Collaborative inventory management in Chinese hospital supply chain: barriers and implementation

BY

Ying fei Wang

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Supervisor: Dr. Kim Tan

DECLARATION

This is to confirm that this is my own work and does not break the University, Department or module conventions on plagiarism as outlined in the MSc Postgraduate

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ABSTRACT

With the development of supply chain, the collaborative supply chain management has increasing popular worldwide in recent years. There are many advanced method of achieving supply chain collaboration, such as VMI and CPFR, which focus on inventory management. In addition, it has been adopted by many industries such as manufacture (Dell) and retail (Wal-Mart).

With the dramatically increasing of China drug market, more and more supply chain problems have appeared recent years. Due to redundant structure and complex network of pharmaceutical supply chain with high supply-related cost, it is necessary and urgent to integrating supply chain and developing collaborative inventory management (CIM). However, there are many problems block the implementation of CIM. This aims of this research is to find the current issues existing in hospital pharmacy inventory management as well as the barriers of implementing CIM in the whole pharmaceutical supply chain. Finally, combining with the capacity of pharmaceutical industry and the culture of China, the solution would be given at the end with some discussions.

In this research, there are two methodology applied, interview and case study. The interview focus on understanding the current issue and barriers from different

members involved in hospital supply chain. It includes 11 interviewees from 4 aspects of the supply chain (manufacturer, wholesaler/distributor, hospital and government). In order to analyse specific problem of hospital pharmacy inventory management, one wholesaler/distributor company is selected from the previous interviewees with its upstream suppliers and upstream hospital. The customised modification is raised by using VMI and CPFR. In addition, combining with the outcome of interviews, the implementation of CIM in future China would be discussed at the end.

Key words: Hospital supply chain, collaborative inventory management, VMI, CPFR

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Contents

Chapter 1 Introduction

1.1 Overview

With the dramatically increasing of China drug market, more and more supply chain problems have appeared recent years. Due to redundant structure and complex network of pharmaceutical supply chain with high supply-related cost, it is necessary and urgent to integrating supply chain and developing collaborative inventory management. The existing research illustrates that the overall costs of this sector can be reduced by implementing collaborative inventory management (CIM) (Bhakoo et al.,2012). Moreover, the CIM could lessen the bullwhip effect.

However, unlike other industries such as manufacture and retail where there have been experienced the supply chain management for a long history. The healthcare sector is behind other industries in practice of collaborative inventory management (McKone-sweet et al., 2005; Baltacioglu et al., 2007).

In terms of the development of supply chain, the attention has changed from simple order making, purchasing and forecasting to collaborative management (Halley and Beaulieu, 2009). According to Bozarth and Handfield (2006) collaborative supply chain focuses on joint activities or establishing relationships with partners. In addition, Barratt(2004) indicates that the supply chain collaboration could integrate the external relationship between supply and demand as well as delivery, so that improving the performance of supply chain significantly.

1.2 Problem statement

In western countries, the pharmaceutical supply chain is constituted by general three echelons: manufacturer, wholesaler/distributor and retailer. In general, there are two channels of sale for manufacturer; one is directly to hospital, or selling through wholesaler/distributor. Moreover, the function of wholesaler/distributor primary is responsible for logistics providing distribution network. In terms of the profits of wholesaler/distributor, although it is relatively lower than other participants involved in supply chain, it still is accepted. Compared with China, there is a small amount drugs selling to hospital. For example in American, the drug sale and hospital are completely separated. There are a few clinical drugs in hospital's inventory.

However, compared with western countries, the situation in China is totally different. The structure of supply chain is redundant and complex with large number intermediaries. In addition, most of wholesaler/distributor runs as sale agent undergoing the risk of accounts receivable from manufacture and hospital this will be explained detailed in 4.1.2.1. It is forbidden that pharmaceutical manufacturers sell their drug directly to hospital no matter the local company or foreign, the selling must via wholesaler/distributor. There are huge numbers of wholesaler/distributors with approximately 13,400 by the end of 2010 and the scale are small and scattered with little market share; this number in American is about 70. As a consequence, the development of market is extremely imbalance and with very low marginal income. Due to the long structure and with low level application of information sharing

between upstream and downstream of supply chain, the bullwhip effect is very serious, so that many backlogs inventory kept hospital and distribution company in China. Moreover most prescription drug control by hospital and the pharmaceutical industry is influenced by strong institutional and regulatory pressures (Shah, 2004).

In 2011, the proposition of separating drug dispensing from medical put forward. That means the government of China supports the inventory of hospital could be managed by distributor instead of dominated by hospitals themselves. This proposition should bring many opportunities not only to the manufacturers, wholesalers but also to the patients. The wholesalers could be more initiative and motivated to dominate pharmaceutical industry. Regarding to manufacture, it is an improvement innovation of medicine and accuracy of forecasting. On the other side, the patients could enjoy a reasonable price of drug due to implementation of collaboration inventory management.

However, it is very difficult to implement collaboration inventory management in Chinese pharmaceutical supply chain so that until today just few warehouse of hospital in Beijing managed by wholesaler/distributors. Therefore, there must be some barriers to implement collaboration inventory management. It is seen from Chinese big environment; First of all, the structure of pharmaceutical supply chain is more complex than other countries. There are less integrated distribution centres and advanced logistic infrastructure. Secondly, the information technology is increasing

widely application, but the information sharing and exchanging between the whole supply chain are still at a low level in China. On the microscopic aspects, pharmaceutical products are characterised by long developmental cycles that are distinctly different from medical devices. These long lead times have a significant impact on capacity planning and supply chain strategies, particularly inventory management (Shah, 2004). In addition, the operation of healthcare supply chain is different from the other businesses because it is extremely difficult for hospital to predict the consumption of patients (Jarrett, 1998; Scheller and Smeltzer, 2006). These factors lead to perennial problems such as stock-outs and drug expiry within pharmacy departments in hospitals.

Therefore, it is necessary to introduce the strategy of collaborative inventory management in China hospital supply chain, and investigate the drivers and barriers of implementation. Finally the suggestions should be given combining with the current status of Chain.

1.3 Objectives of the study

The main objectives of the study are to investigate the current barriers and attitudes of hospital pharmacy inventory management from different roles (manufacturer, wholesaler/distributor, hospital and government) of pharmaceutical supply chain. The investigation is consist of 11 interviews which including 1 SFDA office, 3

manufactures, 5 distributors and 2 public hospitals. In addition, the analysis is also combined with one in-deep case study which involved three echelons of pharmaceutical supply chain for researching specific issues of hospital. In addition, the suggestions would be given combine with the theory of collaborative inventory management. Finally, the discussion of the implementing collaborative inventory management in China is an important part of this dissertation, as well.

1.4 Research questions

Based on core objective of this dissertation, two research questions are come up to satisfy the objective.

Research Question 1 : what are the current issues of hospital pharmacy inventory management in China?

Research Question 2 : what are the drivers and barriers to achieve collaborative inventory management in pharmaceutical supply chain?

Research Question 3 : How to implementing collaborative inventory management in China in the future?

1.5 Scope of study

The study concentrates on the healthcare sector in Mainland China. For understanding comprehensively, 11 interviews involving a supply chain network of three pharmaceutical manufacturers, five wholesaler/distributors, two hospitals and one SFDA (Safe food and drug administration) officer were analysed. One of wholesaler/distributor (KY) with its downstream customer (301 hospital) as a case were also studied in-deep.

1.6 Structure of work

The structure of this dissertation is illustrated below:

Chapter 2 (Literature Review) will introduce the current status of China pharmaceutical supply chain, including the market, structure and network of supply chain. Then the two common methods of collaborative supply chain management: VMI (Vendor-managed inventory) and CPFR (Collaborative planning, forecasting and replenishment) are explained in the next section. Finally, there are the discussions about the existing researches and empirical study in other industries and healthcare industry of these two concepts, respectively.

Chapter 3 (Research Methodology) will illustrate the two methodologies: interviews and case study. The question design and analysis method (Grounded theory) of interviews will be shown. With regard to case study, the primary and second data were collected, which mainly consist of qualitative data. In addition, the analysis method (Data Flow Diagram) was explained, finally.

Chapter 4 (Data collection and analysis) will concentrate on analysis the attitudes as well as the barriers from four perspectives (manufacturers, wholesaler/distributors, hospitals and government). In addition, chapter 4 will analyse deeply the issues that existing in the operations of one of wholesaler/distributors with its partner.

Chapter 5 (Findings and discussions) will show the results of the research, which including the initial and final improvements of 301 hospital pharmacy inventory management for KY with two data flow diagrams. Furthermore, the main drivers and barriers of implementing collaborative inventory management would be discussed in section 5.4. The discussions of CIM implementation in China in the future would be also included in this section.

Chapter 6 (Conclusion) will summary this research and recommend the outcomes. Finally, the limitation of this dissertation would be presented.

1.7 Summary

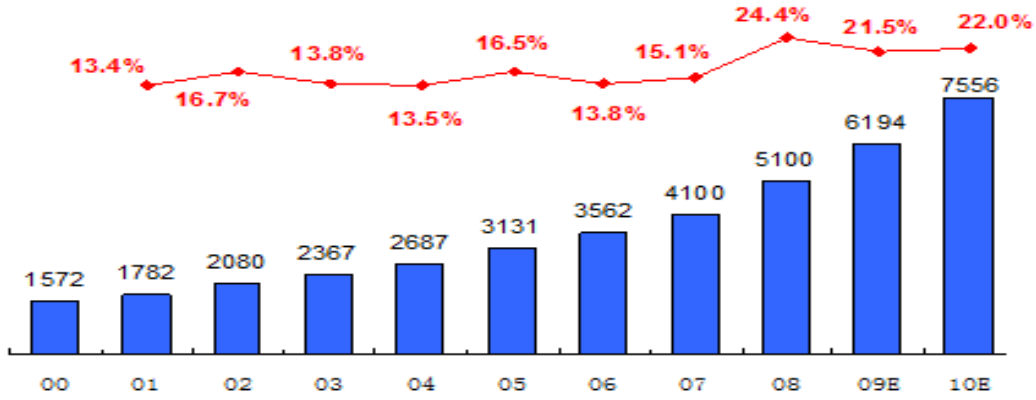
In this chapter, the overview of this dissertation has been mentioned including the problem statement, objectives, research questions and the scope of the study. This study will concentrate on Chinese pharmaceutical supply chain. In total, there are 11 interviewees involved into this research and it could be divided into two parts: interview and in-deep case study. The main goal of this research is to provide insights on the true meaning of collaborative inventory management.

Chapter 2 Literature review

2.1 Current status of pharmaceutical supply chain in China

With development of economy, the position of Chinese drug market has been increasing gradually. The gross sales of drug in China took account for 12.7 per cent of world market in 2010, with increased from 0.88 per cent of 1978. The average increase rate of China pharmaceutical industry would still keep high level about 22-27 per cent each year, compared with world average increase rate of 5-7 per cent in the next 10 years (SPDA).

In addition, according to population census of China in 2010, the number of people over 60 years old was about 178 million, accounting for 13.26 per cent of gross population. Due to increasing of aging of population, China has been the driving force of the world pharmaceutical market according to the report published by IMS Health in 2010. In addition, Chain would be the biggest drug market in 2020 with huge potential and more foreign business would flood into (Yang and Liu 2010).



Base on SPDA

Figure2.1 Chinese drug market scale from2007 to 2010 (a hundred million RMB)

In order to strengthen the competitiveness, the government of China has been invested heavily to promote rapid development of pharmaceutical industry in recent years. This figure shows that the proportion of investment of medical health accounting for central financial expenditure of Chinese government during three years from 2009 to 2011.

