Drivers and Barriers of Cold Chain Logistics in Chinese 3PL Companies

A case study on two Chinese 3PL companies

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Abstract

Cold chain logistics is a booming area in developing country like China. However, not all cold chain programs receive positive results. There are drivers and barriers for the development of cold chain logistics. The thesis focused on finding the drivers and barriers of cold chain logistics for Third-party logistics (3PL) companies in China. Two case companies were interviewed and related scientific papers were interpreted in order to find relevant drives and barriers. Five significant drivers and three significant barriers were identified. Social requirement, development of food industry, customer demands, technology innovation and positive profits encourage the booming of cold chain logistics. While, the unregulated market order, increasing number of competitors and high investment impede the development of it. Generally speaking, the prospects for cold chain logistics are promising, in spite of some barriers. 3PL companies could evaluate factors of cold chain and uncover the major barrier for their own program, in order to achieve better result.

Key words

Cold chain logistics (CCL), Third-party logistics (3PL), drivers and barriers
## Abbreviation list

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<th>Full name</th>
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<tr>
<td>BLP</td>
<td>Bonded logistics Park</td>
</tr>
<tr>
<td>CCL</td>
<td>Cold chain logistics</td>
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<tr>
<td>CCM</td>
<td>Cold chain management</td>
</tr>
<tr>
<td>CIP</td>
<td>Clean in place</td>
</tr>
<tr>
<td>COD</td>
<td>Cash on delivery</td>
</tr>
<tr>
<td>GPS</td>
<td>Global position system</td>
</tr>
<tr>
<td>HACCP</td>
<td>Hazard analysis and critical control points</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply chain management</td>
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<td>3PL</td>
<td>Third-party logistics</td>
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<td>RFID</td>
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1. Introduction

1.1 Background

Cold chain management (CCM) is one of the branches of Supply chain management (SCM). Simchi-Levi et al. (2003) conclude that SCM is to produce and distribute merchandise in right quantities, to right locations, and at the right time, through integrating suppliers, manufacturers, warehouses, and stores in efficient approaches. Cold chain logistics (CCL) also contributes a lot on system wide cost reduction and service level improvement. Shabani et al. (2012) conclude that it is necessary to monitor CCL in order to control perishable products’ waste and toxicity. James and James (2010) also argue that refrigeration is considerable in maintaining food safety and quality.

In developed countries, variety of merchandises target frozen foods market, because it expands quickly. For instance, French frozen food consumption has reached 45% of total food consumption (Moureh & Derens, 2000). However, according to IIR (2009), there is a huge gap of cold chain level between developing countries and developed countries. Food industry grows by an annual average of 13% in China (Bai et al., 2007). But Wang and Zhang (2008) discover that a variety of food products are not distributed or sold through cold chain logistic in China, such as 90% of meats, 80% of aquatic products, generous amounts of milk and almost all bean products.

A growing number of Third-party logistics (3PL) companies are developing in a context of increasing outsourcing logistics activities. 3PL companies have become the main carrier of CCL services. Lots of researches focus on different aspects of Chinese 3PL companies, such as financial impact of information technology (Wang et al., 2008), comparative efficiency (Zhou et al., 2008) and strategic postures (Wang et al., 2006). However, few studies concern CCL services in Chinese 3PL companies. CCL. As a field has not been acquainted by Chinese market, the background knowledge of
CCL needs to be introduced comprehensively. There will be some factors contribute to CCL when 3PL companies operating it; similarly there will be some obstacles. Meanwhile, in order to advance an understanding of 3PL’s CCL macro-environment, it is necessary to evaluate political and economic factors within Chinese context.

1.2 **Aim and research objectives**

The overall aim of this study is to present the barriers and drivers in cold chain operating, and focus on Chinese 3PL companies. Specifically, these research objectives are concluded in following questions:

1. **What is CCL in 3PL companies?**
   - Definitions, developing reasons and environment impact of CCL services
   - Definition of Third-party logistics

2. **In China, what external drivers and barriers will influence the development of CCL’s market?** Factors from three aspects will be considered:
   - The economic reasons
   - Social issues
   - Legal limitations

3. **What are the internal drivers and barriers of Chinese 3PL companies’ CCL?**
   - The drivers and barriers when operating CCL, within a 3PL company
   - The significant drivers and barriers
2. Literature review

2.1 Cold chain logistics

A lot of attentions on the cold chain logistics (CCL) are evident on various researches in recent years. Issues concern CCL is going to be presented, for instance, definition, composition and environmental effects.

2.1.1 Definition of cold chain logistics

CCL also called cold chain management (CCM), which could be categorized into chain logistics or supply chain management (SCM). Jonsson (2008) describes Logistics as one kind of science of the efficient flow of materials. SCM is another term that has similar meaning with Logistics. Lambert (2004) defines SCM as an integration of key processes from end consumer through original suppliers, which provide adding value products, services, and information for customers and other stakeholders. The term SCM encompasses logistics, because SCM involves more process than logistics, such as marketing and product development.

Food chain is defined as the process from the harvest of the food, through manufactory, to transportation and storage, and in the consumers’ end use (Stringer et al., 2007). Cold chain is one special kind of food chain. During the process, the quality of the food products will continuously change; therefore, cold chain is employed to take control of the product quality. According to Kuo and Chen (2010), CCM is a special type of supply chain and is established for temperature sensitive and perishable products. Bogataj et al. (2005) conclude that the process of planning, implementing and controlling flow and storage of perishable goods, related services and information, is cold chain management. Cold chain is a significant part of modern global food commodities (Jol et al., 2007).
2.1.2 The reasons for cold chain logistics development

Shabani et al. (2012) conclude that cold chain was emerged because some products have limited shelf life and require special equipment and facilities for sales, storage and distribution. There are about 60% foods products need to gain good quality and extended shelf life though multifarious ways of refrigeration (Mattarolo, 1990). CCL is one of the branches of SCM, and CCL focus more on perishable products, such as medicine, food, flowers and blood. Cold chain serves mainly to perishable products that must be distributed and stored in restrictive time and condition (Shabani et al., 2012).

Ovca and Jevšnik (2008) discover that maintaining temperature for perishable foodstuffs is vital for food safety and food quality. Jol et al. (2007) also state that improper use of cold chain can increase the possibilities of foodborne diseases, caused by microbial hazards. According to Tirado et al. (2010), increasing temperature has a significant influence on Salmonellosis, Campylobacteriosis, Vibriosis and foodborne illnesses, thus higher temperature is strongly associated with diarrhoeal disease. The rising temperature due to global warming will lead the higher incidence of food poisoning (Schmidhuber and Tubiello, 2007). The development of cold chain is the inevitable outcomes of health and food safety requirements. The application area of cold chain serving is necessary for health, avoiding diseases and deaths (Coulomb, 2008).

