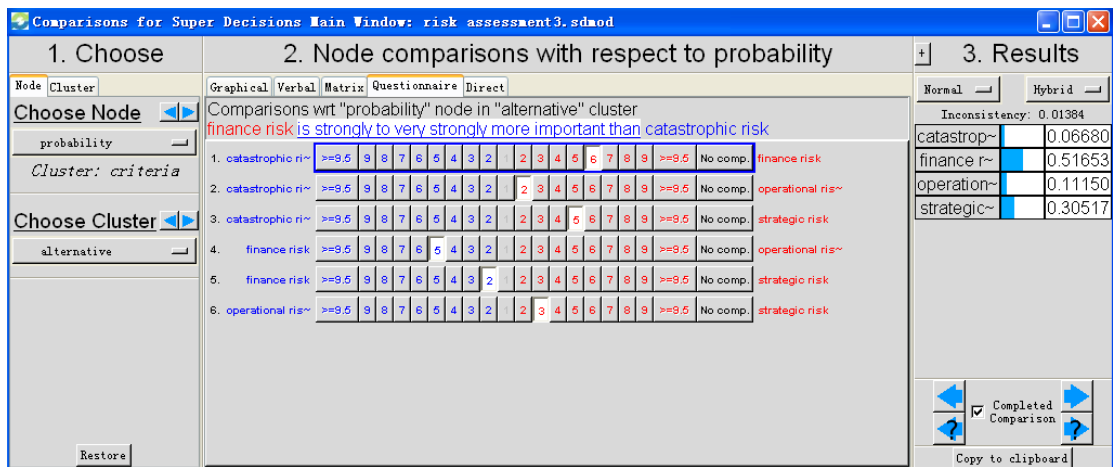


Figure 7. 5 Result and node comparisons under probability

With respect to the risk probability, the experts will compare these nodes of four risks. The 17 averaged data were input into software as in figure, and it shows that financial risk has the highest occurrence rate. Catastrophic risk does not happen often contrasted with other three risks. The inconsistency index is 0.01384 less than 0.1 which shows the valid data input.

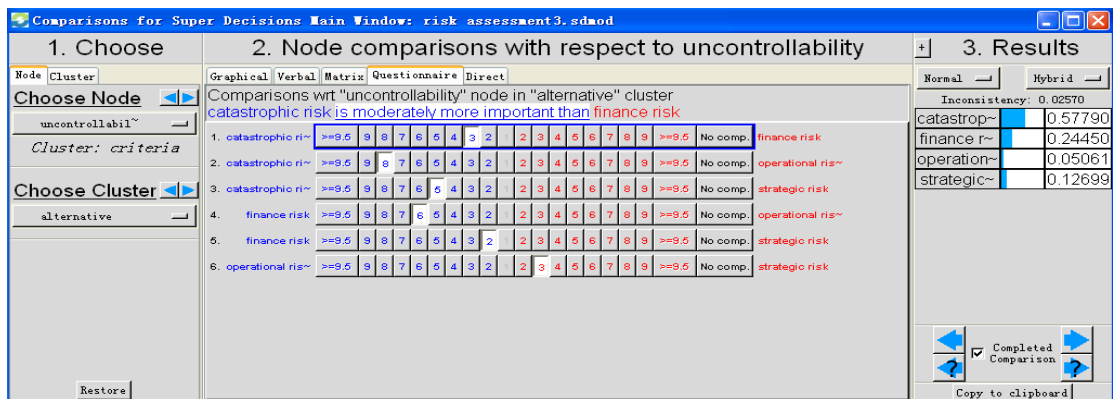


Figure 7. 6 Result and node comparisons under uncontrollability

With respect to risk uncontrollability, as the figure 7.6 of result showing, we can not control catastrophic risk easily, because most of the catastrophic risks are natural and beyond human control. On the other side, operational accident risks are processing risks and we can control them through international standards and proper governance. Also we can not easily control financial risks, as oil price and exchange rate are influenced by many international factors.

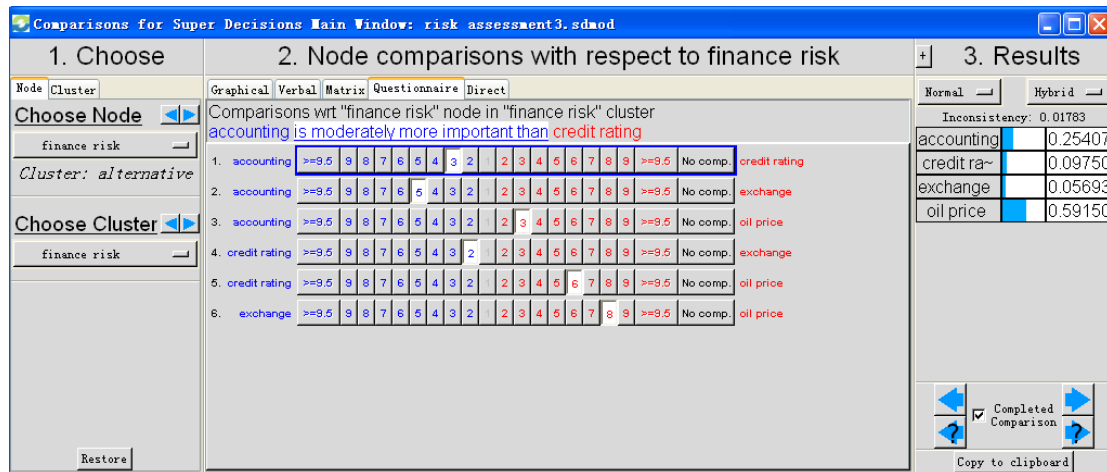


Figure 7. 7 Result and node comparisons under financial risk

With respect to financial risk, there are four risks to be compared. As figure 7.8 showing, according to the valid data (0.01783 less than 0.1), the ranking order from high to low are oil price, accounting, credit rate. Oil price is one risky and key risk factor which can cause huge costs and benefit loss. Exchange does not catch the care from experts. In the practical working, all the dealers will set regulation on the exchange fluctuation and share the loss or benefit caused by exchange.



Figure 7. 8 Result and node comparisons under catastrophic risk

Catastrophic risks always catch great attention because of the media and propaganda. The terrorist activities always make great panic and unrest in the society and industry, while in Chinese air cargo industry, it is not so important. Firstly, terrorist activity is not popular because of the strong government and stable political condition. Secondly, for the airlines, the main terrorist activities are focusing on passengers and aircrafts, air cargo is not the objective. Society risk and economy risk can damage Chinese air cargo industry greatly. Just before this research finishing, the H7N9 virus is spreading in China. It will influence Chinese air cargo from the following points, such as strict check on meat and food, poultry ban, most strict security check and so on.

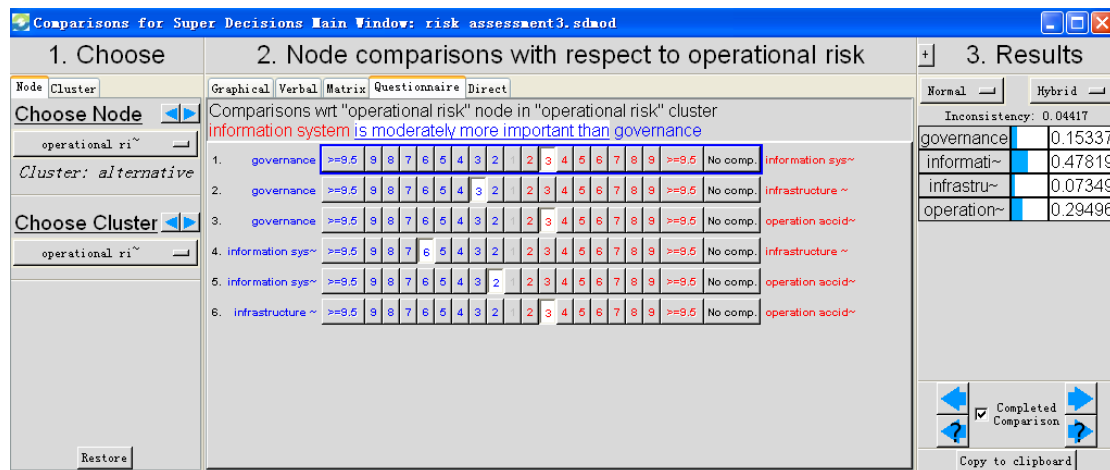


Figure 7. 9 Result and node comparisons under operational risk

With respect to operational risk, as in figure 7.10, the compared nodes are governance, information system, infrastructure collapses and operation accidents. Based on the valid data (0.04417 less than 0.1), information system is most risky and is regarded as the key issue in Chinese air cargo industry. With the information technology development, almost all the participants, such as forwarders, carriers, shippers and governments, have their website and management information system. Through the website, they can operate and manage the business well, and they can connect with other partners. There are several critical barriers which can damage this industry. First barrier is data standardization. Although there is IATA standard in Chinese air cargo industry, there are still much data which can not match smoothly. The second barrier is

data confidential. Many forwarders and carriers would not open their data because of the competition, and this will bring monopoly advantage for them and cause damage for the whole industry. The third barrier is shortage of united platform. If there is one united and security platform which can connect all the information systems, this will bring overall optimization. The experts agree that infrastructure collapse would not happen because of many reasons.

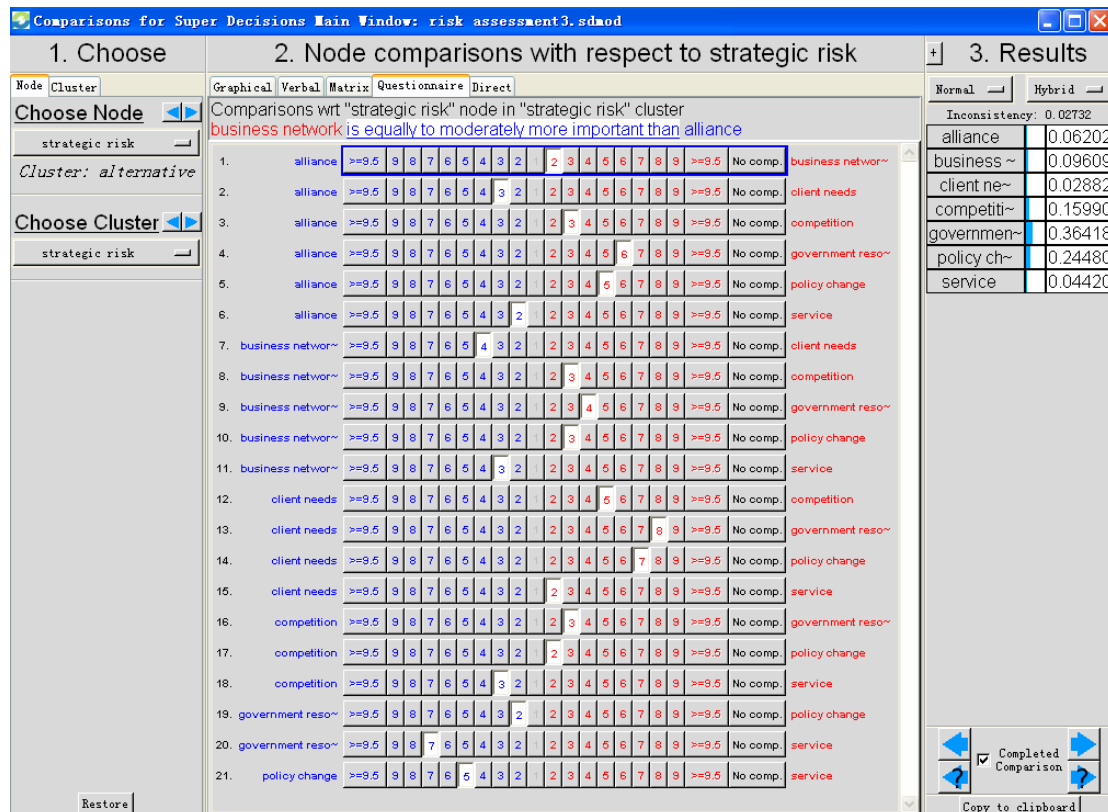


Figure 7. 10 Result and node comparisons under strategic risk

With respect to strategic risk, 7 nodes (risks) are compared by experts. As in figure 7.11, the valid data show that government resource, policy change, competition and business network are four more important risks. According to the Chinese five-year budget and plan, there will be more than 100 branch and regional airport to be finished. No doubt there will be air cargo increasing because of the stable economy growth and stable political government. For the airlines or carriers, they have to build good relation with government to get better flight schedule, license, and good service from airports. For the forwarders, they have to understand well the custom regulations and build alliance with airports to get warehouse and ground handling license.