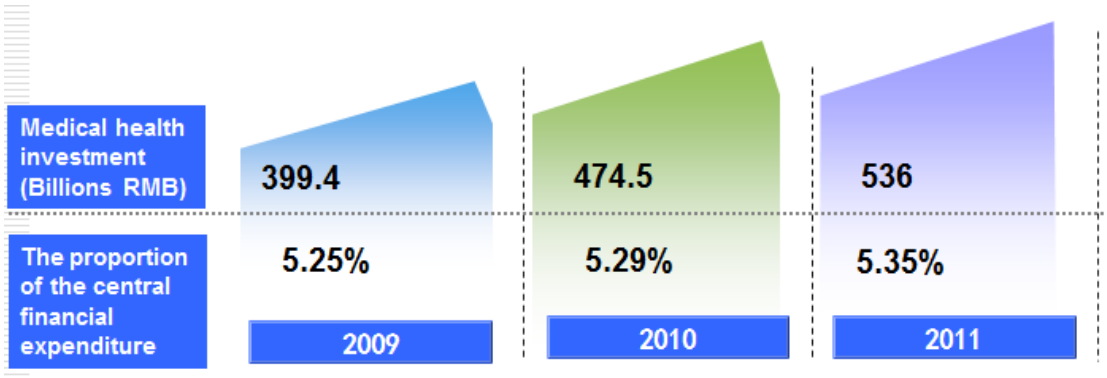


Figure2.2 Investment in healthcare sector in China from 2009 to 2011

2.1.1Hospital dominating market

In chain, the three main terminal of sale are community healthcare institution, retail drugstore and public hospital pharmacy. Among them, hospital is the biggest retail approach. According to the statistics, the sales of hospital pharmacy are more than 70 per cent of market share in 2012 (SPDA).

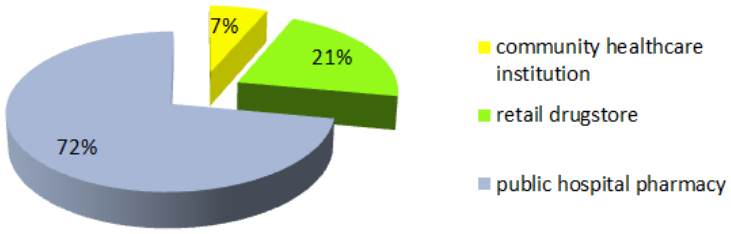


Figure 2.3 Portion of pharmaceutical market share

In addition, the vast majority of prescription medicines sell through public hospital in China (Liu and Cheng, 2000).Each year the centralized purchases of prescription drug are organized by government, but dominated by hospitals. Through the regional price bid, hospitals have right to select who could be the manufacturer for one kind of drug and what the quantity of order. Moreover, the pharmacies are managed by hospitals themselves with amount of labour and capital.

However, separating drug dispensing from medical is a general law in many developed countries, such as America, Germany and Japan. It means that the doctor is

just responsible for making a prescription instead of sell drug. There is a few clinical drug in hospital inventory, which managed by pharmacist (Outlook weekly, 2007)

Secondly, Chinese drug market is supply exceeding demand. The market is chaos with great number of small-scale manufacturers and wholesaler/distributors and located dispersedly. Moreover, approximately 80 per cent of pharmaceutical manufacture of China relies on imitation; it is often that one kind of drug produced by dozens or even hundreds of pharmaceutical factories, result in little differentiation between drugs and a mass of alternate (Yang Shu-jie, Liu Hao 2010). Therefore, public hospital of China has been absolute control power of market.

2.1.2 Structure of supply chain

In China, the typical hospital supply model is six-hierarchy which shown as figure 4 involving manufacturer --- national wholesaler/distributor --- regional wholesaler/distributor --- local wholesaler/distributor --- hospital --- patient.

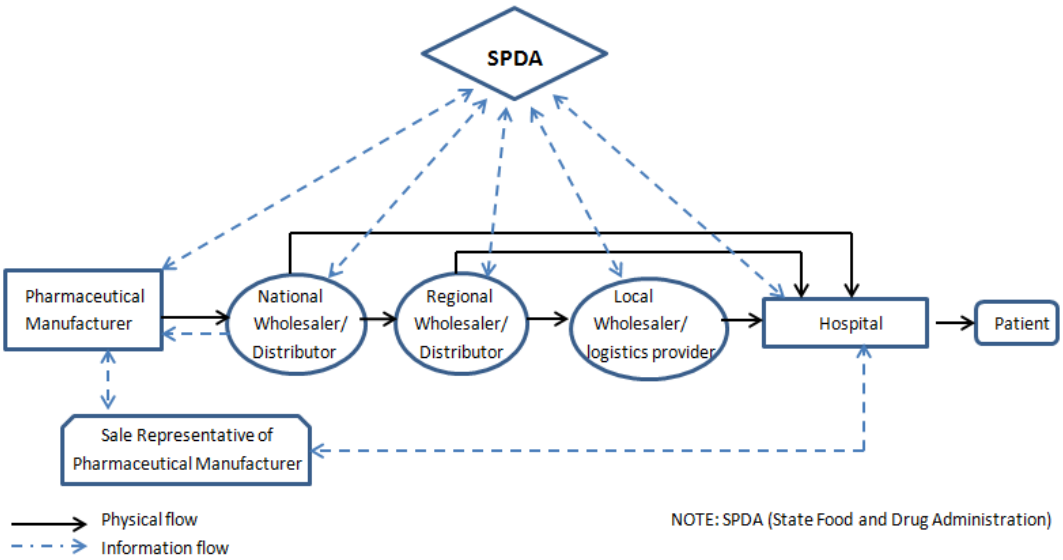


Figure 2.4 the structure of China pharmaceutical supply chain

The characteristics of Chinese pharmaceutical supply chain are tediously long. Drugs firstly are distributed to different provinces from manufacture factories by national wholesaler/distributors and then purchased by regional wholesaler/distributors who responsible for dispatching the drug to required districts. The drugs then from local logistics centre flow into retail market and hospital. Alternatively, drugs for hospitals in metropolis such as Beijing, Shanghai would be distributed directly by local national wholesaler/distributors. However, generally hospitals cannot order from manufacturers directly, due to the undeveloped of third party logistics in China and particular regulation about the pharmaceutical cannot sell drug directly to hospital, it

must though the wholesaler/distributors in Chian (Liu and Cheng, 2000). Moreover, In China, the protectionism of district economy is very common (Hu et al.,2010); according to the GSP (good supply practice) it is nearly impossible to establish warehouse at other districts that outside the scope of business. Thus, it is blocked to national wholesaler/distributors to institute their own national-wide supply network. The drugs have to be distributed by regional wholesaler/distributors and transported through local logistic companies' network.

As consequences of tediously long of supply chain, the most serious problem caused is poor information communication exchange between upstream and downstream of supply chain. It can be seen from figure 4, there is nearly no data transfer between each participant. Each member of this traditional system is mutually independent, pursuing their own interests to maximize profits. With the expansion of the market, it is more difficult to control. The companies do not directly face the end of final consumption. The seriously lagging behind information will ultimately affect the competitiveness of distribution channels and product development (Andy and Mehmet.C, 2010).

Another result of that is the price of drug has been driven up dramatically with cost adding in each stage (Sun et al.,2008). For example, first centralize public biding in December of 2002 within Sichuan provincial hospitals; most of the quotation prices were lower than the wholesale price by one-third. Some even less than fifth of the

wholesale price Huang Y. Z. (2001). However, the average gross margin is not high for Chinese wholesaler/distributor which is about 12.6 per cent，moreover, the average cost rate reached 12.5 per cent (Zhang， 2008). It means there is about 1 per cent margin profit.

Additionally, counterfeit drugs have opportunity to enter the market. SPDA (State Food and Drug Administration) is a department of Chinese governments, which responsible for monitor and trace the flow of drug and control the quality. However, due to supply chain excessive length, it is high difficulty to executive this job. China's SFDA counted 188,122 cases of the distribution of unlicensed drugs and medical products in 2010. (SFDA)

2.1.3 Pharmaceutical supply network

Chinese pharmaceutical supply network is low integrated. As it shown in figure 5, the wholesaler/distributor network presents a shape of pyramid. This shape is better for market penetration, but it would cause poor information communicated（Li et al.,2005）.According to statistics from SFDA, by the end of 2010, there were more than 4678 pharmaceutical manufacturers in China, 13,461 pharmaceutical wholesaling and distribution companies (the number is 200 times that of the United States), 261,996 drug retail stores (the number is five times that of the United States) (SFDA).

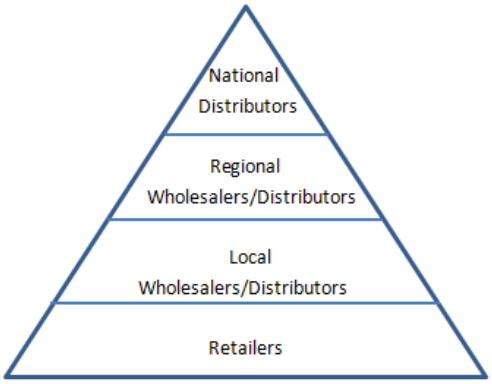


Figure 2.5 Pyramid-shaped Network

However, the vast majority of distributors are very small-scale in China; only approximately 400 wholesaler/distributors have more than 50 million RMB in annual sales. In 2012, the three largest enterprise sales accounted for only about 20% of the pharmaceutical market share. However, in United States, there were about 70 pharmaceutical wholesale enterprises, and the sales of top three commercial pharmaceutical companies accounted for more than 90% of the share of the national drug market. The comparison between and Chain and America has been shown on table 1. China's pharmaceutical supply network is low integrated with lack of supply chain management and, leading to expense ratio of distribution and logistics is more than four times of international advanced level (Zhi Yan consulting company 2012.)

	Market Scale	Number of Wholesaler& Distributor	Number of Leading Enterprises	Market Share (Per cent)	Logistics cost/Sales profits	Net Profit Rate
China	Small	16000	3	20%	> 10%	0.72%
USA	Huge	70	3	96%	2.6%	1.5%

Base on Zhi Yan consulting company 2012

Table 2.1 comparison of China and the United States

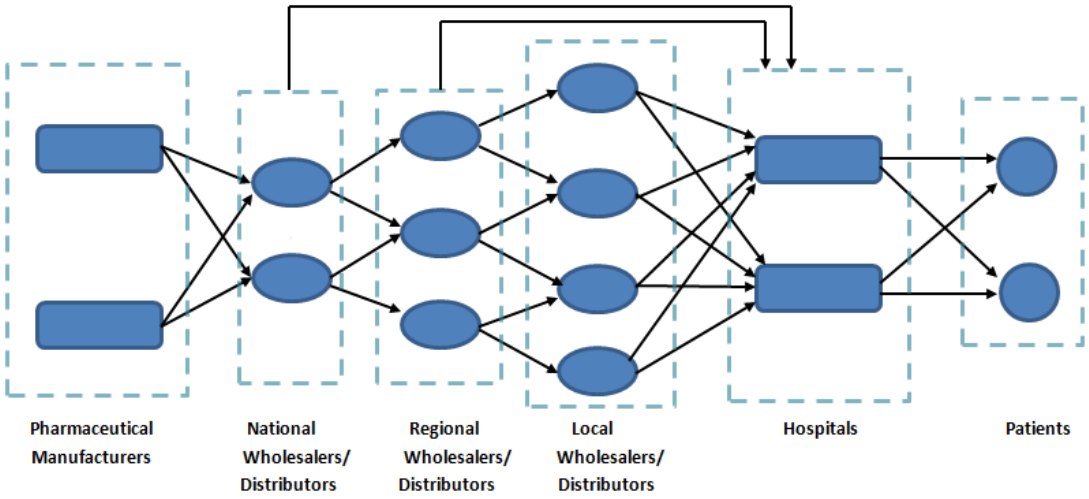


Figure 2.6 the supply network of China pharmaceutical industry

Another characteristic of China pharmaceutical supply networks is over complex and chaos. In general for one large-scale manufacturer, it has more than 50 direct wholesaler/distributors and 150-300 indirect wholesaler/distributors. Local protectionism in China is very normal. It is nearly impossible to establish warehouse at other districts that outside the scope of business. Therefore, currently, only two

strength enterprises Sinopharm and Jointown have their own national distribution networks, and other companies merely have local distribution network (Ma and Huang, 2010).