Due to the globalization, there is an increasing number of global food companies export food products. More goods are being transported further and frequently than ever before, and distance foods have drastically increased in recent years (Wallgren, 2006). Kuo and Chen (2010) conclude that growing food globalization has leading a need of global cold chain for growth. However, the food supply globalization also brings global food safety problems (Motarjemi & Käferstein, 1999). More attentions by governments and companies are needed for CCL.
2.1.3 Composition of the cold chain logistics

Cold chain services of 3PL companies can be classified into three processes Cold processing, Cold storage and Cold transportation and distribution:

- Cold processing
  James and James (2010) define this process, as primary chilling and secondary cooling. The temperature of this stage is vital factor of food safety and quality. Cutting and quick-frozen machineries are needed in this stage, and a low-temperature workshop is also required.

- Cold storage
  Cold storage is defined by Akdemir (2008) as a process that storing perishable foods, pharmaceuticals, or other items under refrigeration. It is obvious that refrigerator is needed. While during the storage process, the monitor of the product quality should be paid special attention.

- Cold transportation and distribution
  Kuo and Chen (2010) describe cold logistics process as sorting, distributing and transporting various cold, chilled, frozen and fresh products to individual or enterprise consumers, in addition, the customer types are food manufacturer and channel dealer, and the transportation type is refrigerated transportation.

2.1.4 Temperature requirement

As mentioned above, the CCL is to control the temperature, while different kind of product demand different temperature and the required temperature also change according to the different stages. James and James (2010) state that a rise of the temperature would add up the risk for food poisoning and food quality declining. Table 1 shows the required temperature for various kinds of product.
Table 1: Required temperature for various kinds of products (Ying, 2006)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°C</td>
<td>Storage and transportation of fruits and vegetables</td>
</tr>
<tr>
<td>10°C~ 0°C</td>
<td>Pro-cooling process of fruits, vegetables, fresh seafood and meat</td>
</tr>
<tr>
<td>0°C~ -5°C</td>
<td>Storage and transportation of slightly cooling food</td>
</tr>
<tr>
<td>-10°C~ -18°C</td>
<td>Storage and transportation of slowing cooling food</td>
</tr>
<tr>
<td>-18°C~ -30°C</td>
<td>Storage and transportation of frozen seafood, ice cream</td>
</tr>
<tr>
<td>-30°C~ -50°C</td>
<td>Storage and transportation of fast foods and tuna</td>
</tr>
</tbody>
</table>

Most of the products that require cold chain technique are mentioned in the table above, while medicine and special vaccine is not included. The World Health Organization states that the temperature needed for vaccine is between 2°C to 8°C (Wirkas et al., 2007).

2.1.5 Technology

There are various technologies are used in CCL processes. Radio-frequency identification (RFID) tag is a wireless microchip product identification tool, and the reading process is fast and automatic, which makes the technique become perfect for fresh product (Abad et al., 2008).

Vacuum cooling, controlled freezing-point storage and ammonia refrigeration are three important refrigerating technologies. Vacuum cooling is the process of cooling product that contains free water by evaporation under vacuum, and it is a rapid evaporative cooling technology (McDonald & Sun, 2000).

Ammonia refrigeration is one of the technologies used extensively in food refrigeration, cold stores and food process cooling. Due to the low cost and high efficiency, ammonia has been widely used in food processing and cold stores at the
early stage of vapor compression refrigeration systems’ development (Tassou et al., 2010). Pearson (2008) concludes that ammonia refrigeration technology is very efficient, reliable and safe, if the requirements of existing safety codes are fulfilled.

Controlled freezing-point storage is the specific and rather new refrigeration technique used in the project. The focal point of the technique is to store fresh produce at non-freezing temperature zone. The technology is more efficient than the older refrigeration technique. Non-freezing temperature zone is defined between the freezing point of water (0℃) and that of the individual material (Guo et al., 2007).

### 2.2 Environment effects of CCL

Energy consumption is required to maintain cold chain working, and emission and waste will be generated while keep cold chain working. There are 40% of food worldwide requires refrigeration and this will consumed 15% of electricity of the world (Mattarolo, 1990). Meanwhile, China has an increasing greenhouse gas emission.

#### 2.2.1 Transportation and distribution

Sea, air, and road transportation can be used in different conditions to support CCL, in order to maintain shelf life of perishable products. Heap (2006) said that about 1300 refrigerated ships, 80,000 refrigerated railcars, 650,000 refrigerated containers and 1.2 million refrigerated trucks were used in the world at that time. Road transport is the dominant part of Chinese cold chain system. Road transport is also a major cause of oil consumption that can contribute to carbon dioxide (CO₂) emissions. China has gradually increasing oil consumption with an annual rate of 4% since 1980, and reached 210 million tons in 2000 (SSBC, 2002). He et al. (2005) estimated that total CO₂ emissions from Chinese on-road vehicles had increased from 148 million tons in 1997 to 230 million tons in 2002, an increase of 55% in five years.
2.2.2 Cold Storage

Cold chain freight in 3PL will be stored in refrigerated warehouses to maintain temperature of the products. Maidment and Prosser (2000) state that the first generations of cold stores mainly concerned with technical and thermal problems, but now operational and handling problems should also be considered. Cold stores consume a certain amount of heat and power. However, He et al. (2005) find that there are few researches on energy consumption of refrigerated warehouses. Duiven and Binard (2002) conclude various factors influence cold stores energy consumption, such as building quality, activity types and room size.

2.2.3 Refrigerant leakage

March Consulting Group (1998) stated refrigerant leakage led approximate 20% of global-warming impact of refrigeration plants. Since 1950, the dominant types of refrigerant in food industry are a batch of chemicals known as halogenated hydrocarbons, and recently climate change has led more concern and changes of refrigerants (James & James, 2010). For instance, Duiven and Binard (2002) said that ammonia dioxide cascade system has showing a good performance on energy saving. James and James (2010) also conclude that ammonia as a cheap, efficient and common refrigerant can help leak detection with its pungent odor. Yang (2007) also discovers that there are three issues in Chinese ammonia refrigeration application: few research on this area and a lack of attention; problems with design and operation; and shortages in safety precaution.