Policy change will influence all the participants within Chinese air cargo industry. Export tax rebate policy change will influence cargo volume, price and whole business. For the shippers or clients, the service consists of price, time and security. So the service within Chinese air cargo industry is a processing and standard issue.

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Here are the priorities.

Icon	Name	Normalized by Cluster	Limiting
No Icon	catastrophic risk	0.13342	0.044472
No Icon	finance risk	0.34323	0.114410
No Icon	operational risk	0.09912	0.033041
No Icon	strategic risk	0.42423	0.141411
No Icon	economy	0.26480	0.011776
No Icon	nature	0.11828	0.005260
No Icon	society	0.54681	0.024317
No Icon	terrorist activity	0.07011	0.003118
No Icon	consequence	0.52784	0.175945
No Icon	probability	0.33252	0.110839
No Icon	uncontrollability	0.13965	0.046549
No Icon	accounting	0.25407	0.029068
No Icon	credit rating	0.09750	0.011155
No Icon	exchange	0.05693	0.006513
No Icon	oil price	0.59150	0.067673
No Icon	risk assessment	0.00000	0.000000
No Icon	governance	0.15335	0.005067
No Icon	information system	0.47819	0.015800
No Icon	infrastructure collapse	0.07348	0.002428
No Icon	operation accident	0.29497	0.009746
No Icon	alliance	0.06202	0.008770
No Icon	business network	0.09610	0.013589
No Icon	client needs	0.02882	0.004075
No Icon	competition	0.15990	0.022612
No Icon	government resource	0.36418	0.051499
No Icon	policy change	0.24480	0.034617
No Icon	policy change	0.24480	0.034617
No Icon	service	0.04420	0.006250

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Figure 7. 11 Priorities overall for all the risks

Figure 7.12 shows the priorities of all the risks, after ranking and summarizing, table can show more clearly the ranking order and priorities.

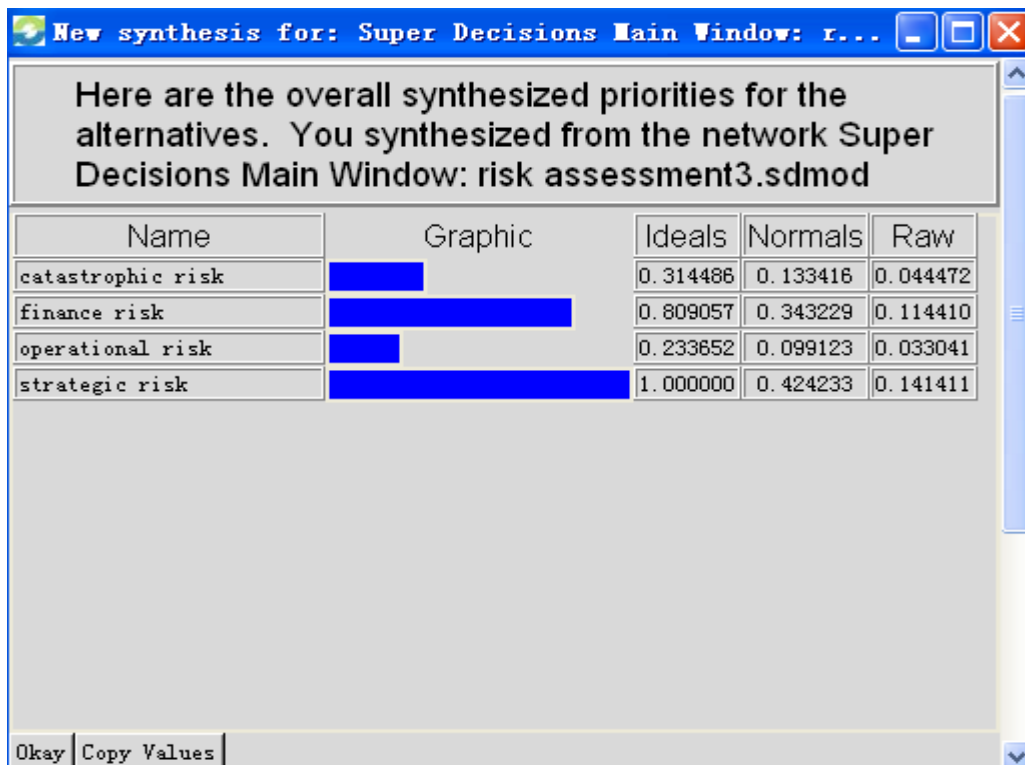


Figure 7. 12 Synthesized priorities for four risks

Figure 7.13 is the final result according to objective of ANP. The objective is to choose one project or proposal based on the criteria and judging matrix. While in this research, the priorities result has more meaning and significance for Chinese air cargo industry. All the risk counter measures are facing the detailed 19 factors.

Table 7. 2 Overall Priorities

risk	rank	risk	rank	rank
Catastrophic Risk	3	Economy	2	9
		Nature	3	15
		Society	1	5
		Terrorist activity	4	18
Financial risk	2	Accounting	2	4
		Credit rating	3	10
		exchange	4	13
		Oil price	1	1
Operational risk	4	governance	3	16
		Information system	1	7
		Infrastructure collapse	4	19
		Operation accident	2	11
Strategic risk	1	alliance	5	12
		Business network	4	8
		Client needs	7	17
		competition	3	6
		Government resource	1	2
		Policy change	2	3
		service	6	14

As in table 7.2, 19 risk factors are classified into three categories, red color means the highest risky and most important risks; yellow color means the medium and moderate risk and important; the white color means the normal and ordinary risk.

The top 7 risks are oil price, government resource, policy change, accounting, society, and competition and information system.

Oil has been discussed in the former chapters, and it accounts for about 40% of all the cost of carriers. It is so important for air cargo industry because of the

following reasons. Oil is one limited natural resource which can be used for only about 50 years in the world according to the World Bank Report. The oil price fluctuation can cause great loss and uncertainty for air cargo industry. With high and fluctuating oil price, it can increase the cost and at the same time decrease the demand. In China, more and more cars and trucks will consume more and more oil, and the oil will be less and less, although there are some small new oilfields.

Government resource is regarded as the second important risk based on the assessment. In China, all the airports are state-owned and most of the carriers are state-owned or state-controlled. For international air cargo business, custom will play important role in the process. In all, for all the participants within Chinese air cargo industry, they should have good resource from government, and communicate smoothly with government.

Policy change consists of international policy change, domestic policy change, tax policy change and local and regional policy change. The policy change can influence air cargo industry from both negative and active aspects.

Because of the world recent financial crisis starting from 2007, shippers, forwarders and carriers have to decrease cost as possible and make full use of every coin. It is more and more difficult for companies to get loan from banks and the loan rate is becoming higher and higher, even usury. Accounting risk is especially important for Chinese air cargo industry during the recent years.

7.5 Result Analysis

7.5.1 Strategic risk analysis

In the first layer, there are four risks, according to the risk assessment result, strategic risk is considered be most important and most dangerous. According to the literature review in this research, many on spot workers and managers are not familiar with strategic risk. For most of them, strategic risk is vague and abstract. In the interview with staffs within air cargo industry, most of them

think strategic can not be measured and checked in their working. Maybe this is the reason why strategic risk is so important and dangerous. Through the part of risk identification, strategic risk consists of seven second level risks, alliance, business network, client needs, competition, government, policy change and service. Turning back to the concept of strategic risk, it is about the strategic direction of one organization or industry. For most of the Chinese companies, they are becoming more and more understanding well the meaning of strategy, and they correspondingly pay more and more attention to the strategy management. Based on the literature reviews of this research and the interviews with practitioners within Chinese airlines, there still big gap between strategy management and strategic risk practice, and the gap is mainly in the ideology of managers, and it is also for Chinese researchers. Strategic risks can be life and death matter for Chinese airlines.

As disused previously, any risk will have stakeholders connected with their own benefit and risks. Strategic risk also is very vital for Chinese government. In China, Civil Aviation Administration of China (CAAC) is the central leading government organization responsible for all the matters connected with aircrafts. Everyone has witnessed the development of Chinese economy and society, and in most cases, this development will continue. As one of the engineers and barometers of economy, air cargo will continue to be the key concern of CAAC. With no doubt, strategic risk must and will be the key political matter. The question now is how to make government know the importance of strategic risks and how to improve the strategic risk management level.

From the nature of air cargo in China, banks have important influence on this industry. Forwarders or clients in most cases are borrowing capital from the bank. The worsening or better development of air cargo industry will decide the living or dying of banks. For banks, one of the good solutions is to set a scanner to scan the risk level of air cargo industry, if it is possible, it can scan all the customers or clients.

There are other stakeholders of air cargo industry connected with strategic risk, such as local Chinese government, airports companies, railway transportation organizations, and so on. In all, every stakeholder must pay all their attention to strategic, then to understand, know, manage and control it.

7.5.2 Financial risk analysis

From the theory point, finance can be regarded as macro economy matters, such as the banks, invest banks, IPO, currency, change rate and so on; it also can be considered to be micro matters which are concerning with accounting of one company, debts, mortgage and so on. From the nature of air cargo industry and combined with interviews with staffs and experts within air cargo industry, there are four important issues concerned with finance, accounting, credit rating, exchange and oil price fluctuation.

Financial risk is regarded as the second important risk factor in this research. As discussed previously, risk identification and assessment result is always decided by research method, experts in interview and times. In this research, one of the main reason choosing financial risk as the second important risk is the dangerous and lengthy financial risk from 2007 all over the world. It is agreed that financial risk is one must part of economy crisis. From the financial risk starting in America in 2007, it gradually evolved into economy risk which has been spread most of the world, especially the developed countries. In this wave of economy risk, China is regarded as one exception because of the high and stable economy growth. While in Chinese air cargo industry, it is now true. From the data from Chinese customs, the growth of Chinese export and import has been decreasing from 2008 to now. It is the same developing track for Chinese air cargo industry.

In all, financial issue is the key and vital factor for economy development, it will influence the air cargo demand, at the same time, and it will influence the healthy operation of organizations within air cargo industry.

It is easy to be confused between Chinese bank benefit with the financial risk within air cargo industry. In these years, the benefit of banking is like a rocket; all the banks can earn much of money. This is because of the Chinese special economy structure and monopoly policy for banks. Chinese banks earn through the low deposit rate and not through high loan rate.

7.5.3 Catastrophic risk

One of the important characters of catastrophic risk is the randomness. This year it is calm and peace, maybe next year, it will cause great damage through economy crisis, nature disasters, society movement and terrorist activities.

Just before I finish this writing of research, most parts in China suffer from historic high temperature, super drought and serious floods. The highest land temperature of Pudong airport arrives 60degrees Fahrenheit. No one or any organization has forecasted this historic nature disaster this year in China. With no doubt, it will cause great damage for Chinese air cargo industry.

The most obvious and serious character of catastrophic risk is its uncontrollability and unpredictability. It is easy to make weather forecast, but it is really difficult to predict earthquake, flood, tsunami and other natural disasters. Without forecasting, it is really difficult to control these risks. Only for earth quake, maybe we can reduce the damage through some little useful measures, like strong and safety house and so on. While for Chinese air cargo industry, it is really impossible to counter economy fluctuation, natural disasters, social great activities and terrorist activities.

For the government, catastrophic risk is one great issue to be solved under the political pressure. In most cases, the government takes measures to deal catastrophic risk because of the society reason, not because of their understanding from air cargo industry. Contrasted with the damage of air cargo industry caused by catastrophic risk, the society damage is more great and serious.

7.5.4 Operational risk

The reason why operational risk is regarded as the fourth important risk factors maybe most of the interviewees and managers think that they are familiar with operational work and it is easy to predict and control. In the operational level, there are marketing, human resource management, sales management, information system and other activities. In this research, through the risk identification process, only four important risk factors are identified to be the second layer risks, governance, information system, and infrastructure collapse and operation accident.

In general, operation risk is regarded as one risk factor which is internal and connected with on spot workers and managers. Central or local governments do not care the operational risk within air cargo industry.

7.6 Conclusion

Chapter 6 has produced ANP method for this research, and this chapter aims to produce a scientific and reasonable result. Because of the practice of risk identification, the author has a close relationship with most of the experts within Chinese air cargo industry. 20 experts were chosen as the interviewees. Based on the 17 valid questionnaires and Superdecision software, risk assessment process produced all priorities for all the risk factors. According the result, consequence is regarded as more important than probability, and probability is more important than uncontrollability. For the four first layer risks, strategic risk is regarded as the most important risk which consists intangible and management risks. Operational risk is regarded as the fourth order.