Numerous participants and overlapping supply network could cause conflict of channel, which refers to companies established two or more channels in the same market. Because pricings of drug are different in different provinces, in order to win customer, some distributing companies purchase the drug with lower sale price that sold in other province, and then sell them to local retailers with the price lower than the rivals, thereby obtaining more profits (Hu chun, (2007). This kind of behaviours has seriously disrupted the market order and reducing loyalty of manufacturers.

2.1.4 Information sharing

In China, 95 per cent of pharmaceutical wholesaler/distributors have IT systems, but is largely due to the rigid rules of the GSP (Good Supply Practice). GSP is a standardized management system referring to planned purchase, inspection, storage, sales and after-sales service and other sectors, to ensure quality of drug during circulation (Ma and Huang, 2010). However, only less than half of the pharmaceutical enterprises operate management by information systems (Hu et al., 2010). Moreover much software just could satisfy the requirements of transportation planning and manufacturing resource planning stage, lack of the awareness of implementation of

the enterprise resource planning (ERP). With regard to information open, there are 88.7 per cent of enterprises have internal LAN, while only 11.7 per cent of companies published the information on the website Kufang (2005).

It has been applied barcode technology for 10 years in China, but the rate of utilization mere 58.8 per cent in pharmaceutical industry, which far below it of food and daily necessities(Lang, 2009). The lower barcode usage would inevitably lead to the low efficient inventory management and high error rate. Moreover, there is on uniform drug code and coding standard for pharmaceutical industry. Different parts of the supply chain develop their own logistics encoding, it results in that codes may only be used in their internal system, not compatible with each other. Thus, information sharing between upstream and downstream in pharmaceutical supply chain is still not achieved. The inefficient communication would inevitably hinder the development of supply chain.

2.1.5 Third party logistic

3PL (third party logistic) could solve this problem. 3PL (Third party logistic) means that the external logistic organization acts as the connection between company and client to provide logistic services. With the increased market competitions and customer requirements, more and more companies outsource their logistic activities to third party logistic service providers in order to pay more attentions on their core

activities (Vaidyanathan, 2005) and to achieve greater competitiveness (Welson, 1996).

2.2 Healthcare supply chain

2.2.1 Supply chain structure

With the development of public healthcare services in many countries all over the world, the costs of healthcare are increasing rapidly. The healthcare issues like medical errors, safety and growing medical costs are drawing more and more attentions (Stock et al., 2007; Gowen et al.,2008). One important aspect of healthcare is its supply. As Grossman (2000) said, in a typical hospital, 38 percent of expenditure on goods is spend on moving and handling supplies, and this is significant compared with less than 10 percent for most industries. Nachtmann and Pohl (2009) give a more recent figure about the proportion of healthcare provider's cost on supply chain. They pointed out that 31 percent of the average healthcare services provider's annual operating expenditure is on the cost of supply chain activities, including infrastructure, assets, information, procurement, delivery, storage, return and healthcare related disposal of products.

Therefore, managing the healthcare supply chain in an efficient way is significant to the performance of service provider on its cost and quality.

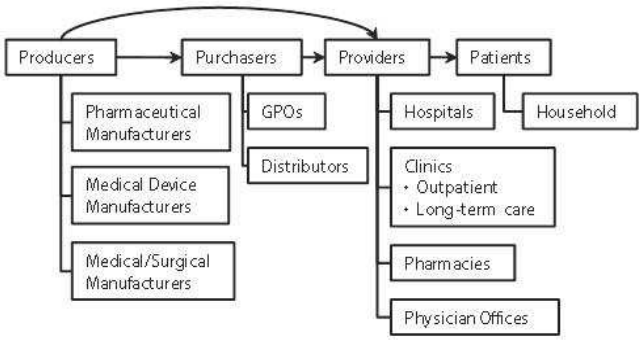


Figure 2.7 Typical healthcare supply chain structure

As it is shown in figure 2.7, the typical healthcare supply chain structure in most developed countries consists of 4 parts: producers, purchasers, providers and patients (Burns, 2002). Moreover, these components could be divided into two groups: the internal chain, like hospital storage and patient, and the external chain, like manufacturers and distributors (Schneller and Smeltzer, 2006).

Producers produce drugs, medical devices, and medical or surgical supplies in the beginning of the supply chain. In general, producers operate significant number of product pipelines to maintain their productivities.

Purchasers, which typically consist of GPOs (group purchasing organizations) and distributors, are responsible for the trades and shipping of products from producers to providers. Shah(2004) states that approximately 80 per cent of healthcare demands in UK are transmitted through intermediaries of purchasers and three dominant purchasers account for approximately all the demand in UK healthcare market. It shall be noted that the purchasers in the supply chain tend to be less and large (Shah, 2004).

The Australian healthcare supply chain also has the similar composition: 35 pharmaceutical manufacturers (Medicines Australia, 2008) and 1250 hospitals(Australian Government: Department of Health and Ageing, 2007), but only 5 distributors/wholesalers(More and McGrath,2002). In addition, providers could also trade with producers directly without the patricianly of purchasers. If the demands are large, hospitals and retailors would request shipments from producers distribution centre directly in the consideration of efficiency and flexibility (Mustaffa and Potter, 2009).

At the final stage of the healthcare supply chain, providers such as hospitals, pharmacies and clinics would use the medical products to provide healthcare services to patients.

As Singh et al.(2006) says that there are three types of flows in the process of supply chain management: physical product flow, data flow, and financial flow. The physical product flow manages the healthcare goods and services to meet the demands of patients. Data and financial flows are used to present the efficiency of product flow and the operating performance in the healthcare supply chain design (Kowalski, 2009).

According to Shah (2004), some typical features of the healthcare supply chain that reflects the performance could be seen. He points out that it would cost 1000 hours to 8000 hours for a product to get through the entire supply chain. Moreover, he says

that the inventory levels are typically equal to 30 percent to 90 percent of annual demand in quantity and this would occupy 4 to 24 weeks stock time of finished goods.

Related to the implementation of supply chain management in pharmaceutical industry, a number of issues would be specified.

2.2.2 Characteristics of medicine

2.2.2.1 Drug life cycle

Like most market products, pharmaceutical products also have their own life cycle. Three stages of its life cycle are tightly associated with the management of pharmaceutical supply chain. Firstly, due to the special characteristics of drug, the lead time of a new drug is long. Besides, the research and development for a new drug would cause large cost. Dan (2004) reveals that the development for a new drug would typically cost 800 million dollars and 14 years. Secondly, after the product has been approved to spread into market, it would meet its period of patent protection. Because the low market competition, pharmaceutical products are spread rapidly to occupy as large market as possible. Due to the high cost on the research and development of drug, Drug Company would make best effort to recoup its cost (Dan, 2004). However, this golden age seem not to bring significant improvement on the supply chain. On the one hand, this competition-free period is shorten, typically from 5 to 1 years (Shah , 2004). On the other hand, when pharmaceutical company mainly

focuses on the large profit, the sense of improving the management of supply chain is low. Finally, the patent protection expired. Large number of alternative products or generics would make the market more competitive (Lauer, 2004). This would produce great pressure on the entire supply chain.

2.2.2.2 Business education

In a supply chain, physicians generally master the of decision-make rights of procurement. However, their sense of supply chain management seems to be low (Scheller and Smeltzer, 2006) This would hinder the improvement of supply chain.

2.2.2.3 Forecasting

Forecast is a key factor in the healthcare supply chain management. But due the special characteristics of pharmaceutical industry, it is difficult to be well operated. According to (Kathleen et al., 2005), the difficulties exist in forecasting frequency, primary diagnoses for patient and the related pharmaceutical product demand.

2.3 Collaborative inventory management (CIM)

Simatupang and Sridharan (2002) say that supply chain collaboration is more than one independent enterprise working together to plan and undertake the operation of supply chain with greater success than before acting alone. It is different from supply chain integration, which indicates interaction and assimilation among members rather than focus on physical combination and structure in a supply chain (Ryu, 2006). There are many routine functions of supply chain involved in collaboration, such as distribution, inventory management.

The collaboration began with mainly focused on information sharing among supply chain participants in order to improve an efficient supply chain (Ryu, 2006). Currently, more advanced technology and concepts are achieving instead of only sharing information. Moreover, these wealth concepts have been discussed worldwide, such as vendor managed inventory (VMI) and Collaborative planning, forecasting and replenishment (CPFR) and collaborative logistics management. It has been generally accepted by many industries, because of the unbroken, synchronized, quick responsiveness and lower inventory/logistics costs (Holweg et al., 2005).

The most important advantage of collaborative supply chain management is reduce cost, accelerate operation and improving quality for both parties involved, through building cross-team, in terms of initially inventory and overall management

(Mehrjerdi, 2009). In addition, Ryu(2006) simulated that the more advanced collaboration mechanisms such as VMI and CPFR gain greater profit than less ones.

2.3.1 Vendor-managed inventory (VMI)

2.3.1.1 Introduction

According to Cetinkaya and Lee (2000), VMI was established by Wal-Mart firstly, which is a type of collaborative supply chain. It can be seen from the name, vendor-managed inventory, the vendor takes full management responsibilities of inventory that belongs to retailer's warehouse. Ryu (2006) indicates that This kind of transfer not only benefits retailers focus on their core business and no more burden inventory management, the suppliers could replenish and delivery the orders more flexible, as well. Furthermore, the information sharing has been deeper through VMI.

The original goal of VMI is to improve the performance of the whole supply chain (Simchi-Levi et al., 2000). Ryu (2006) points out that there is still a limitation because of the nature of the business, which could be a conflict of the relationship between suppliers and retailers in terms of the weight of the profits. To same extent, the suppliers have a saving from inventory reduce in their warehouse, while the low stock level might cause the loss of sales and be counterproductive.

However, with regard to inventory holding cost, the VMI is definitely an effective model of inventory management. Traditionally, in order to lessen the stock outs, some safety stock would be kept. It general has negative effect on inventory holding cost. Compared with the conventional management, the VMI has been overcome the limitation. In current system, the inventory holding costs of retailers are eliminated and the service flexibility is increased by more efficiency arrangement of the production planning, delivery, and replenishment.

2.3.1.2 Existing researches of VMI

In terms of the existing researches, the first one should be mentioned is the performance of VMI on reduction of inventory level and cost. Yao (2002) uses a VMI model to test the effectiveness of VMI. Focusing on the important aspect of VMI--information sharing, he points out that the manufacturer would save more inventory carrying cost than retailer since the ratio of inventory carrying spending or the ratio of replenishment lead time becomes higher. Moreover, by comparing VMI with other two supply chain coordinating techniques, VMI shows the greatest performance on reducing inventory level due to the relative high replenishment frequency. Besides, by using VMI, the safety stock ad cycle inventory could also be reduced to some extent.