2.3 Evolving views on Third-party logistics companies (3PL)

Third-party logistics (3PL) companies have grown in importance since various industrial sectors outsource their logistics activities. Wilding and Juriado (2004)
conclude that the most common reasons of outsourcing are: cost reduction, improvement of service level, and increase in operational flexibility. Term as “logistics service providers (LSPs)” has been used interchangeably and Delfmann et al. (2002) defined LSPs as companies provide logistics services on behalf of other industrial sectors. No matter what terminology is chosen, it denominates different logistics providers, which perform part or all logistics functions of company (Coyle et al., 1996). This thesis uses “3PL” this common accepted term, because it emphasizes the third party responsibility over the logistics process.

3PL companies have developed in the context of a growing trend of long-term outsourcing logistics strategy. They are defined as companies offer complete or partial logistics activities (Rajesh et al., 2012), not only transportation and warehousing (Leahy et al., 1995). Rajesh et al. (2012) also state that a transitioning from basic commodity-service to a more comprehensive service offering has happened on 3PL companies.

The logistics function is to plan, implement and control the flow of goods, services and related information (Council of Logistics Management, 2001). Intense competition for manufacturing industry has enriched the range of 3PL companies’ services. The classification of three major groups of 3PL by Delfmann et al. (2002) also reflects the development of 3PL companies’ logistics functions: the first group only has standardized and isolated logistics services, such as transportation and warehousing; the second group not only has standardized services, but also has other undifferentiated logistics services for all potential customers according to their customers' wishes; the third group design logistics services and logistics systems according to specific customers’ preferences. Various logistics activities associated five major functions of 3PL companies: transportation, warehousing, inventory management, order processing and information system, and packaging (Delfmann et al., 2002). However, it is not enough from a performance management perspective,
3PL companies also need other logistics management, such as traffic management and rate negotiation (Rajesh et al., 2012).

2.4 Current situation of CCL in China

2.4.1 Economic factors

International Institute of Refrigeration (IIR, 2002) estimated that deficiency of refrigeration causes 20%-30% food production waste in the world. Kaminski (1995) estimated that global primary production losses 30% in general, in addition, fruit and vegetables loss about 40%. Kaminski (1995) also discovered that about 300 million tons of products are wasted each year in developing countries, because of non-use of refrigeration. There are also significant differences between developed countries and developing countries. Developed countries lose 10% food (all products) due to the lack of refrigeration. On the other hand developing countries lose 40% (Table 2).

Since 1980s, China’s food industry grows with an average growth rate over 13% per year (Bai et al., 2007). In China, 37 million tones vegetables and fruits are discarded annually; in addition, these vegetables and fruits, which value 75 billion Yuan, are deteriorated in freight and can fully feed 20 million people (Wang & Zhang, 2008). It shows significant gap of cold chain developing process between China and developing countries.

<table>
<thead>
<tr>
<th></th>
<th>World Population</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population in 2009 (billion inhabitants)</td>
<td>6.83</td>
<td>1.23</td>
<td>5.60</td>
</tr>
<tr>
<td>Refrigeration storage capacity (m³/1000 inhabitants)</td>
<td>52</td>
<td>200</td>
<td>19</td>
</tr>
<tr>
<td>Number of domestic refrigerators</td>
<td>172</td>
<td>627</td>
<td>70</td>
</tr>
<tr>
<td>(1000 inhabitants)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Food losses (all products) (%)</td>
<td>25</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Losses of fruit and vegetables (%)</td>
<td>35</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Loss of perishable foods through a lack of refrigeration (%)</td>
<td>20</td>
<td>9</td>
<td>23</td>
</tr>
</tbody>
</table>

2.4.2 Social factors

According to bulletin of China’s Ministry of Health (MOH, 2012), there are 8324 cases of food poisoning accidents in 2011, and 61.67% of these cases are caused by microorganism. Wang and Zhang (2008) said that the food poisoning digit of China was less than reality’s 10%, and they also conclude that the problems of cold chain developing process is main reason of food poisoning. However, Chinese consumers have showed a growing interest in food quality and safety (Bai et al., 2007). More CCL programs are called in Chinese market.

2.4.3 Political factors

Kuo and Chen (2010) propose that government must establish regulations to protect the health of customers, and related industries need to build cost effective cold chain systems to meet the regulations. There are several laws and regulations has various clauses will have impact on 3PL’s CCL projects:

- Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution (MOC 1, 2007)
  The Chapter 1 requires public security, transportation, railways and fishery administrative departments to regulate and supervise atmospheric pollution caused by motor vehicles and vessels.
Chapter 4 *Prevention and Control of Pollutants Discharged by Motor Vehicles and Vessels* has four articles to limit the overall emission discharged by motor vehicles and vessels. In addition, these articles show encouragement and support on clean energy vehicles in order to reduce atmospheric pollution.

- **Food Hygiene Law of the People’s Republic of China (CAIQI, 2011)**
  Chapter 2 *Food Hygiene* has requirements on food containers, packaging, and equipment for storage, transportation, loading and unloading of food, to ensure food safe and human health.

- **Food Safety Law of the People’s Republic of China (WTO, 2009)**
  Chapter 4 Food Production and Business Operation said that governments at all levels encourage chain operation or distribution of food. In addition, Article 28 also ruled that unsafe foods are prohibited, such as rotten or spoilt food.

- **Standards of Ministry of Agricultures of the People’s Republic of China (MOA 2013)**
  In order to supervise food safety, there are various standards from Ministry of Agricultures of China guide foods’ storage and distribution, include HACCP standards.

### 2.5 Cold chain performance model

Factors that can affect cold chain are countless. Joshi et al. (2012) provide a detailed framework to analyze the performance of cold chain in a systematic way. (See figure 1) This model summarized over ten related scientific papers, and is represented in a concise way. Therefore, result and discussion of this thesis is organized according to the model.
Figure 1: The attributes that contribute to cold chain performance (Joshi et al., 2012)

Definitions of attributes:

Cost represents the expenditure for running CCL, which spoilage cost, operation cost, maintenance of refrigeration system cost and so on. The lower the cost is, the better the competitiveness is (Aramyan et al., 2007).

Service level is the capability to satisfy customer needs. It could be features for which are distinguished from other service providers, such as broader delivery coverage, various payment methods and longer opening hour (Aramyan et al., 2007).
*Quality and safety* is defined as customer requirements for the safety, hygiene level, freshness and juiciness of the product, and there are progressively attentions paid on the quality and safety for food industry from the customer, in recent years (Rijswijk & Frewer, 2008).

*Relationship* means the connection between supplier, customer and employee. A harmonious relationship results in greater performance (Likar & Jevsnik, 2006).