19 risks are classified into three categories, red, yellow and white risks. For each kind of risks, all the participants can make risk counter decisions according to the assessment result. While because of the nature of risk, it is influenced by many external and internal factors, so the assessment process

should be done regularly as a scanning machine which can assess the risks from time to time.

Risk assessment is not the end for risk management for Chinese air cargo industry, the purpose of the risk assessment is to support the decision making and bring inferences, in chapter 8, it will discuss the risk counter options.

Chapter 8 Risk Control Options and Air Cargo Supply Chain

Electronic Platform (ACSCEP)

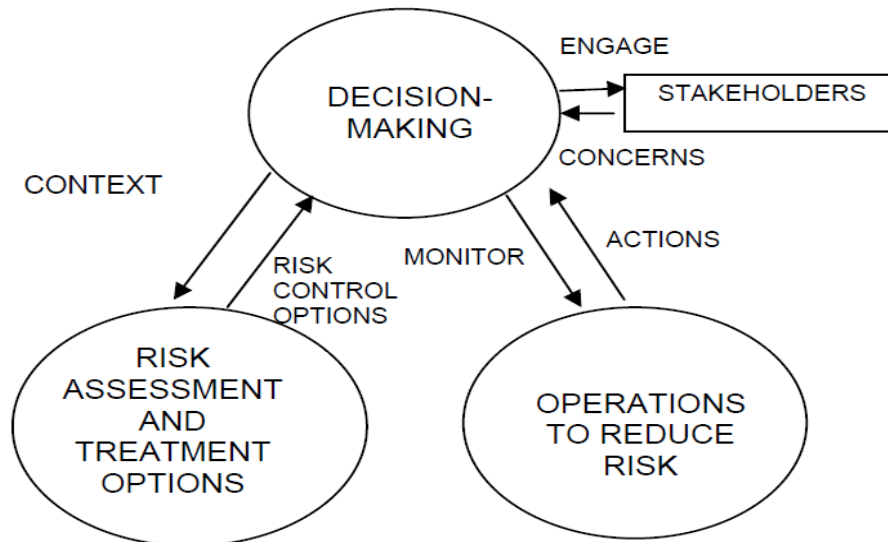
8.1 Introduction

Risk management is difficult and complex, it needs firstly focus on the research field, then to identify the risks; the objective is to do some decision making based on the risk assessment result. In chapter 7, 19 risks were classified into three kinds, red risks, yellow risks and white risks. For each participant and each, there should be some measures to counter risk, avoid risk or decrease risks. For forwarders, they can build alliance with carriers, do oil futures, and strengthen relationship with government and so on to deal with risks. In this chapter, risk decisions should be made under some principles.

I am the expert and board member in Ecargo platform and Ecargo is one practice of ACSCEP. Ecargo can counter many risks through integrated information system based on the IATA standard and Chinese government support. After the introduction of ACSCEP, it tries to find the solution for the risks identified.

8.2 General Risk Control Measures

According to John et al (2003), based on the risk assessment and operations to reduce risk, the stakeholders can engage in decision making, as in figure 8.1 showing. Stakeholders can make decisions and take some risk control options to reduce risks. In the business, some risk can be avoided or outsourced, like nature disasters risk using insurance; some risks should be managed through complex and intelligent risk management, like strategic risks.



Source John Shortreed, John Hicks, Lorraine Craig, 2003

Figure 8. 1 Risk decision model

In company or organization, generally decisions can be divided into three kinds of level, strategic decision making, tactical decision making and operational decision making, as in table 8.1. Strategic decision are concerning with important and key issues, such as goal, constraints and strategy management.

Table 8. 1 Decision making levels

Decision making level	Examples of decision making		
Strategic	Establishing/confirming goals, means, constraints, key risks, stakeholders and setting in context for tactical and sometimes operational decisions for each activity/project.		
Tactical	Choosing how to deploy the most appropriate means for attaining goals and managing tactical risks within the restraints set at strategic level.		
Operational	Implementing tactical choices and managing operational risks.		
Examples of decision makers			
Decision making	For the business	For the project	For the sub-project
Strategic	Non executive and executive senior management	Project sponsor	Project manager
Tactical	Middle management	Project manager	Sub-project management
Operational	Operations manager	Project team and suppliers	Sub-project team and suppliers

Source: BSI, 2000

In business reality, risk can be divided into subject and object. The subject is the people and organizations that carry out the business activity, and the

object is the risk source. The more microcosmic the risk, the more function the subject can affect on the object. In the microcosmic atmosphere, the subject can take some specific measures to control the risk. While the more macrocosmic the risk, the less influence the subject can have. In the macrocosmic environment, the subject can reduce the risk through buying insurance, security, data backup and so on. The relationship can be showed in the figure 8.2.

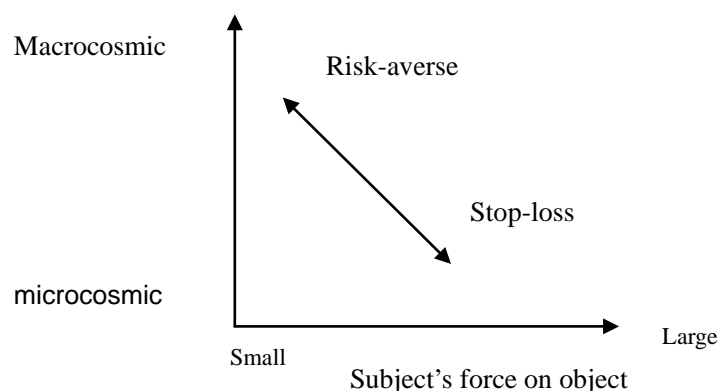


Figure 8. 2 Risk decision model according to environment

Risk control measure decisions are influenced by many factors, generally there are three kinds of factors, the subject who bear the risk, risk itself and the risk control mechanism and policy. As showed in figure . For the same risk, different subjects will have different feeling and understanding, and the risk decisions will decided by the knowledge, cognitive level, risk appetite and the purpose. Take the manager of a company as the example, his risk decision will influenced by his knowledge, risk appetite and his power and aim in the company, maybe the moral hazard exists. For the risk itself, the risk decision will be influenced by the probability, loss, and controllability degree. As showed in figure 8.3, in the microcosmic situation, the decision makers can have more freedom to counter the risks. Within business environment, the government policy, financial mechanism and other government behavior can also influence the risk decisions. Under clear and strict government policy, the illegal risk will cause more loss and harm to the subject.

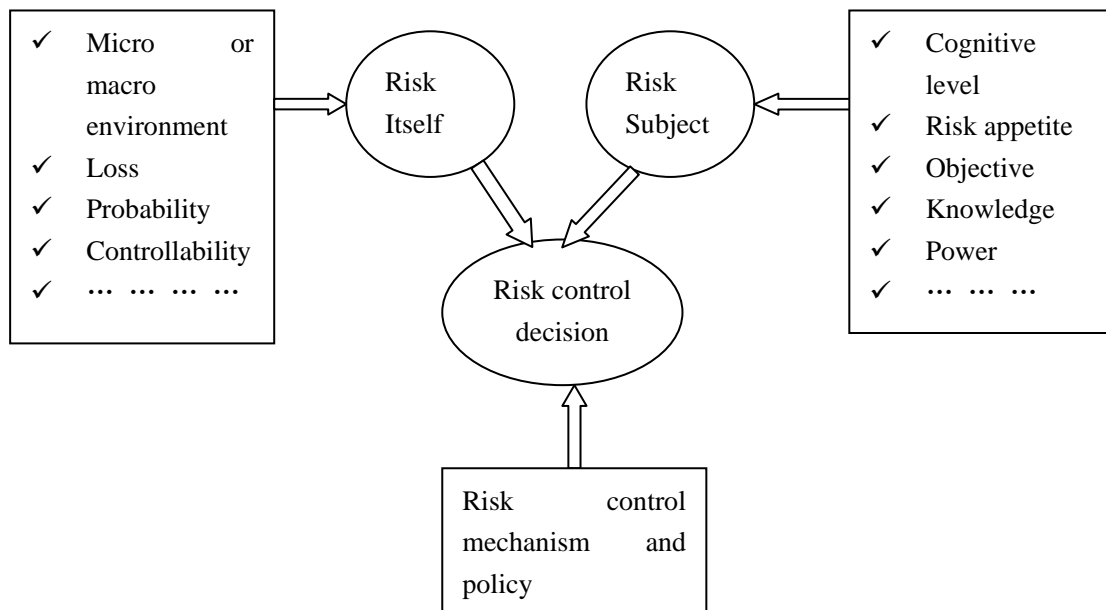


Figure 8. 3 Risk control decision mechanism model

In the charter five and charter six, air cargo supply chain risks in Shanghai have been identified and evaluated. We know that there are four kinds of general risks as finance risk, strategic risk, operation risk and catastrophic accident. Through the evaluation, we got the ranking of 19 detailed risks. The third step is to make decision for the identified risks. As discussed above in figure 8.3, in this research, we do not consider the risk subject factor, and this research proposed some guidance through the risk itself and risk control mechanism and policy. The proposed risk control measures were showed in table 8.2.

Table 8. 2 Risk contents

Risks	Proposed decision
finance risk	Government policy; company management; ACSCEP(Air cargo supply chain electronic platform)
strategic risk	Company management; ACSCEP
operation risk	Management integration; management skill and experience ; ACSCEP
catastrophic accident	Insurance; government policy

As in table 8.2, finance risks can be reduced through government finance policy, advanced management skill and proposed ACSCEP. For example,

government can improve the loan process and improve the credit amount through state-owned banks, and support incentive to the commercial banks. Part of the finance risks can be controlled by the advance management skill. For the strategic risks, they are long term and intangible, through the evaluation, the strategic risk is regarded as the highest risk. Firstly we need improve the strategy management level, and secondly one effective measure is to use ACSCEP. Although we know there are many catastrophic accidents in air cargo industry, through the evaluation, we know that many experts and managers do not worry more about the catastrophic accidents. The reason is that within the industry, there are many kinds of insurance and government protection for the force majeure. For the operation level, the risks can be controlled by the system optimization, more operation experience and management integration, and ACSCEP.

8.3 Air Cargo Supply Chain Electronic Platform in the World

8.3.1 World level platforms: GF-X、CPS、Ezycargo

Global Freight Exchange (GF-X) was founded in 1998 by IBM under the capital from 9 airlines, as Lufthansa German Airlines, American Airlines, Air France, Korean Air and Japan Airlines. This is the world first e-business platform in air cargo industry which can reserve positions, check process, and track condition and so on. In 2002, it has finished more than 600 thousands transactions, got 50 trillion dollar turnover and reserved 11 thousand lines. Later many big carriers and forwarder joined this platform, such as American air cargo, air cargo companies of the United Kingdom, Luxembourg air cargo company, Continental Airlines Cargo, Swiss air Cargo Company, the British Air Group (Exel), Dansuo Freight Group (AEL), Switzerland and Germany Motion Group (K & N), DHL Global express and so on. IBM proposed overall service on establishing, research, outsource and operation which can supply 24 hours and one week service for participants.

Based on the “forever position reservation” service in 2001, more and more air lines jointed into this united service, such as lines on Amsterdam, Brussels, London, Dubai, Hong Kong, New York, Chicago and so on.

Facing competition on international air cargo industry, in 2002, based on the support from Unisys, Cargo Portal Services(CPS) was founded by Canadian Maple Leaf Airlines, Austrian Airlines, KLM Royal Dutch Airlines, Northwest Airlines and United Airlines. It proposed cargo 2000 standard for the international air cargo. Every participant can benefit from IT service on logistics management, integration service, cargo e-tracking and so on. In 2004, CPS realized its reservation from system to system for the world air cargo business. In 2004, more than 500 forwarders joined into this system. In 2005, Continental Airlines Cargo Division and American Airlines Cargo Division joined into CPS.

In order to counter Europe and American platform, Ezycargo was founded by Hong Kong Cathay Pacific Airways Cargo Division, Japan Airlines Cargo, Australia Airlines Cargo and Singapore Airlines Cargo based on the technology support from CCN and GLSHK, which focuses on Asia air cargo market.

Three big heads are the leading international air cargo platforms in the world, while none of them has close business in Chinese air cargo industry.

(<http://www.travelskycargo.com/iportal/default.aspx>)

8.3.2 Company level platform

Air France Cargo-KLM Cargo is publishing all its air cargo rates on OAG Cargo's Air Freight Rates (AFRA) application, providing direct access to real-time rates and information and helping freight forwarders make the most informed buying decisions to over 144 markets worldwide.