In the research of Disney and Towell(2003), the VMI effectiveness of reducing bullwhip effect is studied. Lee et al.(1997) describes bullwhip effect as larger

fluctuations caused by buyer's orders to supplier than sales variability to buyers. In other words, the distortion in upstream is amplified. Consequently, the order variance results in significant cost in the system because of uncertainty of demand in each echelon when moving upward the supply chain. It is noted that this kind of inefficiency is caused by the deficiency in communication in the supply chain structure (Chen, et al. 2000.). As a number of studies indicate, the demand visibility in supply chain would be efficient in coping with such a costly effect (Forrester, 1958). Therefore, a well-established information sharing mechanism would be effective in solving the bullwhip effect. Disney and Towell(2003) researches the performance of VMI on bullwhip effect of a supply chain by measuring the comparison between a VMI supply chain and a traditional supply chain. The traditional supply chain is set as a benchmark to measure the improvement that provide by VMI. By using difference equations with parameters from researches of John et al. (1994), Disney et al. (1997) Naim and Towill (1995), and Dsiney(2001), the VMI supply chain and the traditional supply chain are simulated as mathematical model. In this way, the VMI performance is measured qualitatively and quantitatively.

Consequently, VMI shows great capabilities in resistance with bullwhip effect: firstly, large reduction of bullwhip effect at responding to instable change of demand caused by price variations or commercial promotions; secondly, better performance in terms of the inventory recovery; lastly, less order rate variance due to random customer demand under practical retail sales pattern.

Unlike most researches that focusing on the performances of implementation of VMI, the research of Dong et al. (2007) mainly concentrates on the environmental determinants of the adoption of VMI. He points out that the effectiveness of adopting VMI is not generally positive despite a number of researchers present the remarkable results of adoption of VMI. This concurs with Cook (1998) that the mix influences of VMI cause the abandonments by a number of companies. Therefore, to find out these mixed environmental determinants is crucial for the decision of firm on the adoption of VMI. He supposes five environmental determinants that might be related to the adoption of VMI by buyers, and then survey the purchasing managers of great VMI adopted industries such as Industrial Machinery and Equipment. As a result, three hypotheses are supported: the competitiveness of the supplier's market, buyer-supplier cooperation, and operational uncertainty for the buyer. The first two factors are closely connected to the adoption of VMI while operational uncertainty for the buyer seems to have relative low connection.

2.3.1.3 VMI in healthcare

Not like the widely use of VMI systems in other industries such as manufacture and retail (Achabal et al., 2000; Vigtil, 2007), the application of VMI system in pharmaceuticals industry is still at its stage of development. This results in the relative less number of empirical studies on implementations of VIM systems on healthcare supply chain. However, with the features of sharing risks and reducing inventory costs

of VIM becoming more and more prominent, a number of recent studies highlight the applications of VIM technologies on healthcare field.

Haavik (2000) introduces a VMI software which could help hospitals that based on IDS (integrated Delivery Systems) to reduce the supply chain management costs. The VMI software could derive forecasting data based on the historical information of an item by calculating the standard deviation of the demand and the delivery time, seasonal factors and other related factors. Moreover, combining with the demand information, the software calculate the optimum order, stock level, lead time, and then produce an order. In this way, the inventory and demand information collected at the hospital could be converted into recommendations about amount of orders and delivery schedule for the distributor. This brings a number of benefits: for an average-level hospital with total materials purchased value of 16.7 million dollars, its on-hand inventory requirements could be reduced by 69 per cent which means more free capital and less inventory maintaining fee; the approximate expenses for carrying 30 per cent of inventory could be saved; the purchase-order processing costs 0.631 million dollars could be eliminated because of the order-generating automation.

What Kim (2005) studying also illustrates the advantages of VMI in healthcare supply chain. He presents the function of VIM in enhancing the efficiency of healthcare supply chain in South Korea. He states a concept of EHCP (Efficient Healthcare Consumer Response) which is an industry-wide effort aimed at making an efficient

healthcare supply chain. In other words, the purpose of EHCP is to reduce the cost and enhance the effectiveness in the healthcare supply chain. To meet this requirement, VMI technology is implemented for distributor to manage the warehouse of hospital. As a result, the effect in advancing the healthcare supply chain is pronounced. Firstly, combining with electronic information interchange technology, the information integration in this supply chain management is optimized. Moreover, the workload of staffs in hospital could be reduced so that they could focus on their own specialized work. Finally, the most significant improvement is that the total inventory is reduced by more than 30 per cent.

Compared with the relative simple analysis of Kim (2005), Danese (2006) develops the research of VMI to an extended model by researching a case of one of the world's leading research-based healthcare providers GlaxoSmithKline. He illustrates that the application of VMI in supply chain could be extended from the simple chain level to the network level. For both upstream and downstream of the vertical direction of the network, VMI would be used to realize the information circulation and exchange among players in the supply chain. This could reduce the bullwhip effect, and then reduce the inventory level while keeping a relative high service level (Waller et al., 1999; Disney and Towill, 2002). Moreover, the data exchange in the horizon direction, which indicates the partners in the same echelon, is also useful. This enhances the responsiveness to the demands of customer and the integration level of the supply chain network. In addition, the issue of information sharing across the network

enables each participant to measure performance of other members, and then to build of trust in the long term. However, Barratt (2004) states that it seems to be hard to implement collaboration in practice because of the lack of trust between trading partners. What (Augulo et al., 2004) points out would also support the similar issue with Barratt (2004). He considers that he limitation of trust between the hospitals and the manufacturers would block any form of supply chain management collaboration. Moreover, he presents trust as the most crucial factor for successful implementation of VMI.

As a recent study on the collaborative management of inventory, Ryu (2006) reveals several contingent factors which could be the key issues that would affect the implementation of VMI. The study is based on the supply chain structure of a number of Australian pharmaceutical organizations: three manufacturers, two distributors, and five hospitals. Among these organizations, one manufacturer and both of the two distributors use VMI systems to manage their healthcare supply chain. For this manufacturer, the implementation of VMI is based on the direct connection to the hospital and the characteristics of their providing products. Fisher (1997) says that these products have features of stable demand, relative long life cycle, and low stock-out rate. In addition, Ryu(2006) points out that the “ward box” system is operated in the investigated hospitals to implement the collaborative supply chain management. There are three models of this system, and with the model level increasing, the distributor would have higher capability to manage the providing and

demand in the hospital so that to reduce the inventory and release workloads of the hospital staffs. By collecting analysing data from echelon level to chain level, finally he divides the finding to three specific perspectives from manufacturer, distributor, and hospital, separately, and then he points out five factors that could influence VMI collaborative management: product characteristics, spatial complexity, and degree of goal congruence, regulatory environment, and physical characteristics. This is coincides with the study of Danese (2007) about the collaborative management.

2.3.2 Collaborative Planning Forecast Replenishment (CPFR)

2.3.2.1 Introduction

CPFR (Collaborative Planning Forecast Replenishment) is another method of collaborative inventory management, which was developed by a consumer goods manufacturer---Warner-Lambert, and Wal-Mart in 1996 (Simchi-Levi et al., 2000).

Sherman(1998) defines CPFR as an advanced supply chain management model that apply a holistic mechanism to all the partners in supply chain and to integrate the business activities in the supply chain by effectively sharing and exchanging information based on cooperation. Boone and Ganeshan (2000) claim that, Compared with VMI, CPFR seems to be more advanced in collaboration because it focus on joint forecasting and planning rather than independent; moreover, all partners are involved in common business with positive behaviours.

With the funding support of Wal-Mart, IBM, SAP, and Manugistics, CPFR is developed by Benchmarking Partners in 1996 (Fliedner, 2003). At the beginning of its development, researchers study it on collaborative forecasting. This mainly focuses on the early demand data exchange in the supply chain. In the medium-term of its development, the initial collaborative forecasting is advanced to CFAR (Collaborative Forecasting and Replenishment) (Ryu, 2006). It refers to forecast and replenish jointly

based on coordinative collaboration. Finally, to strengthen the collaborative management efficiently, the function of collaborative production and purchasing planning is developed in CPFR.

According to Kamalapurkar(2011), CPFR is developed as the latest coordination mechanism on collaborative supply chain management. Comparing with the earlier arrangements of collaborative supply chain management, such as VMI, CPFR acts on not only replenishment, but also on demand forecasting and production planning. This concurs with the study of Boone and Ganeshan (2000). They state that the typical VMI gives little chance for customer to participate in decision-make activities; as a result, supplier could not make exact corresponding of demand forecasting, production planning, and replenishment. However, CPFR provides a collaborative and joint environment for both customer and vendor to implement such advanced supply chain management.

2.3.2.2 Existing researches of CPFR

Collaborative forecasting is one of the most important aspects of CPFR. There is a number of studies focus on this function of CPFR. For instant, Aviv(2002) uses a two-stage supply chain model to simulate the collaborative forecasting of CPFR. In the study, the two-stage model presents the retailer and the supplier, moreover, with a single trading product in the supply chain. To achieve a systematic analysis of the supply chain performance with collaborative forecasting, three supply chain settings

about the forecasting and replenishment policy are set: traditional supply chain setting, local forecasting setting, and collaborative forecasting setting. The first one does not have any forecasting mechanism in its supply chain and is set as a benchmark. The local forecasting model set a semi-collaborative collaboration model between the customer and the supplier: the partners in supply chain could share all static data such as characteristic information about their own forecasting process, but no specific information about local inventory and their own demand forecasts. In the collaborative forecasting setting, the only difference with local forecasting is that all partners in the supply chain jointly manage one common forecast process, and then apply it into replenishment policy. By converting the supply chain model and process into mathematical model, the benefits are derived in numerical. As a result, compared with the benchmark, the local forecasting model and the collaborative forecasting model decrease the supply chain expenditure by 11.1% and 19.43% on average, separately. This significant CPFR effectiveness concurs with the study of Boone and Ganeshan (2000). In addition, they point out that CPFR could reduce 6.5% inventory without decreasing of service level.

Like the two studies mentioned above, most CPFR researches mainly focus on identify the advantages such as reducing inventory or cost in the supply chain. In addition, the execution and operation of CPFR defined by VICS (1999) are set as default in these studies (Barratt and Oliveira, 2001; Crum and Palmatier, 2004). However, Seifert (2003) points out that there are a number of different CPFR patterns

in practical. This is coincident with the study of Larsen et al. (2003). It mainly focuses on these variants of CPFR and the contingent factors that result in such a variety. As the source of analysis, it is noted that the collected data is gathered by interviewing form seven companies of different industries. By within-case and cross-case analysis, the author points out that the depth of collaboration and the number of interacting units are two variables to indicate the CPFR collaboration. The depth of collaboration is classified to three levels: communication, limited collaboration, and full collaboration. It is noted that increasing depth of collaboration means more units are interacted between companies. Moreover, the contingent factors for the depth of collaboration and the number of interacting units are given: for the depth of collaboration, CPFR goals, product/market characteristics, and supply network's physical structure would contribute; for the number of interacting units, supply network's physical structure, CPFR development stage would contribute.

2.3.2.3 CPFR in healthcare

Like the studies on VMI, the researches addressing the issues of CPFR mainly focus industries of manufacture and retailer. However, with the increasing complexity of pharmaceutical industry and recognition of advantages of collaborative supply chain management, a number of researches highlight the empirical implementation and issues of CPFR.

In the study of Danese(2004), a supply chain network managed by CPFR is

emphasised. The CPFR is first adopted by the central multinational company in this supply network in 1998, and now widely used on the supply chain management by most partners in the supply network, such as manufacturers, sales companies, and distribution centres. As the authors state, the implementation of CPFR is first set by a specific front-end agreement which is made by managers from all the partners in the supply chain network. This agreement specifies the running process and the allocation of tasks of planning, forecasting, and replenishment. This agreement would also lead the definition of joint business plan, which indicate all the details for each product plan for next year, like cost-service target, lead time, safety stock, etc. Moreover, the CPFR forecasting process is also implemented jointly. The sales histories from distribution centres and the qualitative data from sales companies such as market trends, government policies, would be jointly in forecasting. In details, each sales company is responsible for the sales forecasts for its served country and could exchange qualitative information with other sales companies to enhance forecasts. This idea partly concurs with the study of Danese(2006) about the extended collaborative supply chain management in the supply network. Furthermore, the forecasting data would be correcting sent to manufacturers and suppliers. The managers at these units would check the forecasting data. If any objection exists, they could discuss it with sales companies in the "consensus meeting". After the final forecasting data is confirmed, central software would be used to produce the plans of order forecast. By jointly considering the distribution centre inventory level and the forecasting plans, manufacturer would accomplish the replenishment of distribution

centre by using VMI.