*Innovativeness* can be explained as creative ideas and improvement for every aspect (service, technology and marketing) in cold chain, and continuously improvement is built by innovation (Taylor & Fearne, 2006).

*Traceability* is the process of tracing product information throughout the chain, relevant information contains transaction information, condition information like temperature, location, amount of good and shelf life (Montanari, 2008).

*Return on assets* stands for the ability to conduct production and make profit. Using refrigeration assets and human resources efficiently to achieve the goal for which is lower cost as well as stable quality (Aramyan et al., 2007).
3. Methodology

3.1 Over view of research method

The study was designed as a qualitative case study. Data was collected from peer-reviewed articles, books, organization websites, documents, and interviews and analyzed data using Cold Chain Model. Multiple case studies are exploited in this thesis in order to explore operational processes of CCL. In turn, two main study sections will be presented in this thesis: an in-depth review of relevant literatures and gather of empirical data. The general process is inductive process. An overall study process flow chart was made as figure 2.

![Study process flow chart](image)

Figure 2: Overall study process flow chart

3.2 Qualitative research

Numerous of definitions of Qualitative research can be found in literature. Van Maanen writes the most classic one: (1979, pp. 520)

“Qualitative research is an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to
terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world”.

In the light of the book of Merriam (2009), there are four characteristics speaking the nature of qualitative research: focus on process, understanding and meaning; data collection and analysis are primarily done by the researchers; the process is generally an inductive process; the product of qualitative research is represented abundantly.

This thesis is a qualitative study identified by definition and four characteristics of qualitative research. This thesis found out drivers and barriers of CCL for 3PL, which answered the question how 3PL companies implement CCL? This process is in line with the definition of qualitative research. The thesis focuses on explaining the meaning of related concepts; revealing the process of CCL; finding background information and operating information for cold chain programs. Data and information were collected and analyzed by researchers. There was a lack of existing theory to explain the study questions; therefore, concepts like drivers and barriers were built according to the gathered data, which is an inductive process. In the end, words, figures and tables were used to convey the data and analysis, providing a rich description of findings.

3.3 Case study

There are six types of qualitative research that are frequently seen in social sciences and applied fields of practice: qualitative case study, critical qualitative research, narrative analysis phenomenology, ethnography, and grounded theory (Merriam, 2009). This study belongs to qualitative case study, “an in-depth analysis of a bounded system” (Merriam, 2009, pp. 39). The reason of choosing case study as the overall research strategy was that this study was going to answer why there are some factors contribute to CCL, and why some not, and how to apply CCL. According to Yin (2008), case study has obvious advantages when solving how and why questions.
The study involved two cases, and they represented two kinds of status of cold chain program: one was an ongoing case, and another was a suspending case. The suspending case belongs to Weihai Port Group Co. Ltd. (case company 1), and the ongoing case belongs to Guizhou Zhiji Logistics Co. Ltd. (case company 2). In accordance with the research questions, the two cases are both 3PL companies operating cold chain program in China. The two individual cases could give response from different angle, for example, the suspending case told more about why the program was not able to run smoothly, which generate more barriers for cold chain, and the ongoing case provided more operating data and drivers of cold chain. Moreover, the location and market coverage are diverse: one in northern China (case company 1), another in southern China (case company 2). Due to the large territory, the commercial environment and indicators in China are of great difference. The two case companies were specially chosen to represent CCL in different operating status, to uncover drivers and barriers of CCL, in addition, 3PL companies in different location were also taken into consideration.

### 3.4 Data collection

The data collected for the study thesis could be divided into two parts, literature review and empirical data. Books, scientific articles and documents related to the study are presented in the literature review in a concise way (Murray & Hughes, 2008). It is the section that cannot be ignored, for it shows how the study is connected with the existing body of knowledge. Information collected in literature review is secondary source, because the information was referenced from books, scientific journals and organization web sites. As for the empirical data like interviews data and primary documents are demonstrated in result section.
3.4.1 Data collection technique: interview

Owing to the geographic limitation, data collection techniques like face-to-face interaction and observation report could not be applied in this study. In order to get in-depth information from the case company, semi-structured interview was employed. Jarratt (1996, pp. 9) gives a definition:

“Semi-structured interview allows the researcher to cover a specific list of topic area, with the time allocated to each topic area being left to the discretion of the interviewer.”

Half of the interview questions were designed before the interview according to the knowledge from the literature review, while another half of questions was organized during the interview decided by the information offered in interview. There are two case companies in the thesis, and for each of the company, two interviews were conducted. The interviews were online interview using Skype. The total interview time for Weihai Port Group Co. Ltd. was about two hours, and one hour and a half hour for Guizhou Zhiji Logistics Co. Ltd. After the Skype interviews, some questions emerged during the writing were asked through email, for example the figures presented in the Result were offered by email. Interviewees are the general managers of the two case companies. Choosing general managers is because they have rights to access and offer concerning information.

3.4.2 Data classification

The various kinds of data were scattered and confusing without classification. In order to present the data logically and clearly, the model created by Joshi et al. (2012) was brought in, see figure 1. The model describes contributors of the performance evaluation attributes of a cold chain. Data from companies was reorganized into seven parts: cost, service level, quality and safety, relation, traceability, innovativeness, and
return on asset. The result part was written in line with the sequence mentioned above.

3.5 Data analysis

Changing data into useful information to generate conclusion is called the process of data analysis for which was demonstrate in the discussion part. In discussion, firstly, data presented in the Result and Literature review were discussed dividedly. Next, according to the discussion, drivers and barriers were identified, and listed in the table in order to evaluate the significant drivers and barriers. Finally, to identify significant drivers and barriers, a new method made by authors was used. The new method for the evaluation of the factors was based on qualitative information from interviews and interpreting of the literature. Drivers and barriers listed in the table were given stars according to their importance, and factors that have equal or over four stars were identified as significant drivers and barriers.

3.6 Validity

Validity is defined by Given (2008) as the degree of the accuracy for the facts presented in the study and if the thesis has done what it claims to do. The major purpose of this study thesis is to find out drivers and barriers of CCL for Chinese 3PL companies. As the purpose showed, the entry point of the thesis is narrow; therefore it was easy to focus on the research topic.