AF-KLM Cargo has established a global interface to OAG Cargo which will see the publication of 800,000 active and future rates for freight forwarders

subscribing to AFRA. In addition to market rates, authorized AFRA users can also find promo rates and, when applicable, forwarders can find their own customer agreement rates.

Publishing all AF-KL Cargo rates, including promo rates and customer contracts, in AFRA supports its focus on online transparency for customers through the most efficient processes. This development is part of AF-KL Cargos broad scope of e-services, already offering a clear overview of online possibilities, like e-freight, e-booking, schedules and track and trace. AFRA is just one of the decision support tools offered by OAG Cargo that helps airlines, freight forwarders and logistics providers to optimize the planning of shipments based on extensive schedules and rates expertise, innovative technology, multi-media publishing and industry knowledge. OAG Cargo delivers solutions for routing and shipment planning, dangerous goods regulations, real-time air freight rates, aviation schedule data, operational announcements, tracking and analysis solutions and multi-media cargo schedule products.

Bart Jan Haasbeek, Global Sales Director of OAG Cargo, said: “Air France and KLM were among the launch users of AFRA in 2002. Their experience of the application has established AFRA as a business critical tool to disseminate rate information to customers. The new global interface will see all the latest rates for AF-KL Cargo uploaded into AFRA on a weekly basis. These rates are also bootable via AFRA’ s connections to cargo bookings portals, enabling Both the airlines and their customers to improve their operational and financial productivity.”

8.4 Air cargo supply chain electronic platform (ACSCEP)

8.4.1 Basic definition

Based on my working experience and many interviews with managers within air cargo industry, this research proposed one electronic platform to improve and control the risks in air cargo industry. This ACSCEP is supported by

globalization, international trade, IT technology, IATA regulation and practical industry need.

Here it is regarded as an electronic platform on which all the participants can share information and do transaction with more convenience and less cost.

In theory, Sung-chi Chu et al(2004) did a research on the 4th logistics party, in their book, they put the concept of 4th party into air cargo industry. In fact, only 4th logistics party is not enough for the development of air cargo industry, and one more comprehensive and broader platform is the real solution.

According to Grin (1998), the closer and more direct the relationship with end consumers, the more advantage it will have. In the ACSCEP, forwarders and carriers are as in the same zero distance with consignees or consigners.

8.4.2 The basic backup theory

Coordination theory

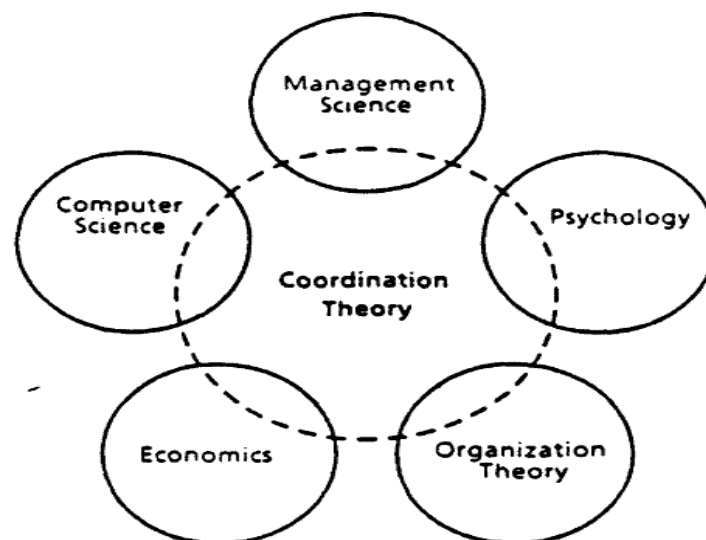
Currently, the process takes more time than needed due to a lack of coordination between freight forwarders and airlines.

The air transportation supply chain poses several challenges: the freight forwarders and the airline should be coordinated and respect each others' needs: the airline should be able to honor its allotted capacity, and the freight forwarder should know approximately how much capacity it will actually need and release unwanted space in a timely matter for the airline, such that the latter is able to add the extra space to the pool of capacity available for free sale. Andreea Popescu(2006)

Unfortunately, this is not the case. It is said that due to the lack of coordination between the airlines and the freight forwarders the traditional airline/freight forwarder team needs two to three times more time than an integrator (like e.g., FedEx) to move an international shipment. (Cargo management group, A., \International air freight and express industry performance analysis 2000," November 2000.)

<http://www.cargofacts.com/annualstudies/index.htm>.

Coordination theory has been developed in order to answer a basic question: how will the widespread use of IT change the ways people work together? Improvements in IT have significantly changed how information can be processed and communicated, which in turn has led to increased interest in the study of interdependencies between organizations. Also, coordination research seeks analogies in how coordination occurs in different environments and disciplines, whether in the fields of management, economics, information processing, or the natural sciences (Lewis and Talalayevsky, 1997). One important use for coordination theory will be in developing and using computer and communication systems to help people coordinate their activities in new ways (Malone, 1988). According to coordination theory, one key application is the information sharing among different parties. Within logistics industry, IT development provides the opportunity to redesign logistics practices in order to take advantage of IT-enabled organizational structures.



Source: Malone, 1988, p7

Figure 8. 4 Decision model of Malone

All the participants need the coordination relationship to do business in air cargo industry. And the ACSCEP has the basic coordination function among the stakeholders.

Logistics integration and parties

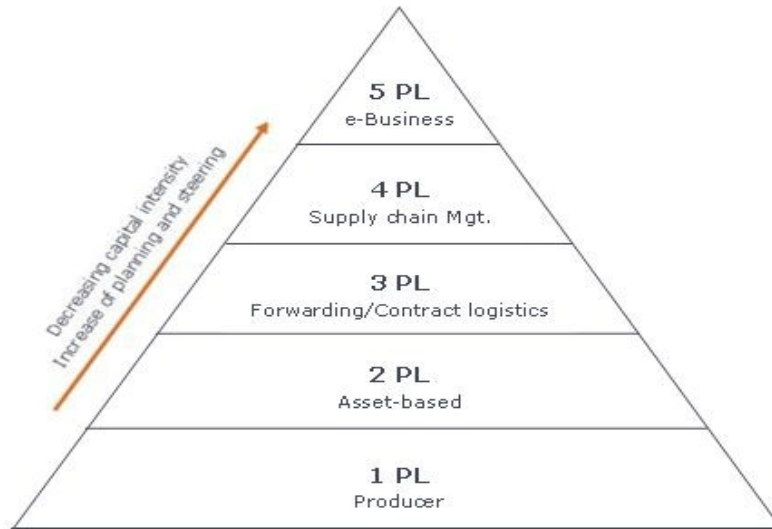
In air logistics industry, first party logistics(1PL) is simply logistics carried out by a first party entity, for example, a firm or one person who transports its goods to its customer or distributors. Similarly, the second-party logistics(2PL) is the party that receive the goods from the first party(Chu et al.,2004).

The third-party logistics (3PL) is one who performs the logistics either for the first party or for the second party, freight forwarders are the typical 3PL.

From the 90s, the third-party logistics had come into being the dominated position in the logistics industry, and it was also called outsourcing logistics, using of external companies to perform logistics functions that have traditionally been performed within an organization(Lieb et al.,1993). Within the third-party logistics, different agents conduct different activities; in general, shippers only deal with forwarders (Wong et al., 2007). The performance of third-party logistics can be measured by effectiveness, efficiency, flexibility, agility, alignment and satisfaction (Lai et al., 2002). After that, some schools of researches has emerged, such as improving the operational level through autonomous logistics control(Schuldt and Werner, 2007) and mathematical models (Leung et al., 2007), developing the reverse logistics models (Srivastava, 2008), and integrating the supply chain management and logistics process to fulfill the globalization trend (Enarsson, 2006).

While, third-party logistics service providers are lack of capability and knowledge (Wai Hung, 2008), and today's air cargo logistics requires integration-physical as well as virtual, this is the starting logic of 4th party logistics in air cargo industry. 4PL is the provision of logistics services to the 3PL, physical infrastructures such as airports, cargo terminals, community logistics centers can be viewed as 4PL(Chu et al.,2004). In nature, 4PLTM is a registered trademark of Andersen Consulting (now, Accenture since January 1, 2001). Different parties in logistics are from different aspect, for example, from organizational perspective or from SCM point of view. This research regards the different party logistics as the levels of integration in air cargo industry, the fourth party logistics can be regards as the more integration system. And 5th

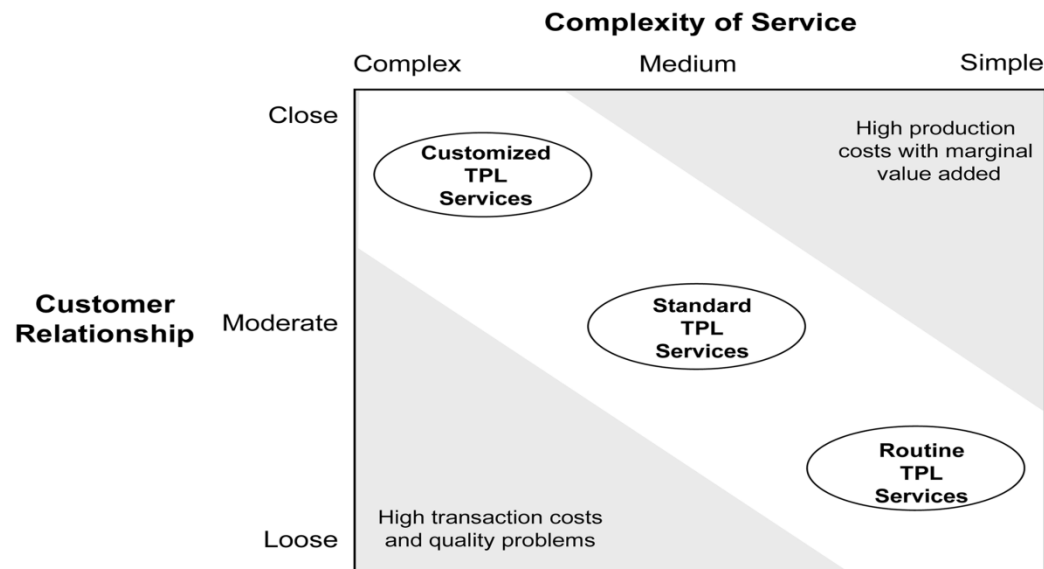
PL, 6th PL, even 7th PL are developed by the researchers, for example, figure 8.5 shows the 5 party logistics.



Source: <http://www.e-lc.biz/nl-BE/Layout001.aspx?PID=94>

Figure 8. 5 Five logistics parties

From the customer service perspective, the 4th or the 5th party logistics means the more close relationship with customer, and more complex service for customers, as the figure 8.6.



Source: service matrix adapted from Makelin and Vepsalainen (1990)

Figure 8. 6 Relationship between customer and complexity of service

In general understanding, the four logistics parties can be seen as in the figure 8.7.

Evolution of the market

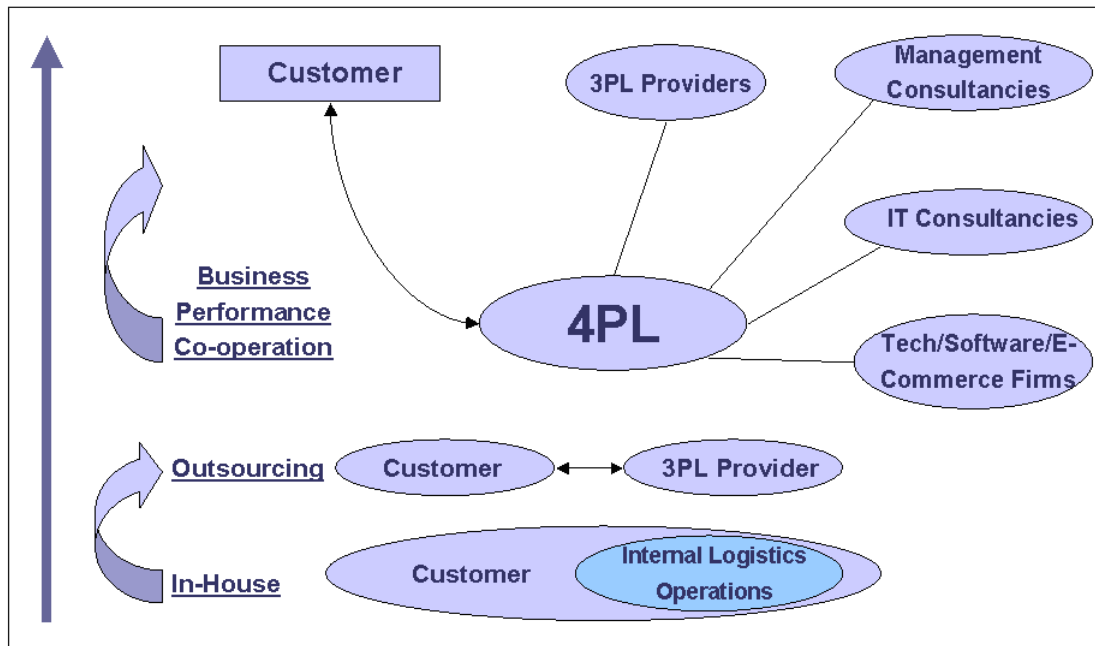


Figure 8. 7 Evolution of air cargo market

From evolution of the logistics parties, ACSCEP is regarded as the platform focusing on synthetic, integration, efficiency and coordination. ACSCEP in the platform includes all the logistics parties within air cargo industry within one specific region.