The study of Danese(2004) presents an entire process of the implementation of CPFR. The business plan of the supply chain is jointly defined by all partners in the supply chain network. Moreover, the sales forecasting is jointly deduced by sales organizations in the same echelon combined with the feedbacks from manufacturers and suppliers. In this way, the supply chain network is advanced not only in vertical, but also the horizontal direction. Finally, it is worth noting that the process in this CPFR system is accomplished by using VMI.

2.4 Research questions

According to the literature review, there is a gap to be filled. Firstly, although a number researches about VMI and CPFR have been adopted by other industries. The application in healthcare sector is still not very popular. In addition, there is a few empirical study combine these two concept together to solve problem in healthcare inventory management. Through the comparison of hospital supply chain between western country and China, there is a long way to go for China in the supply chain collaboration, in terms of information technology, logistic capacity, reasonable policy etc.

In order to fill this gap, three research questions has been shown as follow:

Research Question 1 : what are the current issues of hospital pharmacy inventory management in China?

Research Question 2 : what are the drivers and barriers to achieve collaborative inventory management in pharmaceutical supply chain?

Research Question 3 : How to implementing collaborative inventory management in China in the future?

Chapter 3 Research Methodology

3.1 Introduction

According to Literature review of this dissertation, it explored the gap between Chinese contemporary development of pharmaceutical supply chain and the world advanced pharmaceutical supply level. In order to fill the gap and find the barriers that blocking the implementation of collaborative inventory management in China, the research is designed into two parts. The first part is about the research of holistic attitudes to CIM, which involved 11 interviewees from four different members of supply chain: 1 officer from government, 3 pharmaceutical manufacturers, 5 wholesaler/distributors and 2 hospitals. This research is focus on the hospital supply chain, and the wholesaler/distributor has the direct relationship with hospital. Therefore, the wholesaler/distributor accounts for the largest number of interviews. However, the operation of manufacturers would also affect the inventory level of hospital pharmacy. During interview, it was found that there was one wholesaler/distributor going to run the business of pharmacy trusteeship. To be more in-deep research, the case study was following the interviews, in order to collect more qualitative and quantitative data to analyse.

In this chapter, interviews and case study were adopted by this research with separated explanations in detail. The reasons of why these two research strategies and whether suitable or not would be explained as well in this follow content. Moreover, the detailed principles and method of design and analysis of this research studies were presented as well. The most important part of this chapter was the implementation of

these methods. Finally, the weakness and limitation of these methods would be illustrated.

3.2 Interviews

Burnard (1991) said that interview is one qualitative research method. The interview is the one of the most efficient way of data gathering (Yin, 1994). The method could be divided into unstructured interview and semi-structured interviews (Burnard, 1991). According to Steinar (1996), it is necessary to identify the subject or main topics before execution, but the structure of the interview is flexible. Moreover, the interviewers may add new questions depending on the situation at that time during the interview.

3.2.1 Questions Design

Semi-structured interviews were selected by author and the scope involved 11 main participants in supply chain, which were one SFDA officer, three manufacturers, five wholesaler/distributors and two public hospitals, respectively. To be representative, the three manufacturers consist of one China's state-owned manufacturers, two foreign companies. In terms of wholesaler/distributors, four China's state-owned companies and one private firm taking participate into this research. In the meanwhile, two public hospitals involved as well. In total, the interviewees are 10 operation managers and 1 government officer.

In terms of the topic of interviews, it must be around the purpose of this dissertation and answer the two research questions. Research question 1: what are the current issues of hospital pharmacy inventory management in China? Research question 2: what are the drivers and barriers to achieve collaborative inventory management in China? In order to answer the questions and gain a holistic and comprehensive understanding, the purpose of the interviews is to explore the issues of current hospital inventory management and understand the attitudes to implementing collaborative inventory management from different perspectives. Most important is to collect the drivers and barriers of CIM on hospital pharmacy.

Form the literature reviews, it could be clear that two main decisive factors involved in inventory management which are information technology and logistics capacity. Hence, the interview questions are divided into three parts: Implementation of IT, Logistics level and Inventory management. In addition, according to diverse participants from three parts of supply chain, there are different focuses. First of all for the distribution part, the most important functions are storage and logistics, but without the support of advanced information system these functions could not be achieved. Hence, the questions involve current models of inventory management; the attitudes to implementation of collaborative inventory management; the biggest barriers and divers faced; information sharing and exchange with upstream and downstream partners; logistics level and cost, etc. As the downstream and upstream for distributor, the information flow unblocked and inaccuracy are the most important

element for demand forecasting, innovation of product and production. Thus, the questions more focus on IT and communication within the supply chain. Meanwhile, the attitudes to Joint-inventory management, the drivers and barriers are included as well. With regard to officer, the questions are more holistic which designed for policies guiding to development of pharmaceutical supply chain with focus on integration of structure, changing of market domination and development of medicine logistics. Finally, each participant was asked for one open-ended question about the most processing issues in practical pharmaceutical supply chain.

Themes of questions / Participants	Inventory management	Information technology	Logistics Capacity	Open-ended Question	Policy
Distribution	5	4	4	1	
Manufacture	2	3		1	
Hospital	2	3		1	
Government officer				1	3

Table 3.1 the themes and number of questions of Interview

The designed questions could allow interviewees to focus on the themes and could answer freely. Table 3.1 illustrates the topic and the number of questions. All answers are given by interviewees by their experience and depending on their knowledge of the companies.

3.2.2 Grounded theory

Content and Function / Step	Content	Function
Step 1	Note the Key point after each interview	Record ideas and theories
Step 2	Read through the transcripts	Immersion of data
Step 3	Read again	Heading relevant aspects
Step 4	Collapsing similar heading	More focus
Step 5	Write final list of heading	simplify
Step 6	Category by two other colleagues	Comparison
Step 7	Re-read transcripts and add to be comprehensive	Decision of final category
Step 8	Do it with each transcript and highlighting	Integration
Step 9	Put all coding transcripts together	Collection to make references
Step 10	Pasted onto sheets	Integrate again
Step 11	Check appropriation with respondents	Guarantee accuracy
Step 12	Keep original tape and record	In case unclear
Step 13	Check with original data after finish each section	In order to be closer with original record
Step 14	Compare final results of interview to literature	Make new finding

Source: base on Glaser and Strauss (1967)

Table 3.2 the steps of "Grounded theory"

Although the process of interviews is straightforward enough, it is difficult to analyse and interpret the completed transcripts (Burnard, 1991). "Grounded theory" are adopt by this dissertation and extensively used to analyse semi-structure and open-ended interviews, which created by Glaser and Strauss in 1967. This analysis method in total consists of 14 steps (see figure).

However, the limitations of interviews are not ignored as well. Kerlinger (1986) states that interview as typical methodology of collecting qualitative research is possible to make inappropriately explanation. Although interview focuses directly on the objective of research, the outcomes may response bias. Furthermore, sometimes the

answer could be reflexivity which means the interviewee gives what the interviewer wants to hear Yin (2009).

3.3 Case study

Case study is another approach adopted to investigate the current level of inventory management in hospital supply chain in China. Cohen and Manion (1995) defined the case study could observes the individual characteristics and the purpose of such observations is in-depth investigation and analysis multifarious phenomena. Yin (1984) asserts that case studies are appropriate for the target researching current events and single-case study is appropriate for the research exploring a formerly un-researched project. Considering with pharmacy trusteeship just began in 2011, moreover, few of collaborative inventories management in hospital pharmacy was presented before, thus single-case study is selected in this dissertation.

The information collected from interview represents people's opinions depending on different experiences and is more general level. The case study could reflect more penetrating questions and capture the richness of organizational behaviour and more convincing (Goble GG 1994). On the other hand, Yin (2003) refers that case study as an empirical inquiry that probes a contemporary phenomenon within daily life, especially when there are not clear evidences between phenomenon and context. In

this way, the case study of this dissertation give clear evidence to previous literature review, and fulfil the gaps and give answers to the research questions.

Combining with the attitudes of supply chain contributors, the case study is more comprehensive and penetrating; because the object of this case is selected from above interviews to deep research. During the previous interviews, the author discovers this distribution company is trusteeing pharmacy of one large-scale public hospital in Beijing. However, due to trade secrets, the name of company cannot be disclosed. Although the case study enterprise is singular in this dissertation, the study involves three echelons in the pharmaceutical supply chain from manufacturer, distributor to hospital. Due to most of pharmacy inventory managed by hospital itself, there are mere a few pharmacies are trusteed by distributors in current China. Thus, author chose this relatively largely distribution enterprise and its managed pharmacy as research objects. The research targets finding out the specific issues in practical of current pharmacy inventory management between manufacturer, distributor and hospital and try to optimal solution of the problems.

To be more practical, the solution would be evaluated by different companies and collecting more feedback. Thus, the outcome of the solution of this case would be sent to previous interviewed companies and hospitals. Considering the barriers of implementation, the result need be modify to more suitable and forward to implement into China pharmaceutical supply chain in the future.

However, there is not without disadvantages or limitations of case study. Above of all, according to statistics, until 2010, there were approximately 13,400 distributors including foreign invested and local companies in China. Besides, most of all are small medium enterprises. In additional, different provinces have different policies which probably effect the situation to distributor. Therefore, just only one case's analysis may not very generalization. However, this research like a miniature pharmaceutical industry still could reflect the current status of pharmaceutical supply chain, especially the echelons of distributor and hospital.

3.3.1 Data collection

The data collection is also the important work for research. The kinds of methods to collect are decided by strategy of research. There are several methodologies of data collection for case study, which are survey, observations, interview, etc. In this dissertation these techniques could be divided into two categories; primary and secondary data.

3.3.1.1 Primary data

In this dissertation, in-deep interviews and internal collection could be the main source of primary data. The reason why choose interviews is that mentioned before, it is the most efficient way of case study. The interviews were arranged with operation manager and logistics manager with semi-structure. Semi-structure allows the

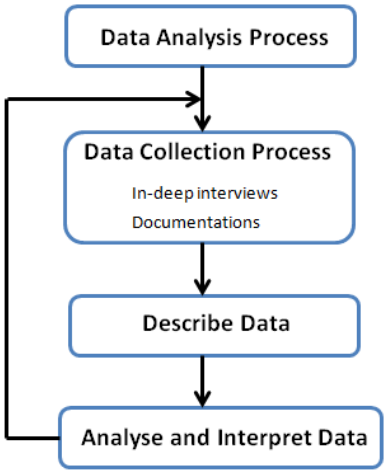
interviewee could prepare some quantitative data like inventory cost. Additionally, some important qualitative questions would be answered more comprehensive if the interviewee knew the topics in advance. From interviews, the operation and management structure within the organization and external of manufacturer and pharmacy in hospital could be known, as well as the purchase and delivery of order management. There are qualitative and quantitative data among them. In terms of the quantitative data, it includes the product return rate. The historical statistics were offered by the interviewee, which reflected the capacity of current inventory management and was very valuable for this research.

3.3.1.2 Secondary data

In order to support interview, secondary data need be collected as well. For example, before interviews, the basic information of the company should be known, such as the scale of the business. This sort of data could be found from the website or annual report of the enterprise. Moreover, it is necessary the collection of the relevant knowledge of the objective for this case study. It includes books, journal or report.

3.3.2 Method of analysis

3.3.2.1 Analysis process



Source: Based on Wolcott (1994)

Figure 3.1 Qualitative data analysis method

Wolcott (1994) proposed an approach of data analysis of case study, which could be divided into three steps shown in Figure 3.1.