Biggam (2008) indicated that there are some doubts for the validity of case study for which is the generalization may not be able to achieve. While, to overcome the doubts for case study, two case companies were involved in this study. These two companies represented north and south of China and suspending and successful program, which increase the external validity of the conclusion.
3.7 Reliability

The thesis is a qualitative case study. Though collecting and analyzing empirical data and comparing it with reviewed literature, the research questions were answered. The empirical data was collected through interviewing the general manager of the case company and the interview questions can be found in the appendix. The reliability is increased because the first hand data collection process was documented. When it comes to literature review, all the secondary data has detailed reference, what is more, the articles used were peer reviewed scientific article, books were published text book, and a few organization website references were used.
4. Result

The data and information of the case companies presented in this section are originated from the answers for interview questions, and reorganized into the model of Joshi et al. (2012) described ahead.

4.1 Weihai Port Group Co. Ltd.

Weihai Port Group Co. Ltd. represents a special kind of group in 3PL companies: harbor. The organization locates on the northeast corner of China in Shandong Province. The special location leads to a frequent commerce with South Korea and North Korea, Japan and Taiwan. There was a suspending project concerning about Cold Chain for fresh produce, which is executed by the Weihai Bonded logistics Park (BLP) for which is a wholly-owned subsidiary company of Weihai Port Group Co. Ltd. The cold chain program receives support from the local government. A designed supply chain process for this cold chain program see figure 3. Processes 1 to 8 are operating by case company, and processes 9 and 10 are not responsible by case company.
4.1.1 Cost

The estimated total investment for the program is about twenty million dollars. There might be additional investment added later on. The investment cost does not include the salary for the employees and maintenance cost.

Plenty of high-tech equipment are employed in the process: Clean in Place cleaning equipment (CIP cleaning equipment), detoxify machine, vacuum pre-cooling equipment, controlled freezing storage equipment and controlled freezing distribution car. These facilities are expensive and needed well maintenance, which surely add up expenditure. Besides from the facility cost, administration cost, building cost and energy cost are also contained in the total investment. The energy consumption type is electronic and the total volume is around two million eight hundred and eighty thousand kWh for a year.

The program is designed to have 20 senior technique manager and 500 workers. Owing to the project suspension, there is no training program available yet, although there is a plan for training. Data for cost of waste product is not presented for the same reason.

4.1.2 Service level

The cold chain program offers agriculture product and byproduct, which produced within Shandong Province and fresh produce from southern China. Product from local suppliers is mainly distributed towards South Korea and Japan. At this moment the delivery coverage for the program is only China, South Korea and Japan, while Russia, America and European Union will be the future market. Broader delivery
coverage will be offered for various customers. When it comes to convenience for the customer, customer like retailer could reach the product by train, bus and ship; therefore it is easy for customer to reach the product.

The product availability of the program is splendid because of the rich product supply. The company located in Shandong Province for which is famous for its various agriculture product, in addition, the city of Weihai has abundant fishing resources. The harbor of Weihai and convenient train and road transportation could bring the special tropical product into the cold chain system. There is regular shipment from Weihai to South Korea and Japan, and most of the days the weather is good for sailing.

There are many local aquatic and vegetable product process companies in Weihai, and these companies divide the local market. This circumstance decides that service in low-end market will gain less profit. To avoid failure, the cold chain program is targeting middle and high-end market, and providing high quality service, for example high quality product and Just in time delivery.

According to the market investigation, there will be many large-scale cold chain programs being built in the future and they will offer the same kind of service.

4.1.3 Quality & safety

Subject to legal constrains, operating a cold chain business project requires possessing “the Administration of Food Circulation Permits” and following the “Measures for the administration of Food Circulation Permits”. The company has already had the certification required, and operating the circulation process by law.
4.1.4 Relationships

Relationships with employees have two different conditions. The management team is satisfied with the work time and wages. Their wages is not given from the sub company but from the headquarters, which means the wages is not completely consistent with the profit of the sub company. While the workers sometimes are complaining about the wages they received when the season profit is not so good. As for the working condition, the working building is new and well designed; therefore, employees are all satisfied with it.

The suppliers of the cold chain program had not settled yet. The market analysis indicated that there are many small family fresh product-processing companies. The companies are separated and hard to integrate. It will take times to find suitable suppliers.

4.1.5 Traceability

When the fresh product is transport into the workshop, there will be a quality inspection in the reception area. Hence, there is only one point of monitoring at the level of farmer.

During transit, the first inspection is conduct before loading the good; the second inspect will take place during the transport process, and the frequency of this inspection could change according to the transport time range. The final inspection is carried out before hand in the good to the customer. Therefore, three monitor points during the transit.

This program uses RFID technology throughout the process. Using RFID advances the degree of details of information about items monitored, thanks to the rich information store function of RFID tag.
The cold chain process is semi-automatic. Most of the processing procedure is done by machine, while human resources are also used to operate and monitor the machine, and the distribution process needs human resources as well.

4.1.6 Innovativeness

“Controlled freezing-point storage” is used in the project. Product stored at non-freezing temperature zone showed higher physiological and business value, and it could prolong the shelf life product. Vacuum cooling is another cooling technique used in this cold chain process. According to figure 2, after packaging, there is vacuum pre-cooling section. Applying vacuum cooling for fresh product could shorten process time and saving energy.

4.1.7 Return on asset

The analysis for profit is showed in the following way (see figure 4):

![Figure 4: Estimated financial analysis](image)

- **Annual sales**: 40,000 tons
- **Average price**: 10,000 Yuan per ton
- **Cost per ton**: 8200 Yuan
- **Profit per ton**: 1800 Yuan
- **Sales revenue per year**: 400 million Yuan
- **Net profit per year**: 72 million Yuan

72 million Yuan is the estimated profit one year, while there are changes when the program failed to reach the profit. The risk forecasting shall be added into the
calculation, therefore, the annual profit times 80 percent, and the moderate annual profit is 57 million Yuan. The annual rate of return of the project per year will be 40 percent, conservative estimated. On the basic of these numbers, after two and a half years, the program could reach the breakeven point, which means the investment is retuned.

4.2 Guizhou Zhiji Logistics Co. Ltd.

Guizhou Zhiji Logistics Co. Ltd. is located in Guizhou province, which is in southwestern of China. The company, founded in 2002, is a legally registered and private-owned company. Guizhou Zhiji Logistics Co. Ltd., formerly a logistics service-counseling center, nowadays is a logistics company with comprehensive services of storing, transporting, distributing and transiting. Case company has begun to operate cold chain project in 2012.