Air cargo logistics online community

Driven by covering destinations worldwide from customer, JIT practice, supply chain integration, IT development, globalization, diversity demand needs, standardized logistics process, the traditional logistics process, which focus on the delivering right product to the right place within right time(Stank et al.,1998), is out of date now. Waihung(2008) proposed one innovative online logistics community to add right decision, right group, right value and right integration to the traditional air logistics. In the new century, single player can not satisfy all the customer needs, even with loose cooperation with other partners, the new emerging integrators also can not fit the diversity customer needs. The air cargo logistics must be more agile, flexible, precise, global and electronic. In the opinion of Wai Hung, the online logistics community can fit the new diversity needs. In fact, the concept of “community” in air cargo industry was

proposed by Leung et al.(2000), they argued that the community network can enable agents to cooperate together within one virtual environment to benefit from the integration and consolidation with the help from IT. Up to now, no research has considered logistics process, virtual community, collaboration, partnership and knowledge in a holistic view (Wai Hung, 2008).

The most important contribution of logistics community is that the operation of virtual community must be in a platform environment-a place for building large-scale distributed applications ((Lau and Lee, 2000), storing contents (Carlson et al., 2001) and standardizing information for business processes (Reimers, 2001).

The past researches on platform are mainly on the interaction and communication within a company or an enterprise context(Sawhney et al., 2005). Chu et al.(2007)began to analyze how to conduct integrative activities inter-organizationally on a common platform .

8.4.3 The backup from practice

CTRIP

CTRIP was founded in 1999 and the headquarter is located in Shanghai. In 2010, it invested into Eztravel(<http://www.eztravel.com.tw/>) in Taiwan and Wing On Travel(<http://www.wingontravel.com/>) in Hang Kong. It was called the seamless connection model between internet and traditional travel industry. It is a electronic virtual platform on which hotels, travel agencies, air ticket agencies and airlines can satisfy their customers' needs.

Alibaba

Alibaba is one Chinese e-business platform company who connects millions of business clients together all over the world. It facilitates the world business through three virtual transaction markets, international trade market(www.alibaba.com), Chinese national business market(www.1688.com) and world wholesale market(www.aliexpress.com) .

IT development

IT developments are the basic supports in technology, there are two most important IT innovations which can surely facilitate the formulation of ACSCEP. One innovation is the ability to combine information flow with materials flow, in other words, to synchronize both flows. The second innovation is the continuing development of the semantic Web which will further extend the Web of informational resource to a Web of computable resources.

8.4.4 The Structure of ACSCEP

The basic function Framework

This ACSCEP has one basic function framework which includes E-collaboration function, E-management function and E-information function. Within the platform, the participants can negotiate the service; settle the finance issues, sharing the data virtually, as showed in figure 8.8.

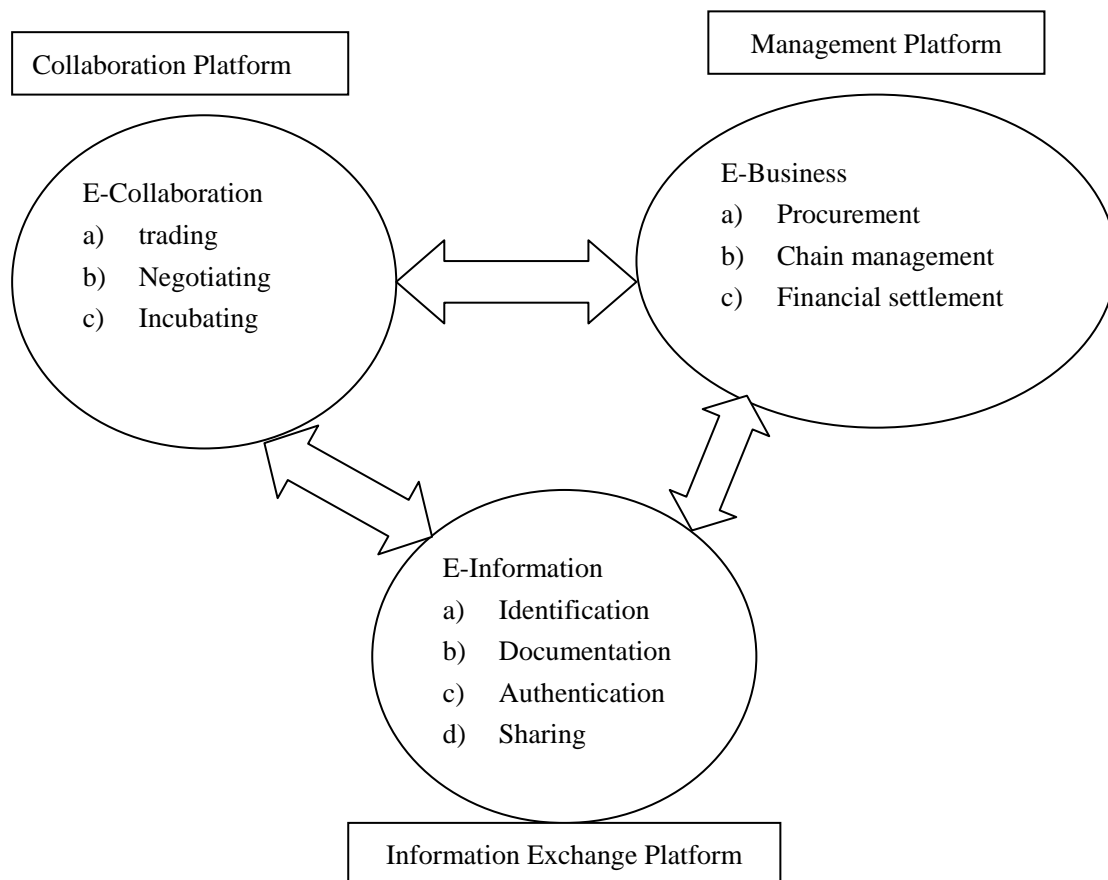


Figure 8. 8 Function framework of ACSCEP

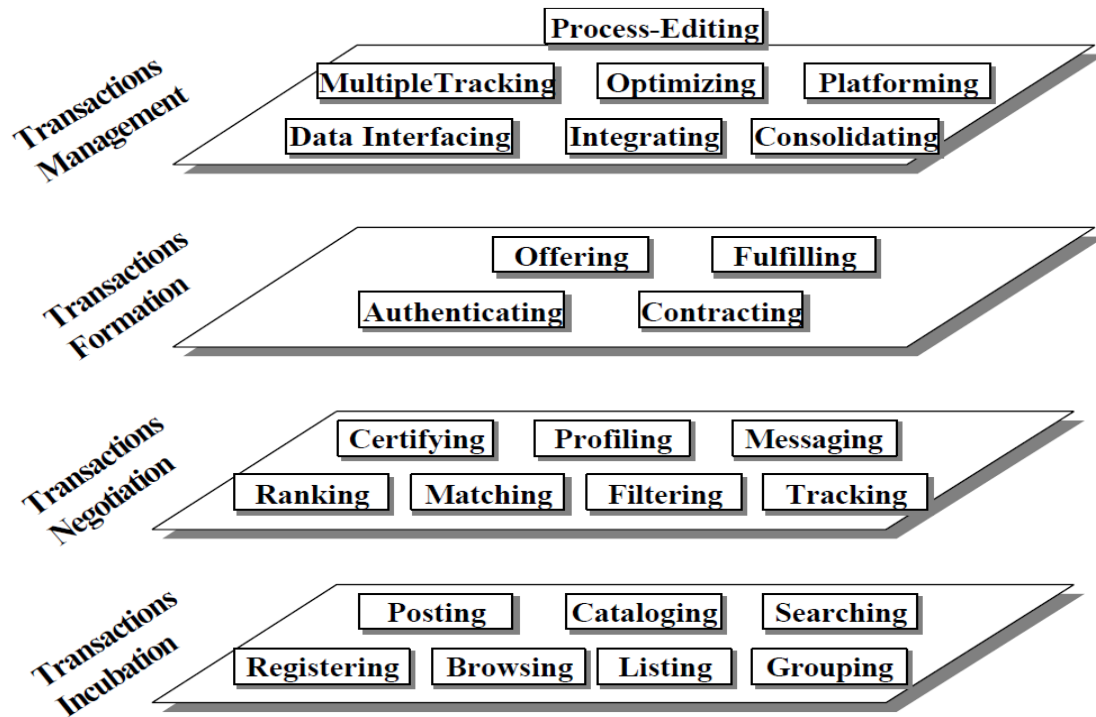
Connection structure

The air cargo industry is one international industry which will be influenced by international organizations, regional negotiation agreements, and national regulations and so on. It must have the seamless connection function among different standards.

In the international level, IATA is the most authority organization which has many standards, such as Freedom flying, Cargo 2000 and so on. For the national level, China has China E-port and Shanghai E-port, the ACSCEP must can connect with their platforms. Because of the security issues, America proposed one Total Scan program for all the import and export goods. America is the biggest import destination country, so the ACSCEP must satisfy the America connection standard.

Business activity structure

Within the air cargo industry, the main activities are warehousing, picking and packing, flow-monitoring, process management, retail-kitting, print-on-demand services, vendor management, order management, quality control, consolidation and pre-assembly of material flows, merchandising, several e-business service , insurance , customs clearance and financing service. According to Leung et al. (2007), the proposed ACSCEP must solve the operation activities as the figure 8.9.



Source: Leung et al. (2007), p10

Figure 8. 9 Business activity model of ACSCEP

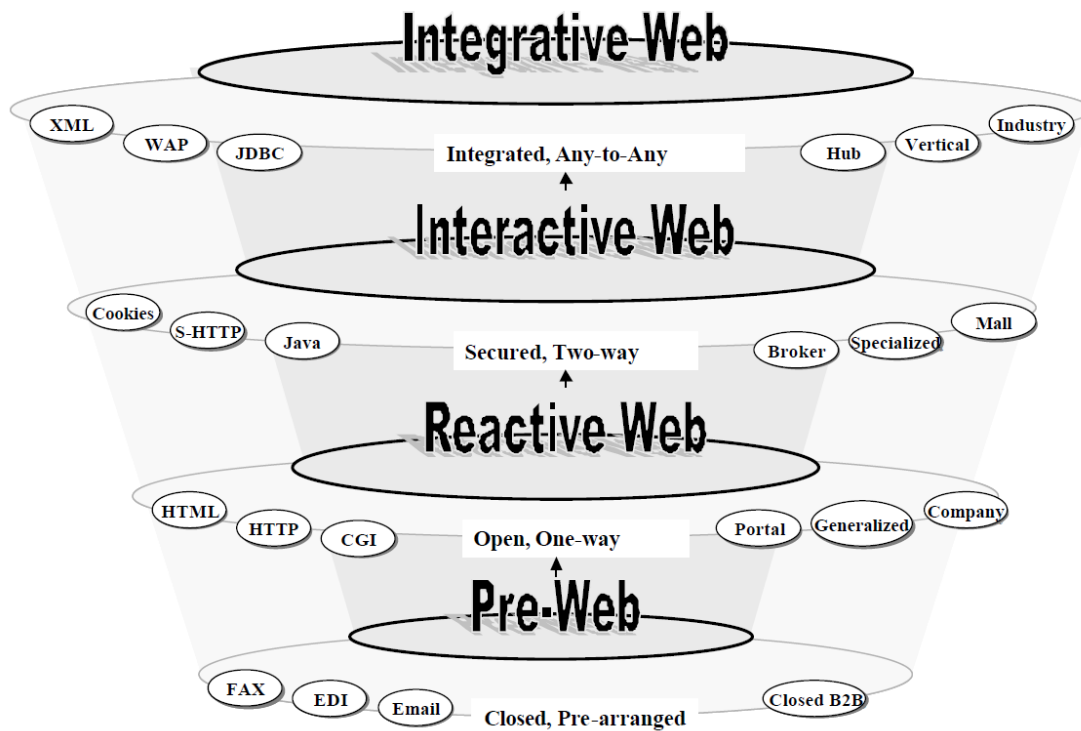
Table 8. 3 ACSCEP functions

Searching	enable guided retrieval of specific information
Registering	enable receipt and storage of requested information
Browsing	enable unguided information viewing
Listing	provide information in linear representation
Posting	deliver selected information
Grouping	enable guided association of selected information
Cataloging	organize information in a specific structure
Tracking	maintain/keep records of tracked information
Messaging	send as synchronized information
Certifying	establish the existence of specific information
Profiling	create preference information
Filtering	sieve through information
Matching	search then link related information
Ranking	sort information in accordance with specific criteria
Authenticating	verify by matching of certified information

Offering	receive information within a prescribed range
Contracting	accept then record offered information
Fulfilling	transfer of requested or approved digital information
Platforming	set up exchange of dynamically shared information from multiple sources
Data	standardize representation of shared information from multiple sources
Interfacing	link multiple tracked information
Multiple tracking	search and group multiple tracked information
Process-editing	combine matched tracked information of multiple sources
Integrating	combine consecutively ordered information
Optimizing	select best process-edited information

Internet Web structure

From the IT point, four kinds of webs are needed in ACSCEP, integrative web, interactive web, reactive web and pre-web, integrative is the most advanced and abstract one which is developed from the pre-web, as showed in figure 8.10.