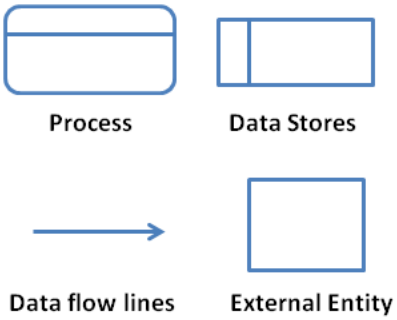
3.3.2.2 Data flow diagram

With regard to analysis tool, there are many business process modeling techniques shown on the Aguilar-Saven's review in 2004, such as chart flow, role activity diagrams (RAD). However, the data flow diagram (DFD) was adopted by this dissertation. Compared with other techniques, the data flow diagram is for structure

analysis and easy to understand. In addition, according Aguilar-Saven (2004) DFD is as the name said which displays the flow of data or information from one place to another. It also describes the link processes between different external entity and the processes relate to the users and outside world.

The reason why this dissertation selected this approach is that the case study focus the pharmacy collaborative inventory management thought analysis the relationship between those three parts (manufacturer, distributor and hospital) and their information flow exchange. DFD could introduce the data concerning the performer. Moreover, DFD only shows the information flow, which is very convenient for research to develop and reader to understand. In this research, the Data Flow Diagram (DFD) technique is applied to describe the current and improved process of inventory management between the three supply chain contributors. The draw of the DFD was based on the flow chart of order replenishment process and the interviews from the distribution company.

There are four main components need used to show the diagram, which are Data stores, Date Flows, Processes and External Entities (see Figure **).



Source: Gane and Sarson (1977)

Figure 3.2 four main components of DFD

The Date stores are as a file or database responsible for storage of information. The external entity like a terminal sends out and accepts data within the organization by achieving the process which receives input data and yields outputs. The process is as a link between external entity and data stores. The arrow guides the direction of information flow and generally be named with the data. In addition, the data flow lines link all activities within the system including sources, process, data store and external entity.

3.4 Conclusion

From this research, the attitudes of achieving collective pharmacy inventory management and the drivers and barriers were analysed by interviews from different aspects of pharmaceutical supply chain. Additionally, the main problems existing in current pharmacy inventory management were explored by in-deep case study. Having identified the issues, a potential solution was then proposed by using data flow diagram drawing an improved state of collective-managed inventory.

However, expect that the method limitations were mentioned before, there are still some improvement could be achieved. Above of all, the situation of pharmaceutical supply chain is very complex in terms of policy, profit distribution, area control. Mere 11 interviews and one case study must not be covered over. However, the time of research is limited with 3 months. The research strategies of this study may be the better approach to execute. With regard to date collection, the sources are from China companies, thus, it is necessary to translate all the interviews from Mandarin to English. To some extent, the differences culture between eastern and western may affect the understanding and interpretation of the results.

Chapter 4 Data collection and analysis

4.1 Introduction

This chapter mainly illustrates the data collected from interviews and case study, and with the in-depth analysis. There are 11 interviewees involved into the research. The issues they facing in current inventory management will be presented as well as the attitudes to implementing collaborative inventory management (CMI). Meanwhile, the divers and barriers of implementing CIM in China are the most important part of interviews. In terms of the case study, the company is selected from the interviews. Combining with the specific questions existing in the inventory management, the suggestions for improvement would be given in Chapter 5.

4.2 Interviews

4.2.1 Manufacture perspective

Three manufactures took participant in the interview which involved Harbin Pharmaceutical Group Factory, Astellas China Pharmaceutical Ltd. and Pfizer China Pharmaceutical Ltd. The background comparison is shown as Table 4.1.

Harbin pharmaceutical Factory is one of branch factory of Harbin pharmaceutical Group. It is a large national pharmaceutical company and one of the 500 large industrial enterprises in China. It is famous for antibiotic production. The company runs with Quality first, the pursuit of human health as main goals. At present, there has been 8,000 staff with 2,000 technical staff.

Compared with Harbin factory, Pfizer developed more widely, it is the world's largest pharmaceutical company with its headquarters in New York. In 1980s, it entered into Chinese market. By far, the business is across over 200 cities with nearly 10,000 staff, and has been built 8 factories in South-east of China. The production line includes chemical drugs, bio-pharmaceuticals, vaccines, health drugs, etc. The top manager said that the goals of Pfizer in China are satisfying customer demand and keeping focus on their satisfaction.

In terms of Astellas, it is a young enterprise, which has been reorganization since

2005. However, it grows rapidly being a second large prescription drug pharmaceutical group in Japanese with leading six area of immunosuppressive of organ transplantation, urinary tract, infectious diseases, CNS / pain, diabetes, and tumour. In 2007, it access to China pharmaceutical market with providing innovation and reliable service and making contribution for human health.

Name of company	Attribute	Leading domain	Core goals
Harbin Factory China	CHN	Antibiotic production	Quality first and care human health
Pfizer China Ltd.	US	Drug of urinary &reproductive system and endocrine system, etc.	Customer satisfaction
Astellas China Ltd.	JAP	Drug of diabetes, and tumour, etc.	Innovation and reliable service

Table 4.1 the main characteristics of three pharmaceutical companies

From the literature review, it could be found that information exchange and sharing is the most important requirement for achieving collective inventory management. Therefore, the questions of interview mainly focus on information technology communication. When asked whether have information sharing with downstream partners, fortunately, the answers from all the interviewees were yes. However, it was just achieving between partly distributors. On one hand due to the different level of

development about hardware equipment, some distributors could offer online checking, such as sales, inventory data, time, batch number, the name of end customers. While little offer synchronized data checking for manufacturers. With regard to another protection policy in China, foreign pharmaceutical manufacturer in China are not permitted approaching medicine directly to hospital. It must contract with large-national distribution company which as sale agent, as well as taking participant in medicine bidding in China. Therefore, for Pfizer and Astellas the documentation of bidding are issued and submitted through the distributor that contracted. However, this kind of information sharing mere is by email. On the other hand, the reason that blocks information sharing is application of different software. As a consequence, the transmission of information are lagging, uncertain and unstable from distribution companies to manufacturers.

<table>
<tr><th>Support</th><th>Un-support</th></tr>
<tr><td>Harbin Pharm. Factory & Pfizer China</td><td rowspan="2">Astellas China Pharm. Ltd.</td></tr>
<tr><td>Drivers:
1. Capture market information timely
2. Promote product innovation
3. Easy to supervision and management
4. Uniform data management
5. Reduce energy loss
6. Reduce inventory and logistic cost
7. Increase stock turnover
8. Increase rate of funds utilization</td></tr>
<tr><td>Barriers:
1. Loss competitiveness once information be opened
2. The reliability of hardware equipment
3. Large amount of investment
4. Allocation of benefits</td><td>Reasons:
Unnecessary for current situation in China.
It is general that keeping a little more inventory for demand increase.
By far, there is few problem about inventory management as long as inventory period at 0.5-1.5 month.</td></tr>
</table>

Table 4.2 attitudes for implementation CIM from manufacturers

However, when asked the attitude for implementation of collaborative inventory management of hospital pharmacy, the three manufacturers became different. The

Table 4.2 shows the detailed of the diffidences. The operation manager of Harbin and Pfizer tend to support the implementation of collaborative inventory management. Because they both thought it allows manufacturer more involved in market and grasping the market dynamics. It is possible making production and resource planning timely. Especially for Pfizer as drug import, it is important to arrange the quantity and category, hence to reduce energy loss, inventory and logistics cost. Moreover, the systems must be uniformed with supply chain collaboration, it makes easy to monitor inventory level and make collaborative decisions with distributors as well as increasing stock turnover and rate of funds utilization.

Although the young Astellas agreed with the point that collaborative management promotes product innovation, the company still not support inventory collaborative management. The operation manager thought it is unnecessary for current situation of China. The sales of representatives could be the link between manufacturer and hospital for promoting drug for doctor, gain some feedback of the drug use, as well. In terms of inventory, they hope to keep a little more stocks for urgency and rise sales as long as controlling the inventory coefficient between 0.5 and 1.5. In addition, there are not no barriers worried of implementing collaborative inventory management. From the aspects of Harbin, huge amount of investment needed for redesign and reform the infrastructures and systems. Furthermore, it factor of policy could not be neglected as well. Without government supports, it is hard to achieve successfully. On the Pfizer hand, it worried about losing competitiveness once sharing important

information with more partners. Moreover, how to allocation benefits once managed collaboratively pharmacy inventory still an uncertain problem.

4.2.2 Distributor perspective

Compared Name Items of company	Rank Of Scale	National network	Provide 3PL	Logistic system	Information Sharing	Attitude of JIM
Sinopharm	1	√	√	WMS TPL etc.	Partly upstream and downstream	Positive
SHP	2		√	WMS etc.	Partly upstream and downstream	Positive
Jointown	4	√	√	LMIS 6.0 WCS TMS etc.	E-business	Positive
KY	21		√	iWMS etc.	Partly upstream and downstream	Neutral
Beijing Jewim	<100			WMS DPR EDI RF etc.	A few 3PL	Negative

Table 4.3 Current status of distribution companies

The interviewee distribution companies are Sinopharm, Shanghai pharmaceutical

holding Co.Ltd. (SHP), Jointown, KY, and Beijing Jewim Pharmaceutical Co.Ltd., respectively. Sinopharm and SHP are two large-scale State holding enterprises. They are two monopolies in China pharmaceutical distribution industry. Sinopharm owns the largest national distribution network with 25 distribution centres country-wide and covering all first class hospital and 95 per cent second class hospital in Beijing. The company has provided the third party logistics services since 2002. By far, it has provided service for Bayer, GlaxoSmithKline, Beijing disease control and prevention centre, etc. Compared with these two state-holding companies, Jointown is a young private distribution company with focus on developing their logistic service and E-business. It has wined 4200 upstream and 64000 business partners. Moreover, the development of E-business has achieved the information sharing between customers and allowed it being the third of China in mere five years. With regard to KY, it is a Beijing local distribution company. Due to continuously expanding market, it has contracted with 301 hospital pharmacy for supplying 80 per cent of medicine. It would be analysed detailed as a case in section 4.3. The SME (Small and medium-size enterprises) --- Jewim also was included in this interview. The scale of company is a key factor for the attitudes of implementing collaborative inventory management.

4.2.2.1Main issues

Positive	Neutral	Negative
Sinopharm ; SHP ; Jointown	KY	Jewim
Key for CIM: Policies	Key for CIM: Guanxi	Key for CIM: Trust

Main issues:

1. Imbalance inventory
2. High inventory cost

Drivers:

1. Enhance and increase the benefits of distribution company
2. reduce bullwhip effect
3. Increase stock and capital turnover rate
4. Achieve overall planning and decrease inventory and logistics cost
5. Risk-sharing with upstream and downstream partner

Barriers:

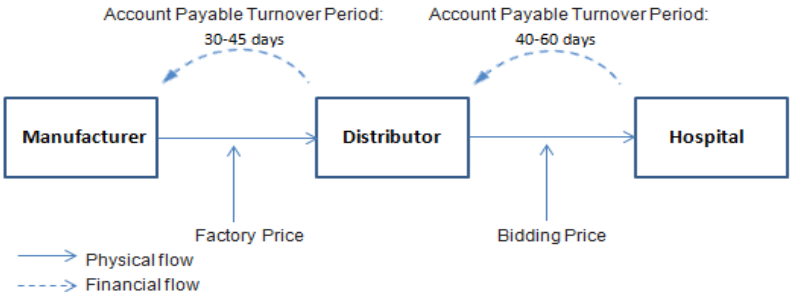
1. Low level of information technology communication and diversity of system
2. Unwilling to share information, especially hospital
3. Low integration of supply chain
4. Uncertainty of risk-taking
5. No standard process (drug code and logistics)
6. Territorial restrictions

Table 4.4 attitudes for implementation CIM from distributor

Compared with manufacture, there are more thorny issues facing on distribution companies. In addition, the barriers are not only about information communication, more factors from hospital and government, as well.