4.2.1 Cost

Main costs in CCL are equipment cost and maintain cost. Ammonia refrigeration the refrigeration technologies used by case company in food refrigeration, cold stores and food process cooling. Ammonia refrigeration is chose because of its low cost and high efficiency. But the equipment cost contains refrigerating storage and vehicles are still a large part of investment in CCL. The transportation vehicles have different size to satisfied different customer requirements. 4.2-meters, 9.6-meters and 15-meters refrigeration trucks, with Global Position System (GPS), are a large part of capital assets. Due to short running time of CCL, the repairing cost is low now. Maintain cost contain employee salary, electricity and fuel expenditure, they are significant parts of total cost. Employee training cost is low, because the operating processes are easy to maintain, and special technical people are hired, not trained, for instance, drivers and professional logistics staff. Because of the limited delivery coverage now, case company keeps a relative low cost.
There is no cost on dealing with emission from running CCL, or other environmental aspects. Because there is few compulsory laws and regulations concern environment, and Chinese administrative supervisory mechanism put few attention on this.

4.2.2 Service level

Guizhou Zhiji Logistics Co. Ltd. is always pursuing higher service level. Tailored logistics plan will be offered after getting across customer’s situation. Company tries to provide various payment methods in order to create customer convenience, for instance, Cash on delivery (COD) and web payment. After consignee signing invoice, case company also offers a service to return the invoice to consigner. Small-branch storage is another service being offered to create more convenience for customer, and acquiring more kinds of customers. Online service in working days and 24-hours hotline gives longer service time in order to satisfy customer.

4.2.3 Quality and safety

Although HACCP system is promoted by China Ministry of Agricultures, case company has not got this certification yet. However, all operating procedures and products quality are consistent with applicable laws: Food Hygiene Law of the People’s Republic of China and Food Safety Law of the People’s Republic of China. Guizhou Zhiji Logistics Co. Ltd. also provides product safety assurance to ensure food safety. If products are spoilage because of inaccurate temperature, consigner can get compensation maximum triple of cold chain service price.
4.2.4 Relationship

Guizhou Zhiji Logistics Co. Ltd. has good relationships with partners. There are some competitors in this area; however, most customers are in long-term relationship. Case company value partnership highly, and is always trying to improve service level.

Employee relationship is also a vital part in developing strategy. Case company is going to training a group of professional CCL talents, and this is strategic supplement in long-term business expanding. However, there is no specific operating plan on this area.

4.2.5 Innovativeness

Guizhou Zhiji Logistics Co. Ltd. put most innovation on new competitive services, such as new payment methods, new order method (online ordering), and value-added services. Employees are encouraged to offer suggestion and customer requirements are always appreciated.

Technology innovation is highly valued, and refrigeration equipment and refrigeration vehicles with GPS are used. However, technology innovation is a high cost investment and cannot be put to use easily.

4.2.6 Traceability

In order to control the freshness of goods, temperature data during storing is recorded by computer. GPS systems on each truck can post back real-time data during transportation. Real-time data contain: transportation routes, transportation speed, and temperature changes in the cargo space. Thus the transportation time can be controlled through monitoring route changes, and temperature during transportation can be monitored to ensure fresh of merchandise.
4.2.7 Return on assets

CCL project of Guizhou Zhiji Logistics Co. Ltd. has already begun to make profit. However, CCL is not a high-profit project comparing with other logistics projects, because of its upfront investments. In Guizhou province, an increasing number of 3PL companies have got into game recent years, make it is difficult to increasing price.
5. Discussion

5.1 Macro-environment

According to literature review, there is a significant gap of CCL utilization between China and developed countries. The food industry of China is dramatically increasing while there is a development lag in CCL. Moreover, Chinese consumers have focused more on food safety and quality. All these are drivers, which show a promising market of CCL in China. In addition, there are 61.67% of poisoning accidents caused by microorganism (MOH, 2012). So Chinese Ministry of Agricultures releases various supporting standards to push more organizations operate CCL.

Meanwhile, the Food Hygiene Law, Food Safety Law, and Law of Prevention and Control of Atmospheric Pollution give the requirements on CCL. 3PL companies need to do a lot of work to meet these requirements, so in the short-term these laws increase the difficulty and complexity to run CCL. However, in fact these laws can regulate the CCL market order in long-term, and it will continue working to improve and standardize the macro-environment of CCL. According to Whitehead (1995), food law, national food control strategy and food control agencies are three indispensable parts of an effective food control system. The evidence shows that in the Chinese food control system there still exist some defects, and this can be a barrier for CCL.

Moreover, CCL will generate some environmental effects. The cold storage will consume large amounts of energy and possible have refrigerant leakage. Above all, Chinese government focuses a lot of attention on carbon dioxide emission these years, but the transport and distribution procedure will release a lot of carbon dioxide. These can be barriers of CCL’s operation. However, inspection of environmental impact in China is weak, and companies pay few attentions and investment on this problem. So this is not a significant barrier.
5.2 Empirical operation of 3PL

5.2.1 Cost

For Weihai Port Group Co. Ltd., high-tech equipment, such as CIP cleaning equipment, detoxifying machines, vacuum pre-cooling equipment and controlled freezing equipment are in needed, costing plenty of investment. In addition the energy consumption of the cold chain project is high, due to the electricity used. Last but not the least, as Aramyan et al. (2007) said, cost contains spoilage cost and maintenance cost as well, which clearly added up expenditure of CCL program.

Though ammonia refrigeration, the cheaper technology, is chose by Guizhou Zhiji Logistics Co. Ltd. to reduce cost. CCL projects still need a certain amount of investment on special refrigeration equipment and transport vehicles. In addition, comparing with other logistics projects, CCL has higher electricity and fuel expenditure. Though there are few costs on dealing environmental emissions, the high cost is really a barrier of CCL project. It needs a large investment at the very beginning of the project.

5.2.2 Service level

Aramyan et al. (2007) defined service level as features for which distinguished this company from other service companies. In the case of Weihai Port Group Co. Ltd., at the low-end service level, 3PL companies need to compete with small food processing companies, and at the middle and high-end market, there will be some other 3PL companies strive for the same market. High quality service can help to satisfy customers; however, the competition is hard, because the services hardly can stand out from numerous competitors.

Guizhou Zhiji Logistics Co. Ltd. has offered some value-added service to satisfied customer, and to be attractive to target markets while distinguishing from similar
competitors. High service level gain more customers for them, but this only means more existing customers, not new markets. Few drivers can be seen in this aspect.

5.2.3 Quality & safety

In order to run CCL, Weihai Port Group Co. Ltd. is required to have certification and follow the correspondent law, which consume money and time to maintain. The detailed law requirements are described in the microenvironment part ahead. However, the local government supports the CCL because it could upgrade the quality and safety of the fresh product. So government’s support is really a driver of CCL.