Source: Leung et al. (2007) p17

Figure 8. 10 Internet web structure

Extended platform structure

In this research, we focus on the three key players within air cargo supply chain, shipper, forwarder and carrier. The main business transaction is among these three participants, while in reality, banks will support cash flow to this chain; insurances support the transportation risk control; air ports will supply the need space and air craft rest, and so on. So the ACSCEP will support all the stakeholders within this chain, here is the extended structure of ACSCEP in figure 8.11. In the extended structure of ACSCEP, the entire stakeholder can participate in the virtual platform to share information, supply service or product and benefit from this platform.

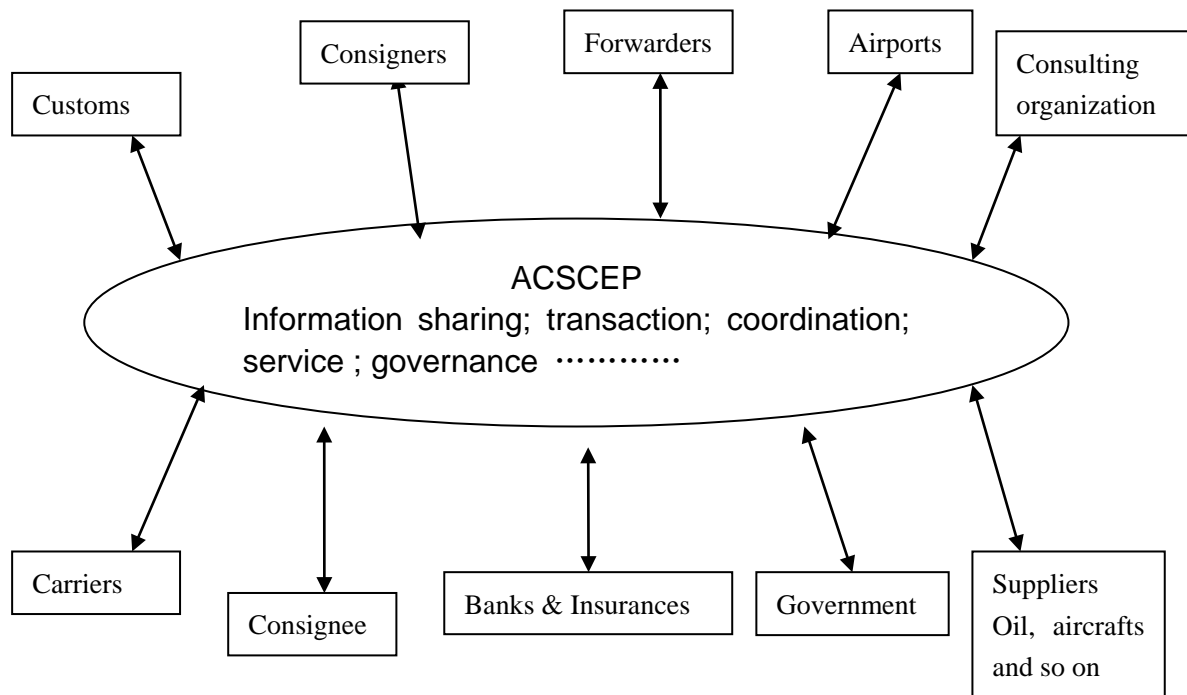


Figure 8. 11 Extended platform structure

The obvious benefits the air cargo supply chain can get are the cost decreasing, time reduce and more transparent. In the ACSCEP virtual environment, the shippers can get most carrier information, including price, space schedule, so they can chose the most beneficial carrier. The same principle with forwarders, the shippers can chose forwarder in ACSCEP to get best service.

8.4.5 The ACSCEP challenges

The ideal ACSCEP is in the near future, and there is still long way to get the successful platform. Here are some challenges.

Participation Motivation

Any action will have the back motivation, for the participants of ACSCEP, only they have the reasonable motivation, they would join in this platform. In the first, the benefit of joining in may be not clear, so the difficult is to start the first kick. Before the implementation, it is useful to analyzise all the motivations for each participants, and then use some marketing measures

Standard Data connection

As one practical and universal platform, ACSCEP should satisfy the key participants' needs, such as forwarders, shippers and carriers. At the same time, it should make the data sharing possible; that is to say, the key regulators and players could upload and download their information and data. For the ACSCEP in shanghai, it must has standard data connection with the request from IATA, national platform (as China E-port) and shanghai custom.

Data share risk

One of the important aims of ACSCEP is to be information symmetry. Shippers can get enough and right flight and price information, so they can chose according to their needs. Would the carriers share their true data within the air cargo supply chain? How could they compete each other? In traditional business model, the forwarders will consolidate the shippers' needs and get profit from the information asymmetry. It should find a good and proper way to let them share the important information.

8.5 Leading ACSCEP Practice: Ecargo

The ACSCEP is one promising future; this kind of platform must be realized with the industry development. The present questions are who will be the leader and who can be the leader. The organization to implement ACSCEP must have the ability to alliance key carriers, to integrate different competitors and make profit for every participant.

8.5.1 China TravelSky Holding Company

Incorporated in October, 2002, China TravelSky Holding Company is a national enterprise under State-owned Assets Supervision and Administration Commission of the State Council. TravelSky Technology Limited, which was founded in October, 2000 jointly by Civil Aviation Computer Information (CACI) center and all domestic Chinese airlines, got listed on the main board of Hong Kong Exchanges, stock code 0696.HK. In July, 2008, China TravelSky Holding

Company, with TravelSky Technology Limited as its core, completed business and asset restructuring and got listed in Hong Kong, boasting a registered capital of RMB 1.843 billion and total assets of RMB 8.26 billion. The company (hereinafter referred to as “TravelSky”) is headquartered in Beijing, with more than 4000 employees.

As a leading provider of information technology and commercial service in China’s air travel and tourism industry, TravelSky’s Core business is oriented toward airlines, airports, ticket sales agents, travel enterprises and relevant civil aviation institutions and international organizations, providing comprehensive service including air passenger service, air travel distribution, airport passenger processing, air cargo data processing, internet travel platform, domestic and international transport revenue management system as well as final settlement and liquidation services. After 30 years of development and improvement, a complete, rich and powerful information service line and a multi-tier service-oriented system for different customers have been established to increase the efficiency of industry players.(<http://www.travelsky.net/english/>)

8.5.2 Ecargo

(1) Ecargo Description and Framework

Ecargo is one public, neutral and national resource share logistics information platform. It can provide one-stop and industry level application and service for all the participants and regulators in air cargo industry. In nature, Ecargo is promoted by government under the background of domestic strategic need. It integrates all the information and resource in the air cargo supply chain under the conference of IATA standard.

ILink is the data exchange platform which is regarded as the standard and base of industry information exchange. Portal is the main service connection window and immediate interactive communication tool for all the participants. It

can provide host-based business application and separated information added value. The main framework can be described as in figure.



Figure 8.12 Ecargo Model

(2) Application Activities

- CCSP—for forwarders

CCSP is one-stop and custom solution proposal for forwarders. They can transport data and exchange data through this platform with airlines, ground handing, customs and governments. They also can take real-time tracking and query the status of the goods by the platform, and realize One Hub Total Solution

Main functions:

The pre-entry function of delivery: with this function, forwarders can transport the delivery information to ground agents in advance, and they can receive the feedback from ground in time, the feedbacks are including accurate weight, number of pieces and collection, transportation time and so on.

MAWB recording function: forwarder can complete the recording input of international, domestic waybill and neutral waybill through MAWB function. And forwarder can send MAWB information to airlines or ground agents.

Forwarder can preview, edit and print international or domestic MAWB,

HAWB recording function: forwarder can complete international HAWB information input and help to send information to airlines or ground agents.

Document management function: freight forwarding through the document management can control the waybill inventory and usage, to reduce the use of the error rate of the waybill number.

Shipment status inquiry function: forwarder can do goods state function track of the state of the full range of goods and access to timely and accurate shipment status information.

System management functions: through the system management functions, forwarder can modify personal information and login password; system management functions company information, customer information maintenance, the maintenance of basic data platform.

Flights search function: Forwarders can check flights query function and flight information.

Electronic booking functionality: freight forwarding by electronic booking function can be online is sent to the airline cargo booking request and receive timely airline booking confirmation information, combined with the main function in accordance with the booking information to fill in the main, single-acquisition, single-return of the airlines making it easy, fast, high-quality completion of the entire system of single process.

Agent distribution function: Forwarders canvassing on the platform and delivery. Canvassing, freight forwarding agents routes information posted on the platform for other freight forwarders or shippers of the goods to the release of information carried on freight forwarding. The time of shipment, freight forwarders or shippers posted on the platform they need to transport cargo information or to find the ability to transport freight forwarders.

- iGHA—practice in air cargo terminals ground handling

Air Cargo ground handling system is domestic cargo terminal to host deployment, standardized platform presented ground business processing system, cargo terminals between users both independent of each other, but also to share business data, allowing users to get the private system experience. Business support platform includes outbound business processes,

services, statistical services and other standard ground handling business into port business processes, ground and warehousing costs, including value-added services such as data exchange, but also as local freight system remote backup systems.

- iGSA—practice for air cargo sales forwarder

Air cargo sales agents systems supply airport cargo space sales agent role-oriented sales department (or air cargo sales company) provided important business applications, sales management, control and operation of the platform.

- iFIR—infosky-Flight Instruction Report

infosky-Flight Instruction Report (i-FIR) is one set up in the airport ground cargo and mail stowage department and aircraft balance between departments, set stowage the balanced data acquisition, transmission, processing and sharing-in-one information exchange and processing platform, for between the two sectors, real-time delivery of the latest electronic installed programs and installed results.

- iReport—practice for air cargo logistics data report

Aviation logistics platform-based data reporting application for the cargo terminal, the Airport Group, airlines, and industry regulation units to provide statistical analysis of data to meet the diverse perspectives. Platform customized data reports, the market share of customers, sales, airline operations, the volume of forecasts, profit margins, cost structure and other aspects of quantitative assessment. The platform This service could help freight companies to analyze the decision-making, the auxiliary functional departments of the government to regulate the transport industry.

- CFPS—air cargo terminals ground handling

CFPS is to provide services for the domestic airport cargo terminal, cargo terminal has a complete ground handling business and warehousing operations, part of the cargo terminal and chief business agent airline sales space; product can meet the major domestic freight business operations and

international freight business operations.

- iCargo

iCargo provides airlines with industry-standard, fully functional, coverage from the sale, operation, management full control of the air cargo business systems.

- nCargo— case for China Eastern Airlines

nCargo is a customized system for China Eastern Airlines, China Cargo Airlines and Shanghai Eastern Logistics Co., Ltd.

Key functions:

Space management: the amount of accommodation plans daily flights and accommodation, booking management, installation plan

Data exchange: packets plans customized packets sent automatically configured according to user needs packets plan and set links automatically sending packets.