From the interview, two urgent issues were found in terms of current inventory management. First of all, is imbalance inventory that reflected in two aspects. One aspect is overstock which caused by enlarged demand. The logistic manager from Sinopharm explained that it is general for distribution companies, because the supply chain is excessively long so that magnify the bullwhip effect. In addition, the orders of hospital are forecasted independently by pharmacist with less supply chain knowledge. Thus, the forecast itself may inaccurate. Almost all drug suppliers worried about whether their inventories could fulfil the demand. In order to avoid that, generally they would hold more inventories. As a result, for the suppliers at which top of supply chain, they have more overstock than others. Considering with the short life time of drug, it would bring high risk to distribution company. It is evidenced by Jewim that their average inventory cycle time is 59 days. It means the product held in warehouse nearly 3 months. Consequently, it creased much unnecessary cost, such as holding cost, premium, etc. Another aspect is stock out which caused by pressures of capital turnover. From the interview, Sinopharm and SHP indicated that one of

important driver encouraging them to support implementation of collaborative inventory management is pressures of capital turnover. Take SHP for example, the manufacturers generally requires the time of payment for SHP within 30-45 days, while the payment period of downstream hospitals for SHP is about 60 days. From this perspective, it can be seen that the role of pharmaceutical distribution companies in fact, played as a 'Lender'



Source: based on SHP interview

Figure 4.1 Account payable turnover period of pharmaceutical industry

Therefore, once hospitals delay the payment time, moreover the company without enough capital for next purchase, it is very risky for stock out. However, it is because bulk ordering. If implementing collaborative inventory management of pharmacy, the demand controlled easily by suppliers, hence, narrowing the quality of order. Additionally, it accelerates the capital turnover rate and more conducive to development of SMEs.

The second issue are high inventory and logistic cost. KY's manager said that the cost of inventory and logistic expenditure approximately taking account for 65 per cent of total cost. There are two reasons, one caused by the characteristics of drug, such as, hygroscopic, perishable. Thus, the requirements of storage and transportation are relatively high. The other factor is economics of scale, small companies has no ability for establishment of distribution and logistics centre across districts. That is why, Jewim still not develops their own logistics team. According to calculation of the logistic budget for Jewim would exceed one third of the scale of sales. However, it is tolerable for Sinopharm, SHP and Jointown these large-scale companies which have abundant capital and sale market. Nevertheless, the businesses with strength are generally unwilling rent the facilities to SMEs, or even not cooperate with them. Hence, the development of distribution industry is unbalance because of less parallel collaboration. As a result, it is hard for SMEs to survival under the fierce competitive market. The private company Jointown suggested that it is better for SMEs concentrate on explore the core business and outsource the logistics part in order to shrink unnecessary cost.

4.2.2.2 Barriers

In terms of the barriers, the general problem that blocked the development of all distribution companies is information exchange and sharing, which is the same question as manufacturers. However, the reasons caused the problem are a bit

different, it not only diversity of software but also about the traditional thought. For upstream, for example, Beijing Jewim, do not have online information checking system connecting with suppliers. It was told that different manufacture has different system, hard to uniform and it would be costly. For downstream, hospitals insist on information privatization. Historically, the hospital as the biggest customer dominates the market and control the power of management and sale in China. Once open information, it certainly loses the dominated position. Therefore, hospitals unwilling to share information with any other supply chain participants. From another aspect the distributor itself, Sinopharm and SHP expressed that they hope get more information from both suppliers and customers, but unwilling to share more sales strategies and sales data with others in order to guarantee the leadership of the market. Especially the private company Jointown, it has to admit that its powerful logistic network, but not provide basic information checking. A reason from one manufacturer, it is suspected that Joint purchase from the province where low factory price and sells to another district with higher retail price. It is not allowed in China generally. However, in order to gain more profits, many companies have tried it. Therefore, it is unable to offer information online checking.

Secondly, the barriers are from standard of industry. This is a limitation to the development of the industry. It has been a barrier for nearly 20 years in drug supply chain, from manager Xiao of Sinopharm. There is no uniform code applied in the whole supply chain. Current only basic drug which about 300 species do has uniform

code. For others, there is one coding system for manufacture, and other one for circulation and even different between different company. Therefore, it brought difficulties for drug monitoring and tracing, furthermore having negative effects on information exchange of enterprises between each other and the development of drug logistics.

The final barrier which strongly raised by the SMEs Beijing Jewim, it is territorial restrictions in China. It is extremely strict for local enterprise to establish warehouse cross districts. For example, Jewim is a company of Beijing, it is not permitted to establish warehouse in Shanghai.

4.2.2.3 Attitudes

With regard to the attitudes, it is not exactly same between different interviewees for implementing collaborative inventory management. Sinopharm and SHP presented support, because it could weaken the domination of hospital and increasing the control of distribution company. Moreover, it reduce the cost of imbalance inventory and they relief slightly from pressures of capital. SHP emphasised that inventory control would be effectively improved through implementation. Furthermore, the risk and cost are also shared by upstream and downstream partners of supply chain, under the current institutions and systems. When asked the key factor for successful implementation, policy is considered by the top three companies (Sinopharm, SHP

and Jointown). They thought it not be success without the government support in China. Although the CIM reduce bullwhip effect, increase the benefits of distribution company theoretically, there are many uncertainties, whether the implementation successes still need the examination of practices, the viewpoint from KY. However, KY referred to Guanxi the Chinese unique culture also is the essential for collaboration. On the contrary, Jewim has negative attitude to CIM, because the requirement and investment are too high to bear, it is less suitable for SMEs.

4.2.3 Hospital perspective

Two hospitals involved in the interview (Peking University people's hospital and 310 hospital). They are both first-class public hospital of Beijing. There are two reasons why choose them. Firstly, Beijing is the capital of China and the medical resource and the scale of hospital are the best and biggest in the country. In the meanwhile, thousands of categories of drug are managed by pharmacy.

In general, it would be thought that hospital is an excessive profits organization in China. However, from the interview, only to find that Chinese hospitals especially first-class hospitals are operating loss which result of more concerning about health care, the level of research, while ignoring the operations. In terms of drug purchase process, it is managed confusingly. Contact supplier, product receiving and delivery of invoices, each key functions of the procurement chain cannot be separated. Moreover

there is no approval before purchasing, on written record, so that cannot check whether the quantity and drug regulations exactly same as procurement order after the product arrived. The other question is inventory management not standardized. HIS (hospital information system) has defective which affect the record of inventory level. Moreover, it is independent between hospital information system and financial settlement system. Consequently, the collection and statistics of data is lagged and the accuracy of data is seriously affected.

Both hospitals indicated that they have already recognised the issue which is hospital not good at operation. Moreover professor Wang said that Peking University people's hospital has ready outsource partly non-core business, such as scavenging and funeral service, but pharmacy still managed by themselves, because the drug management is one of biggest resource of profits for hospital. Although the management of drug inventory is not satisfying, there is hardly any stock out due to one category of drug having two or three suppliers. However, the overstock frequently happens. It could be improved by internal information construction and hospital resource planning. While, 301 hospital supports the pharmacy trusteeship and has contracted with KY for managing 80 per cent of drug in 2011. The detail analysis is shown in section 4.3.

4.2.4 Government perspective

The interviewee is one of officer from Beijing SFDA (Safe Food and Drug administration). The primary question that most concerned is whether the government support the collaboration management of hospital inventory. From above companies' interview, it is found that the decisive factor for company is government policy. Without the support of government, all theories cannot be achieved.

The officer specified the most direct and important policies impact on the pharmaceutical distribution industry in contemporary China including: basic drug management, drug bidding management, drug price management, GSP (Good Supply Practice) regulation and healthcare insurance, etc. However, in the long term, the most far-reaching policy is the reform of public hospitals. From 1985, the reform of healthcare industry started until now has entered the third stage. The third stage focus on division of medical treatment and drug sale. In addition, it has been proposed about establishment of pharmacy trusteeship pilot among public hospital since 2011. However, currently there have not detail processes and regulations. The practice need to depend on the status of pilot hospital.

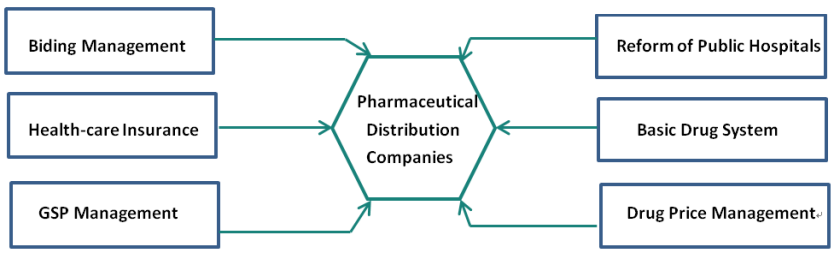


Figure 4.2 The policies impact on pharmaceutical distribution companies

4.2.5 Discussion

Regarding implementation of collaborative inventory management, the attitudes vary from different participants. However, in general, it accepted by manufacture and distribution companies and gains the guide of government. However, the hospital still hesitate their position.

From the aspect of pharmaceutical manufacturer, especially the foreign companies (Pfizer and Astellas) security of the information is the most concerned problem. It depends on the goals of the company. For example, Astellas is focus on product innovation, which means having risk of disclosure business secret once open information with partner. One more reason same as Pfizer is worried about the competitive would fiercer. While the most concerned problem of the Chinese local company is huge investment. There is less confidence for changing information system and worries for reliability of software. In the meanwhile, it reflects the traditional concept of supply chain still controls the Chinese company.

However, with the demand increasing, these companies all have recognised the importance of information sharing. Furthermore, there are many drivers attracted them, such as increase stock turnover, reduce inventory and logistics cost and planning reasonable production. The most important reason is accurate and timely seizeing market. Therefore, most manufacturers are willing to make changes initiatively.

Compared with manufacture, the biggest barrier is the same which still information communication. However, it is caused by more of downstream factors which are hospital and government's attitudes. Although the hospital has recognised the operation loss, they are still unenthusiastic to the collaborative inventory management of pharmacy. Because it has been a long-established for sale drug by hospital in China and never changed. The conventional thought is still deep-rooted. However, division of hospital and pharmaceutical has been raised by current China government. Actually, this proposition mainly for solve the problem of high drug price. From aspect of supply chain management, it can be seen that there are huge opportunities for intermediate links of supply chain---distribution company. Due to enhance the domination of market, reduce bullwhip effect and inventory, and increase stock and capital turnover rate, all the distributor desire the reform of hospital and implementing collaborative inventory management in pharmacy. Yet, some large-scale company are more positive while, the SMEs have more pressures to accept this reform.

Apart from this, another barrier is high cost of logistic which obviously in small and medium enterprises. Although there are many drivers supporting collaborative inventory management, it also put forward higher requirements for distributors, such as faster and more accurate delivery. It is a challenge for the SMEs which have no matching logistic capacity for drug supply. Therefore, the Beijing Jewim has a negative attitude to collaborative inventory management. On the contrary, the large

economic scale companies (Sinopharm, SHP and Jointwon) very support supply chain collaboration even if the worries about the risk of disclosure of trade secrets. Because collaborative inventory management not only control effectively inventory level, but also make the capital risk-sharing with upstream and downstream of supply chain. Therefore, no matter government or manufacture and distribution company, they generally support the implementation of collaborative inventory management. However, there are still worries. Only the practice could test the theory. In the next content, the case of KY is detail analysed.

4.3 Case study

4.3.1 Background

Due to trade secret, the name of company has to only be replaced of 'KY' in below.