There are many standards and laws have requirements on quality and safety, and cold chain help a lot in keeping food safety. Guizhou Zhiji Logistics Co. Ltd. also put a lot of attentions on quality and safety control. However, there is little safety problem in reality operation, and quality has not become a competitive area between competitors yet. So quality and safety control is not a significant driver in operation.

5.2.4 Relationship

The CCL project of Weihai Port Group Co. Ltd. is suspending. Therefore it is hard to evaluate the relationship with different stakeholders. But the relationship with customers is valued, because this influences the market and sales, and decides the possibility of launch of this CCL project.

Although, the need of CCL is increasing, now the market of CCL is still limited. Relationship with customers is vital for CCL, because Guizhou Zhiji Logistics Co. Ltd.’s most businesses are long-term collaboration. This means customers’ need is one of the important drivers for 3PL companies. And the relationship with employee cannot see significant use in CCL project.
5.2.5 Innovativeness

“Controlled freezing-point” and “Vacuum cooling” are the innovative technologies employed by Weihai Port Group Co. Ltd. in the program. Guo et al. (2007) indicated that controlled freezing-point technique could prolong the shelf life of product for which is a technical advantage. This technique requires for professional people and training for workers, turning this aspect becoming a barriers for CCL. Vacuum cooling can shorten the process time, according to McDonald & Sun (2000). Innovation can be a vital driver for CCL.

Guizhou Zhiji Logistics Co. Ltd. has innovations on services and technology, and these have helped CCL in attracting customer. But in this new market of CCL, the innovativeness is not a very important drivers for case company in short-term.

5.2.6 Traceability

Weihai Port Group Co. Ltd. uses RFID technology to trace the product. As Abad et al. (2008) propose, RFID can improve the production efficiency and the cost is not high nowadays. Hence, RFID technology is a driver for CCL. However, the inspection of the quality and safety raw material in China is absence most of the time, making the trace of the product meaningless and blocking the development of CCL.

Guizhou Zhiji Logistics Co. Ltd.’s GPS system increases the cost of CCL project, but it is a useful technology to tracing products distribution. Traceable processes make company can control CCL better, and steerable temperature make better products quality. All this shows traceable procedures help CCL.
5.2.7 Return on asset

According to the calculation Weihai Port Group Co. Ltd. can retrieve the investment in two and a half years, which is quick. Therefore, short investment retrieve is drivers for CCL in this case.

CCL projects do have positive earnings. However, comparing with 3PL companies’ typical logistics project, CCL need a larger upfront investment and smaller market now. Even so, profits and promising markets are significant drivers for Guizhou Zhiji Logistics Co. Ltd. to develop CCL.

5.3 Drivers and barriers

Building on the discussion presented above, drivers and barriers are concluded. There are nine divers: *laws and regulations* standardize CCL in long-term, *society has high requirements* on food safety, increasing *development of food industry*, *higher service levels* do help to gain customers, *support from government* offers more room for CCL, *quality and safety control* help to offer more outstanding products, *customer relationship* is vital for 3PL’s CCL, *innovation* on service and technology also contributes on CCL, and promising *return on asset* makes 3PL to pursue.

Six barriers are: *laws and regulation* increase the difficulty and complexity of operating CCL in short-term, CCL has a series of *environmental impacts*, the CCL’s *market order* has not been clearly regulated, an *increasing number of competitors* enter this promising market, *high cost and large investment* upfront, and 3PL companies’ similar services limit a *low unite price* of merchandise.

5.4 Significant Drivers and barriers

The operating situation is different between Weihai Port Group Co. Ltd. (case company 1) and Guizhou Zhiji Logistics Co. Ltd. (case company 2). Various drivers
and barriers are evaluated depending on the severity in Table 3. Thus significant driver or barrier that has equal or over four stars is identified.

Table 3: Evaluation of drivers and barriers

<table>
<thead>
<tr>
<th>Factors</th>
<th>Case company 1</th>
<th>Case company 2</th>
<th>Significant factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drivers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits from laws and regulations in long-term</td>
<td>☆</td>
<td>☆</td>
<td></td>
</tr>
<tr>
<td>Social requirements on food safety</td>
<td>☆☆</td>
<td>☆☆</td>
<td>★</td>
</tr>
<tr>
<td>Development of food industry</td>
<td>☆☆☆</td>
<td>☆☆</td>
<td>★</td>
</tr>
<tr>
<td>High service level</td>
<td>☆</td>
<td>☆</td>
<td></td>
</tr>
<tr>
<td>Governments’ support</td>
<td>☆☆</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality &amp; safety control</td>
<td></td>
<td>☆</td>
<td></td>
</tr>
<tr>
<td>Customer relationship</td>
<td>☆☆</td>
<td>☆☆☆</td>
<td>★</td>
</tr>
<tr>
<td>Innovation</td>
<td>☆☆</td>
<td>☆☆</td>
<td>★</td>
</tr>
<tr>
<td>Return on asset</td>
<td>☆☆</td>
<td>☆☆☆</td>
<td>★</td>
</tr>
<tr>
<td><strong>Barriers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limits from laws and regulations in short-term</td>
<td>☆</td>
<td>☆☆</td>
<td></td>
</tr>
<tr>
<td>Environmental impacts</td>
<td></td>
<td>☆</td>
<td></td>
</tr>
<tr>
<td>Unregulated market order</td>
<td>☆☆</td>
<td>☆☆☆</td>
<td>★</td>
</tr>
<tr>
<td>Increasing competitors</td>
<td>☆☆☆</td>
<td>☆☆</td>
<td>★</td>
</tr>
<tr>
<td>High cost and investment</td>
<td>☆☆☆</td>
<td>☆☆</td>
<td>★</td>
</tr>
<tr>
<td>Low unite price</td>
<td>☆</td>
<td>☆☆</td>
<td></td>
</tr>
</tbody>
</table>

Two factors get one star. Quality & safety control and Environmental impact are mentioned as inconspicuous drivers in case company 2.
Three factors get two stars. Benefits from laws and regulations in long-term is identified as drivers by both case companies, while the contribution is not remarkable at present. Consequently only two stars are given. High service level is the same. Government support matters to case company 1, so two stars are given. While the situation is not the same with case company 2, no concerning information is found.

Two factors get three stars. Limits form laws and regulations in short-term and low unite price all get one from case company1 and two from case company 2, which means two cases are facing pressure from laws and regulation, while pressure of case 2 is more intense.