Outbound: official single system, mail system alone, the official international single system, mail system alone, the international division of a single system of single, AWB inquiry management, log ULD loading, stowage flights, flights were diverted with the condition monitoring of outbound flights. Function above, the completion of the receipt of the cargo terminal, single, and leaving all operations.

Getting goods: up the goods monitoring information management, detail up the goods up the goods manual registration, pick up the goods quality analysis.

Transit: transit arrival list query the transit booking queries, transit of goods arrival query, transit of goods inquiries into port: goods into Hong Kong operation, inbound flights quality management, arrival into port list, bill of lading back to a single management, is not normal goods management, diversion order management, triage management applications for whole crate operation, handling inbound flights, waybill, cargo, crate, and monitor into the quality of the data of Hong Kong, not normal goods management.

(3) Public Service in Platform Industry Level

- iTracing—air cargo status and real-time tracking service

Air cargo status tracking service is doing cargo transportation, warehousing, regulatory and other aspects of mass running data acquisition, analysis and calculation, to provide users with a circulation of each shipment intuitive, accurate real-time status data. Cargo tracking service designed for the entire aviation logistics industry and even society as a whole logistics industry to provide three-dimensional, diverse cargo tracking information.

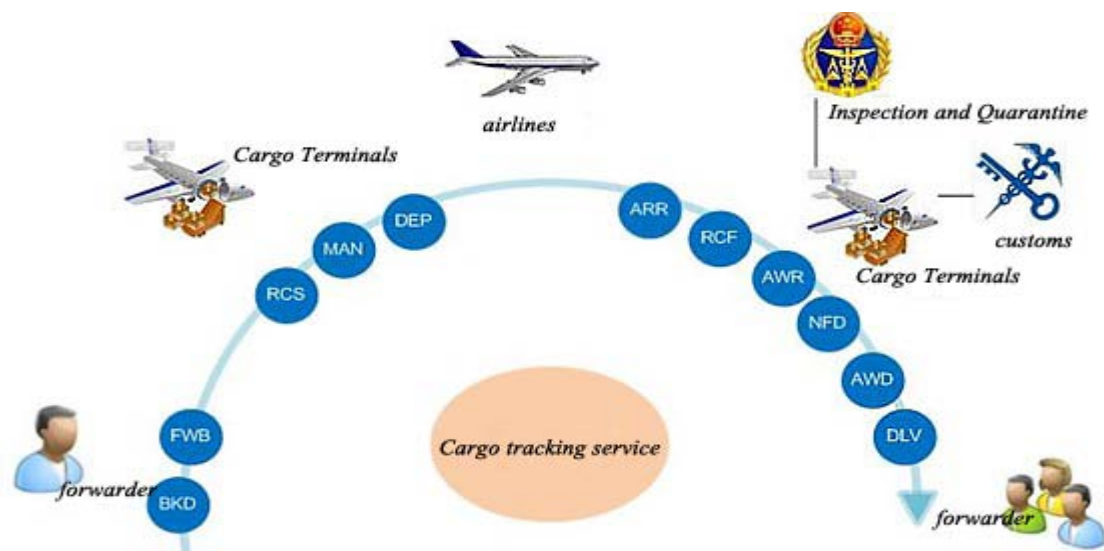


Figure 8. 13 Cargo tracking service in Ecargo

- iACM—service for airlines cargo production

iACM mainly supports advanced and full of advantage air cargo system solutions for airlines.

Main functions:

Customer management: the airlines and eCargo platform agent sales relationship management; with eCargo platform iGSA, iASA, iTracing application platforms and services, airlines as an agent / owner to provide seamless service access and improve customer service.

Document management: a complete document management capability to support the airline's headquarters - regional centers - Sales - agent's document management system full support neutral waybill business; agent automatically through eCargo platform document distribution and use of monitoring.

Waybill management: complete waybill entry, printing; agent through the eCargo platform entry, complete the waybill waybill data (FWB) timely delivery to the IACM; waybill data audit function.

Flights and space management: China the Air Letter ICS system flight plan data is automatically loaded services; supports custom airlines FOC system integration services, flight dynamics automatically updated; simple and flexible space management functions, improve space management level and efficiency.

Booking management: convenient and flexible booking management functions to support the waybill, No waybill, volume, long-term booking form; through the eCargo platform to the cargo terminal to send the flight booking (CBA), guidance cargo terminal loading real-time acquisition the agent system alone and cargo terminal cargo handling data; through eCargo platform, comprehensive monitoring of booking the actual arrival of goods, the transport situation.

Cargo handling: through the eCargo platform real-time acquisition of flight manifests reported (FFM) and cargo status (FSU), the transport of goods throughout the data can be automatically generated. The convenient hand cargo handling maintenance functions throughout the cargo tracking capabilities.

Management Report: timely and comprehensive data collection to provide a solid data base management reports; wide variety of typical data reports, such as sales reports, production reports.

Industry Unicom: supports industry data exchange standards such as the IATA CargoIMP / CargoXML built with the platform eCargo Unicom capacity.

- iCustoms—China Customs Air Cargo Electronic Declaration Service
iCustoms is Chinese unified electronic customs clearance, aviation logistics information platform data exchange the service receives Airlines, airport cargo terminal, the agent of the Standard Industrial packet data, electronic customs declaration services data conversion customs to meet the requirements of

customs manifests packets, and different access requirements in accordance with the customs of customs electronic manifest transmission. Electronic customs declaration services support the customs receipt of information, release information feedback to the user's private business

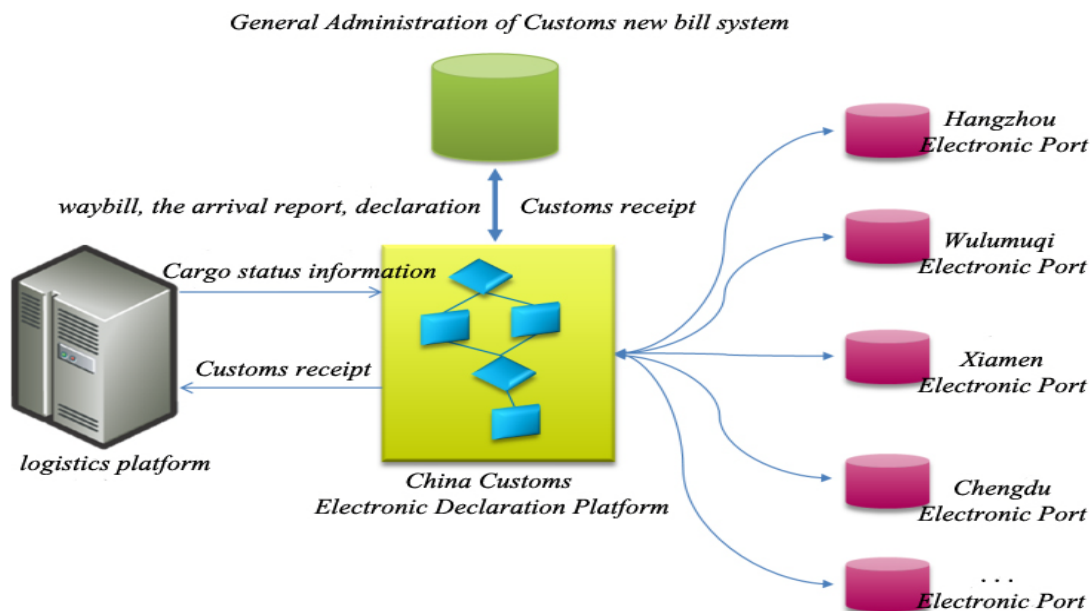


Figure 8. 14 China Customs Electronic System

- iLink—data exchange service
- iAWB—neutral waybill and electronic waybill service
- iSCS—security check service
- iFLI—infosky-Flight Loading Data Interaction System

iFLI is a connected mobile terminal software the aircraft balanced departments and ramp handling department, the system can realize the stowage installed one-way ramp electronic transmission, thus facilitating the ramp to receive timely information and does not query the latest loaders normal cargo information, guidance apron work.

- iTTY—Freight intelligent data exchange Terminal Services

In all the platform value can be summarized as the following: all users can be accepted in this comprehensive information platform, united industry standards and the integration of industry data.

8.6 Risk Control Analysis under the Implementation of ACSCEP

8.6.1 General analysis

As one effective risk control measure, it can not solve all the problems and counter all the risks. As discussed above, the catastrophic accident risk can be controlled by insurance and government, and most of the finance risk can be controlled by government policy and financing mechanism, while the ACSCEP can help to mitigate these risks. In ACSCEP, the shippers can easily find competitive insurances to get enough information and right price. For the forwarders, they can use their status in ACSCEP to substitute the bail to carriers, in this way they can save the cash flow.

In fact, the ACSCEP is one best measure to control the strategic risk and operation risk. Here we will discuss from the benefit of shippers, forwarders and carriers.

For shippers in traditional business model without ACSCEP, shippers always outsource the air transportation totally to their signed forwarders, mostly only one forwarder. The forwarders will collect the air transportation needs from as many as possible shippers, and then negotiate with carriers about the place, time and price. In this case, shippers do not know the information about the carriers. With ACSCEP, they can know the carrier flight information and save time; they can get the price information and save money; they can know the insurance information in case of disasters to reduce loss; they can find alternative forwarders to have better service.

For the carriers, in traditional way, they get the delivery information from forwarders. Normally, they sell in advance one part place to forwarders in fixed price and schedule, the rest place is for the floating price and temporary needs from forwarders. In ACSCEP case, they know enough and direct information from shippers, they can arrange the crafts and lines according to real needs. They can save transaction time and get higher price, and the most important

they can get the margin maximization through full use of craft space. For example, before the deadline time, any emergent and temporary delivery can be extra benefit for carrier; the price can be very low.

ACSCEP will cause the integration and reorganization for the forwarder industry, the profit model will change, their core profit source will return to their service. In fact, forwarders can benefit from ACSCEP through more and flexible flight information, transparent price, reliable customer and more customers.

8.6.2 Financial risk analysis

Under the ACSCEP, most of the financial risks can get solutions. After joining into ACSCEP, participants can get membership and have good credit rating recorder, which can help them to get loan from banks and other financial organizations. Exchange risk can be solved by contracts and negotiation; accounting risk can get solutions through ACSCEP, such as free capital subsidies, loans from banks and other measures. ACSCEP is supported by China government and it will concern the most important and key issues within air cargo industry. For the oil price risk, Chinese government is discussing to propose one stable oil price mechanism to solve this problem.

8.6.3 Strategic risk analysis

ACSCEP is one state-owned proposal which will have close relation with government and state-owned airports and airlines. Joining into this platform, the participants can attend conferences and meeting hold by governments. They can master any policy change as soon as possible to take measures to face changes. As a member of ACSCEP, it is easy for them to build alliance with other organizations. For the carriers and forwarders, business network is very important for them to benefit from economy scale. A comprehensive network can decrease the cost and attract more clients. Every client can find

their need in ACSCEP, as here are many options on time, schedule, carriers and price, in this way, they can get perfect service.

8.6.4 Operational risk analysis

ACSCEP is one national platform which can connect with IATA standards. Every separated system can join it and benefit from it. With the united information system, they can share the data and benefit from the platform data. At the same time, it is easy for them to pass the custom check and standard.

8.6.5 Catastrophic Risk Analysis

Catastrophic risk is one special case under the ACSCEP. This platform can supply useful information and services. For example, stakeholders can find excellent insurance companies to counter catastrophic risks.

As one effective risk control measure, it can not solve all the problems and counter all the risks. As discussed above, the catastrophic accident risk can be controlled by insurance and government, and most of the finance risk can be controlled by government policy and financing mechanism, while the ACSCEP can help to mitigate these risks. In ACSCEP, the shippers can easily find competitive insurances to get enough information and right price. For the forwarders, they can use their status in ACSCEP to substitute the bail to carriers, in this way they can save the cash flow.

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8.7 Conclusion

Firstly, it concludes that many strategic decisions should be make under the risk identification and assessments. Only after clear understanding of risks, the decision can be scientific and reasonable. Secondly, in the world there are three leading platforms, such as GF-X、 CPS and Ezycargo. They can promote the world air cargo development through integration and information system. In China, the Ecargo is one practice of ACSCEP which is proposed by China government. In all, ACSCEP can solve many Chinese air cargo risks. As a expert and member of Ecargo platform, I proposed that Ecargo is a good risk counter measures.

Chapter 9 Conclusions

9.1 Main Conclusions

This research summarizes the main conclusions as the followings:

Understand the real world air cargo industry and the trends, it is sure that air cargo industry will develop further with the globalization, world trade and economy growth.