Two factors get four stars. Social requirements on food safety are identified as drivers of both companies. Since it is one of the main reasons for companies to get start with CCL program, each company gets two stars. As for Innovation, two cases have innovative technologies in their program, and the techniques are important for both companies to carry out CCL. Hence two stars are offered by each case.

Six factors are given five stars. Development of food industry gets three stars from case 1, because of the prosperous food industry of the local area; two points from case 2, location of company 2 also has booming food industry although less booming compared with company 1. Customer relationship and Return on asset are all get two points from case 1 and two points from case 2, meaning these two factors are significant drivers for both companies. The other three factors are significant barriers: unregulated market order, increasing competitors, and high cost and investment. The market order in China is not so good for cold chain and the disorganized market limits the booming of CCL. Competitors in CCL are increasing in recent years that became a barrier. The cost of running a CCL program is high for both companies.

So, nine drivers and six barriers were identified according to macro-environment of CCL in China and empirical data the cold chain performance model. These drivers
and barriers were evaluated on the basis of their importance using evaluation model made by authors. At last, five significant drivers were recognized, they are: social requirements on food safety, development of food industry, customer relationship, innovation, and return on asset; three significant barriers are: unregulated market order, increasing competitors, and high cost and investment.
6. Conclusion

The thesis studied CCL, a particular logistics chain that applied to process, storage, and transport and distribute temperature sensitive and perishable product. It was found out that temperature control through the logistics process could decrease the huge loss of the perishable product and secure the quality and safety of the product to some degree, therefore CCL was established. Despite of the advantages of the CCL, environment impact of CCL cannot be ignored. Road transportation caused oil consumption and CO₂ emission; energy consumption of CCL is huge; refrigerant leakage contributes to the global-warming. Companies provide logistics service for other industrial sectors is denominated as 3PL companies.

The major purpose of this thesis is to conclude drivers and barriers for CCL of Chinese 3PL companies. External and internal drivers and barriers are presented below.

The external drivers for CCL were benefits from laws and regulations in long-term, government support, society requirements on food safety, and development of food industry. External barriers include limits from laws and regulations in short-term, environment impact, and unregulated market order. Among these factors, society requirements on food safety and development of food industry are identified as significant external drivers for CCL. Unregulated market order is decided as the major external barriers.

Customer relationships, high service level, innovation, quality and safety, and return on assets are identified as internal drivers. Internal barriers are increasing competitors, high cost and investment, and low unite price. Three out of five factors are determined as significant factors: customer relationship, innovation and return on asset. As for internal barriers, expect low unite price, the other two are significant.
There is few studies focus on CCL of Chinese 3PL companies, and most of studies focus on this area is highlight on macro-environment of CCL. However, some significant internal drivers and barriers are discovered through case study: customer relationship, innovation, return on asset, and high cost and investment, which have not been given attention before. This thesis has contributed at more comprehensive background of CCL by drawing upon a combination of literature and empirical experiences to determine the importance of drivers and barriers. There are five significant drivers and three significant barriers, and it is obvious that factors can contribute to CCL are more than factors can prevent it. CCL has clear room for improvement, and it is an opportunity for Chinese 3PL companies. These factors can help government to know how to make better policies to promote CCL. Top management 3PL can further know how to boost CCL according to drivers, and avoid or eliminate the barriers. Thus 3PL can be able to make more effective use of internal and external drivers as resources, and will be more successful to enhance competitiveness more effectively.

6.1 Managerial implications

One of the major conclusions of the study is the drivers and barriers for Chinese 3PL companies. This conclusion is based on Chinese macro-environment of CCL market according to literature and specific 3PL companies’ experiences. 3PL companies that are intended to carry out CCL in China can use this result in market analysis and CCL project feasibility analysis. For the companies that are operating CCL now, the result can help with finding their bottleneck of program and developing competitive advantages.

The evaluation method of significant factors for CCL is another finding in the thesis. This model can identify significant factors based on the analysis of literature and empirical data. It is especially applicable for qualitative factors, which are presented in words rather than figures. The method is not influenced by companies’ size or type,
and could be generalized to most companies. When companies with CCL use this model, these drivers and barriers listed by this study can be used as a reference to analyze their own significant factors for operating CCL, and develop more efficient CCL. Companies without CCL can use this method to evaluate some qualitative factors in their operation processes to identified significant aspects.

6.2 Further study questions

This study uncovered the barriers of CCL for Chinese 3PL companies. Hence the following question would be how to get rid of the barriers, such as how to reduce the environmental impact of CCL, how to gain competitive advantage in CCL market, and how to reduce cost and investment.

During the study process, we found out that there was little research about systematic management tools for CCL, and the case study showed no efficient management system as well. Under the circumstances, further study may focus on the efficient management tools for CCL.

This thesis is a qualitative case study for CCL. Due to the time limit quantitative research method was not used. While quantitative method could help with the generalization of the result. Future study could consider looking at the same question from a quantitative view.

Many innovative technologies have been used in CCL, such as GPS, RFID, Ammonia refrigeration, controlled freezing point and vacuum cooling. What is the difference among these technologies, and which kind of technology is more suitable for CCL are valuable questions to answer.
This study only focused on Chinese 3PL companies that employed CCL; hence the conclusion may not suitable for other kinds of organizations. Drivers and barriers of CCL in manufacturing industry can be a further study area.
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Appendixes

Interview questions

Four interviews have carried out. The following questions were reorganized systematically.

1. The reason for employing cold chain logistics.
   a) Possible aspects: customer requires for cold chain, top manage decisions and social or legal factors affection.

2. What kind of refrigeration technique is used in cold chain logistics? Does this kind of technique require professional people?

3. What is the detailed procedure for your cold chain program? What is the estimated cost for it?

4. What kinds of machine are used? (For example, what kind of machine is used for storing the goods and the types of tools used throughout the transportation processes)

5. Is there some special requirement for packaging? If there is, why needs it and what are the particular requirements?

6. What about the employee training for cold chain project? Is there some training program is running?

7. Do the top managers attach importance to the cold chain project?

8. Is the cold chain project profitable? How much investment is required to run the project? How long it will take to get back the investment?

9. What kinds of product does the cold chain program offer?

10. What technology is used to trace the product?

11. Is there some difficulty when operating the cold chain?
   a) Possible aspects: pressure from technique, management, and politics. Do the frequently occurred food product quality problems affect the cold chain
management? For example: frequently quality check from the government, the break out of various kinds of virus generated from chicken and cattle.

12. What is the energy consumption estimated for the program? Any energy saving action in the program?