The technology advances, political situation, economy outlook, international trade and oil have been described from the point of international perspective. In the following years, there are still macro uncertainties and risks, such as the risk of deeper crisis in the Euro area, fiscal cliff of United States, hard landing of large developing economics, double-dip global recession. It can help to understand the role of risk in air cargo industry, because this research will be done under the background of internationalization.

Below international layer, air cargo industry is the focused field of this research. It summarized the history development, structure, characters, trends of air cargo industry, especially the air cargo difference between China and world air cargo.

The basic source, different concepts, risk origination, classification and elements are clearly stated. It is summarized that risk is the uncertainty of the objective. Risk can not be researched isolated from risk management and control. Started from risk per se, some other concepts are analyzed, such as enterprise risk management, supply chain risk, risk in air cargo industry. For the enterprise, two typical frameworks are introduced as COSO framework and CAS framework, and both are popular in enterprise all over the world. Risk can be happened because of stakeholder relationship, information asymmetry, force majeure, technology, market failure, system risk and the process of risk transmission. This analysis will be helpful for the later risk identification.

Through risk identification methods comparison, literature review, RBS,

brainstorm and interview methods are used, and they can be beneficial and complementary each other. Some methods, such as cause and effect diagram, are proper for risk identification and risk assessment also. The two-layer risk model was summarized base on the combined four risk identification methods for the further risk assessment and analysis.

Four first-layer risk factors and 19 second-layer risk factors have been analyzed, the analysis is based on the literature review and the author's working experience.

There are thousands of risk assessment methods all over the world.

There is no universal and all-agreed risk assessment for any projects or organization.

Risk assessment method choosing may depend on the nature of the risks, character of the organization, attitude and ability of the participants, investment on risk assessment (including capital, time and energy invested) and other external or internal factors.

Risk assessment is absolutely not an automatic and mechanical processes, judgment from experts are necessary anytime.

It is important however, to remember that the risk assessment never can be made as a mechanical process, there will always be a need for a judgment by skilled experts.

For the risk assessment of Chinese air cargo industry, ANP is a scientific, reasonable and practical method. Firstly because of the character of this research, it is a doctor candidate research which is based on my working experience. It is easy for me to find the experts within air cargo industry to be interviewed in the process of risk assessment. Secondly, it is impossible for me to invest much money and time on this research work, and using more complex and integrated methods is difficult. Thirdly, according to the nature of risk in Chinese air cargo industry, it is impossible to find the exact and accurate risk occurrence probability. From the point of consequence of risk, we can compare and image the consequence, but it is impossible to forecast the exact

loss for any risks. ANP method can produce a ranking for the risks through the comparison from experts, it will be helpful for the decision making on how to deal with and control the risks.

Experts' judgment and suggestion are indispensable and complementary in risk assessment, including ANP method. Firstly, scientific data may not speak for themselves and the process requires careful interpretation. Secondly, scientific data may seem conflicting or inconsistent and it needs judgmental synthesis. Thirdly, in the absence of data, assumptions are necessary and it requires judgment about plausibility of assumptions; finally, choice of and/or construction of models may require judgments that are beyond the expertise of the risk assessor. (Ulf G..Ahlborg, 1996)

Chinese air cargo industry will be the engine of the world air cargo growth.

Air cargo development changes into air cargo supply chain development.

The air cargo supply chain risks have their principle formulating mechanisms, such as information asymmetric, IT, subjectivity of risk and so on.

For the time being, according to the opinions from 17 experts, 19 risks within air cargo supply chain are ranked.

Through the author's working experience, analysis and interviews, ACSCEP can be the effective risk control measure and platform.

9.2 Innovative Points

9.2.1 Question Innovation

Most of the past researches were focusing on the security or revenue management in air cargo industry, no research was founded on the air cargo risk management.

Air cargo transportation is one kind of supply chain, or we can say it is one part of supply chain. Air cargo supply chain concept was proposed by Andreea Popescu(2006) and was researched by John A. Muckstadt et al(2009). This research is the only systemic and comprehensive research on air cargo supply

chain.

9.2.2 Methodology Application Innovation

ANP method is one mature method in project management and other fields; it is first time used in air cargo industry for the evaluation. In this research, risk identification methods are reviewed and compared. There are many risk assessment methods for all the risks, and a comprehensive and scientific review has been done to choose one best method.

During the risk identification, some experts were interviewed. At the same time, questionnaires and brainstorm are used integrate. Based on the relation with experts, risk assessment can be done under the expert interview and questionnaires.

9.2.3 Practical Application Innovation

ACSCEP is the key innovation point based on author's working experience and interview, and many theories and practical business success cases support this model. As an expert and member of Ecargo, I proposed that Ecargo can be a good ACSCEP practice. Ecargo can solve many risks.

9.3 Limitations

Air cargo industry is changing with the world economy and global development, and risk is changing with the subjects developing. So the identification and evaluation in this research will be restrained by the experts, time and geographical factors.

It is difficult to find more experts in air cargo field to get interviews, the more experts, and the better result will be produced.

Most of the risk factors will change at any time, so the result will be different maybe at other moment. It is better to do the risk identification and assessment as a scanning machine regularly.

This research was done in Shanghai, because of the international character of air cargo industry; maybe it is better to enlarge the field into the world.

ACSCEP is still facing many challenges and difficulties.

Effective risk management is only sustainable in an organization if there is constant attention in the form of audits, reviews, and other forms of monitoring. (John Shortreed, John Hicks, Lorraine Craig, 2003)

9.4 Future Research and Expectation

It is better to do the risk identification and evaluation regularly, for example every several years. In practice, the risk identification and assessment can be the base for strategic decision making.

Chinese air cargo industry is totally different with Europe and American air cargo market; it is possible to do the comparison research among them. Are there the same identified risks between China and France? For the same risks, French experts and Chinese experts may have different priorities.

In working practice, Air France has its cargo business in China, is it possible to build one joint venture integrated platform to connect Chinese market and French market?

ACSCEP is one new model which needs further detailed and theoretical study. Ecargo can be a case study to against world information platform such as GF-X、CPS and Ezycargo.

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Appendix 1

Risk Identification Questionnaire

Here in the table are risks which can be important or not for Chinese air cargo industry, please share your opinions to identify the final risks for research. All your opinions and information are only for this research.

First layer	Second layer risk	
	Choice comments	Choice comments
Finance risk	Oil price	Credit rating
	Exchange	Capital
	Liability	Cash flow
	investment	accounting
	New?	New?
Strategic risk	Police changes	Product
	Client needs	Service
	Alliance	Business network
	Brand	Governmentresource
	Price	competition
	New?	New?
Operation risk	Information system	Human resource
	Governance	Operation accident
	Infrastructure collapse	New?
Catastrophic accident	Nature	Society
	Environment	Injury
	Economy	Terrorist activities
	New?	New?

Appendix 2

Chinese air cargo risk assessment questionnaire

Please use the number to show the importance between two factors, “1” means the importance between factor i and factor j is at the same level; “3” means factor i is little more important than factor j; “5” means factor i is obvious important than factor j; “7” means factor i is very important than factor j; “9” means factor i is absolutely important than factor j; and “2,4,6,8” individually means the importance as showed.

Risk Criteria Comparison

	Probability	Loss	Uncontrollability
Probability	1		
Loss		1	
Uncontrollability			1

Under Loss

	Finance risk	Strategy risk	Operation risk	Catastrophic accident
Finance risk	1			
Strategy risk		1		
Operation risk			1	
Catastrophic accident				1

Under Probability

	Finance risk	Strategy risk	Operation risk	Catastrophic accident
Finance risk	1			
Strategy risk		1		
Operation risk			1	
Catastrophic accident				1

Under Uncontrollability

	Finance risk	Strategy risk	Operation risk	Catastrophic accident
Finance risk	1			
Strategy risk		1		
Operation risk			1	
Catastrophic accident				1

R1 factors

	Oil price	Credit rating	Exchange	Accounting
Oil price	1			
Credit rating		1		
Exchange			1	
Accounting				1

R2 factors

	Police changes	Needs changes	Alliance	Service	Business Network	Government resource	competition
Police changes	1						
Needs changes		1					
Alliance			1				
Service				1			
Business network					1		
Government resource						1	
competition							1

R3 factors

	Information system	Governance	Operation accident	Infrastructure collapse
Information system	1			
Governance		1		
Operation accident			1	
Infrastructure collapse				1

R4 factors

	Nature	Economy	Society	Terrorist activities
Nature	1			
Economy		1		
Society			1	
Terrorist activities				1

Résumé :

En général, cette recherche se compose de quatre parties, sur fond de recherche, l'identification des risques, évaluation des risques et des suggestions de contrôle des risques. Arrière-plan de recherche comprend l'introduction de la recherche, l'auteur fond et revue de la littérature sur les théories et les concepts clés et les mécanismes de formulation de risque.

L'identification des risques est la première étape importante de la gestion du risque d'entreprise. Dans cette recherche, remue-méninges, une interview, RBS et les méthodes de revue de la littérature seront utilisés ensemble pour identifier les risques dans l'industrie chinoise de fret aérien. Du point de vue de la théorie, il expliquera pourquoi il choisit ces méthodes et met en œuvre la comparaison des méthodes. Grâce à l'interview, enquête auprès des experts, deux couches de facteurs de risque ont été créées.

Pour les méthodes d'évaluation des risques, il y a principalement environ 14 méthodes indépendantes d'évaluation des risques sont discutés, veille stratégique, l'analyse du pire cas et ainsi de suite. Pour l'évaluation de l'industrie chinoise de fret aérien du risque, l'ANP est une méthode scientifique, raisonnable et pratique. Le jugement et la suggestion des experts sont indispensables et complémentaires dans l'évaluation des risques, y compris la méthode de l'ANP.

En raison de la pratique de l'identification des risques, l'auteur a une relation étroite avec la plupart des experts au sein de l'industrie chinoise de fret aérien. 20 experts ont été choisis comme les personnes interrogées. Basé sur les 17 questionnaires valides et des logiciels de Superdecision, le processus d'évaluation des risques réalisée toutes les priorités pour tous les facteurs de risque. Selon le résultat, 19 risques sont classés en trois catégories, les risques rouge, jaune et blanc. Pour chaque type de risques, tous les participants peuvent prendre des décisions contre des risques en fonction du résultat de l'évaluation.

L'évaluation des risques n'est pas la fin de la gestion des risques pour l'industrie chinoise de fret aérien, le but de l'évaluation des risques est de soutenir la réalisation et apporter des inférences décision.

En Chine, le eCargo est une pratique de ACSCEP qui est proposé par le gouvernement de la Chine. En tout, ACSCEP peut résoudre de nombreux risques de fret aérien chinois. En tant qu'expert et membre de la plateforme eCargo, j'ai proposé que eCargo est un bon des contre-mesures de risque.

Mots-clés: Chaîne d'approvisionnement, Fret aérien, Identification, Evaluation, Contrôle des risqué

Abstract:

Generally this research consists of four parts, research background, risk identification, risk assessment and risk control suggestions. Research background consists of research introduction, author background and literature reviews on key concepts and theories, and risk formulation mechanisms.

Risk identification is the first and important step of enterprise risk management. In this research, brainstorm, expert interview, RBS and literature review methods will be used together to identify the risk in Chinese air cargo industry. From theory perspective, it will explain why it chooses these methods and implements the methods comparison. Through the interview, survey with experts, two layers of risk factors have been founded.

For the risk assessment methods, there are mainly about 14 independent risk assessment methods are discussed, as strategic scanning, worst-case analysis and so on. For the risk assessment of Chinese air cargo industry, ANP is a scientific, reasonable and practical method. Experts' judgment and suggestion are indispensable and complementary in risk assessment, including ANP method.

Because of the practice of risk identification, the author has a close relationship with most of the experts within Chinese air cargo industry. 20 experts were chosen as the interviewees. Based on the 17 valid questionnaires and Superdecision software, risk assessment process produced all priorities for all the risk factors. According the result, 19 risks are classified into three categories, red, yellow and white risks. For each kind of risks, all the participants can make risk counter decisions according to the assessment result.

Risk assessment is not the end for risk management for Chinese air cargo industry, the purpose of the risk assessment is to support the decision making and bring inferences.

In China, the Ecargo is one practice of ACSCEP which is proposed by China government. In all, ACSCEP can solve many Chinese air cargo risks. As an expert and member of Ecargo platform, I proposed that Ecargo is a good risk counter measures.

Key words: Air Cargo, Supply Chain, Identification, Assessment, Control of Risk