KY is a large-scale comprehensive enterprise, specializing in direct hospital sales, cross-regional distribution, vaccines sales, medical devices sales and retail business. In recent years, KY has gradually grown to be a pharmaceutical industry chain service provider offering customization, quality and integration services. Advanced information technology in operation attract many companies collaborate with it. The long-term partnership has been established with over 700 well-known pharmaceutical manufacturers both in China and aboard, which including Merck, MSD, Wyeth, Pfizer, GSK, Baxter, Fresenius and Novartis, etc. Win-win has been a core value of KY for many years. In addition, KY committed to continuously improve efficiency of

products circulation with achieving the goals of protecting human life and health.

On the other hand, KY is continuously developing their third party logistics. By far, there has been an independent bonded warehouse, two GSP standard warehouses, two separated cold warehouses, comprehensive services of package, transportation and inspection, etc. It also provides delivery service in Beijing 24 hours one day and 5 days a week with promise of half-day for reaching in the client and 2 days for the client outside Beijing. Moreover, the good cooperation relationships are with Beijing custom, SFDA (Safe Food and Drug Administration) and CIQ (Quarantine Bureau), etc.

KY explores business actively with improving self-enterprise construction of logistics, information technology and internal supply chain structure integrating. Currently, it has already contracted with Beijing 301 hospital about pharmacy trusteeship. This was first large-scale hospital in Beijing signed with distributor for supply of 80 per cent drugs. KY managed as the third party, sharing responsibility for partly social functions. Thus, the cooperative relationship will be closer than before. However, it is a giant challenge for KY. Beijing 301 hospital is a large and comprehensive hospital with medical, healthcare, teaching and research. There are approximately 3000 categories of drug and 80 per cent means about 2400 categories for KY. However, the old processes of replenishment still not be changed.

KY is effort to develop the customized information management system for achieving integration and exchange of information and sharing of sources with upstream and downstream partners. However, the most urgent issue is the change of supply model result in achieving collective supply chain management as soon as possible.

The old model of pharmacy inventory management would be present in 4.3.2 with detail analysis as well as the main issues.

4.3.2 Pharmacy Inventory management

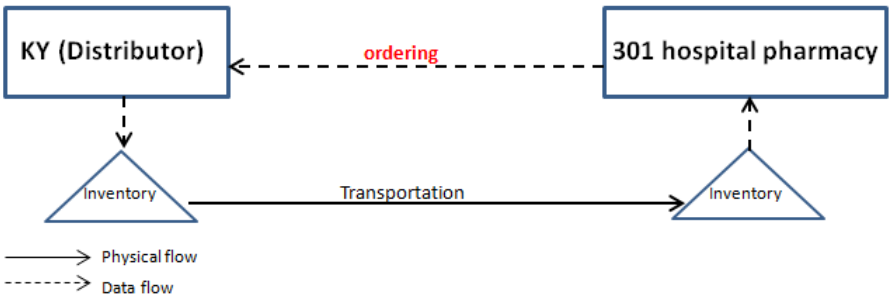


Figure 4.3 old process sketch

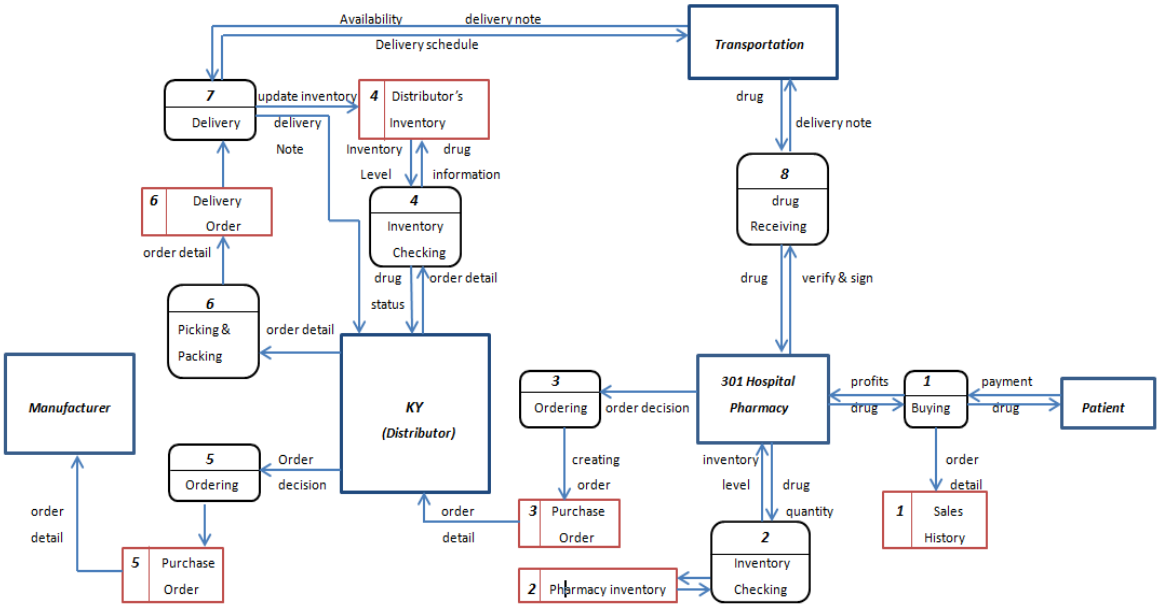


Figure 4.4 the old model of drug replenishment in 301 hospital pharmacy

Figure XX shows that the old model of inventory management in 301 hospital pharmacy with focus on the relationship between distributor (KY) and hospital pharmacy. This is a date flow diagram; consist of external entities, processes and data flow. It cannot be seen the physical flow from the figure. In the picture, the rounded rectangle means process of creating data, and the red rectangle is file or database of each process. The numbers shown on the each process and database represent the occurred orders. In term of the blue arrows clearly show the flow of information which are mainly from right to left. In this case, patients buy drugs from hospital pharmacy with doctor's prescriptions; this process achieved one database of sales history. Then the information of drug quantity transmits from pharmacy system to warehouse and checking the status of inventory with record. Unfortunately, these two valuable file would not open for the upstream partner (KY). Generally, each month an order is sent to KY through HIS system. The quantities of required drug are decided

by pharmacists according to their experience and skill and considered with historical statistic of inventory in hospital. In detail, each week the lists of drug purchase planning are submitted from sub-pharmacy of 301 such as outpatient pharmacy, emergency pharmacy, and examined and verified by pharmacy department once a month, finally purchasing order by purchase department. Once KY received the order, the order detail which including the category and quantity are transmitted to KY's warehouse. The IWMS checks the whether the current stock available to 301. If the inventory could not fulfil the requirement of order, the operation manager will be noticed and decide how many stock need to order from manufacturers or suppliers. In this case, the delivery will be delayed. However, some drug could be replaced by other drug with general same functions. Under the permission of hospital, the distributor could do some exchange in order to satisfy the customer. If current inventory keep within the normal level, KY would calculate the economic order quantity and purchase from manufacture. Take Lotensin as an example, it is a kind of Antihypertensive drug, which be ordered from Novartis once or twice a month. After confirmation with customer about the order, the order detail will resend to warehouse, and then picking and packing with DPS (Data processing system). In the meanwhile, the delivery order is produced and sent to schedule delivery time with transportation. Normally, the products will be delivered with 24hrs. Once the products are shipped, the hospital would be noticed with the arrival time so that arranging products receiving. When the product arrived at the hospital, the staffs of pharmacy verify the category and quantity with delivery order. If there are correct, they sign on the

delivered note which then bring back by drivers. However, if the packaging is broken or the number and category of drug are not same as they ordered, they would contact KY as soon as possible by phone to rearrange next sanding, regarding the wrong drug are returned and brought back by drivers. Once received the delivered note, the inventory information would be changed by stock keepers.

4.3.3 Product return rate

From the interview and documentation of KY, the issue of high product return rate existing in current business between KY and 301 hospital.

4.3.3.1 Backlog stock

There are many return drugs to KY every year, which including the backlog stock during several months and damage product during transportation; it accounts for 4 per cent of KY's gross sales altogether for 301 hospital. In addition, the backlog drug would return to KY with purchase price. All the economic losses are responsible by KY totally. It is a big blow for an industry with already very little profit.

In terms of backlog stock, it accounts for approximately 3% of all return products. The categories of drug are more than five thousand in 301 hospital. The wide range of category and a large amount of drug cause frequent errors in inventory accounting and management. The may slow down the information feedback of medicine inventory

level. Furthermore, the forecasting of demand is predicted by doctor and pharmacist. Due to lack of professional knowledge of supply chain management, the forecasting of demand is always fluctuating and incorrect. In order to guarantee the enough drugs to supply in pharmacy, the quantity of order is frequently higher than normal level or plus or minus a certain percentage according to former order quantity without systematic hospital resources planning. Moreover, the warehouse staff neglect inventory checking regularly. As a consequence, many drugs could not be consumed as soon as possible. With time accumulation, these products turn to backlog stock. In addition, the backlog products are stored in the pharmacy warehouse as the castoff and without cares; most of them are damaged and expired. All backlog drugs are repurchasing from hospital once three months with the same price. In China, it is forbidden that sale expired medicine by reduce the price. Thus, KY has approximately 0.6 million RMB loss from this dispose every year. For decreasing the uncertainty of demand, KY makes forecasting according the change of seasons and preparation in advance. Because the temperature changes obviously between four seasons, there are some common diseases and regular demand of drug. For example, the demand of cold cure increases largely in winter. Although it is a guide for predict in advance, it still cannot solve the fundamental problem. On the other hand, this kind of self-forecasting makes there are large inventory of useless drug and no drugs in urgency situation. It seriously affects the development of medical business. Moreover, it accounts for about 40-60 per cent of 301 hospital liquidity.

4.3.3.2 Logistic waste

Another waste caused by logistics. Although the transports are running by KY itself, there is still 1 per cent loss caused during transportation. Because the amount of demand increased by 60 per cent, the requirement of transportation increasing as well. For example, vaccines are transported under relevant low temperature. In the case of mechanical stoppage of vehicles during delivery, it affects directly on the quality of vaccines. Another reason for logistics waste is traffic congestion. Beijing is famous for its traffic congestion. In order to relieve the pressures of transportation, there are limited vehicles by license number at each working day. Therefore, it has serious effect on schedule and availability of vehicles.

These two questions directly reflect the barriers facing on KY are passive information sharing and uneconomic logistics.

4.4 Conclusion

From interviews and case study, the two biggest questions that existing in current inventory management are imbalance inventory and high inventory and transportation cost. The inventory problem is caused by inefficient information communication among in supply chain. While, the logistics cost reflect low logistic capacity. In order to solve this problems, almost participants have the positive attitudes to implementing inventory management, because there are many drivers such as enhance market

position, reduce inventory cost, etc. However, some worries of information security are existing. In addition, hospitals still have hesitate attitude for pharmacy trusteed by wholesaler/distributor. Although the government give the proposition of pharmacy trusteeship, there is still not detail guidance for how to execution. Therefore, the implementing of collaborative inventory management still relies on the negations with hospitals. Thus, KY and Jewim both indicate that key for implementing collaborative inventory management are building long term trust and developing Guanxi (individual relationship) in China.

Chapter 5 Finding and discussion

5.1 Introduction

This chapter shows the initial and final suggestions for KY by using collaborative inventory management. To be more practical, the final suggestions are modified following the feedback from previous interviewees with form of data flow diagram. In addition, combine with the outcome from interviews, the discussion of implementing collaborative inventory management in China is presented finally.

5.2 Suggestion for KY

According the issues in case study and the review from literatures, the process of order replenishment was redesigned on the basis of collaborative inventory management. Furthermore, combined with the current limitation in practice between KY and 301 hospital, three suggestions has been proposed as below: establishing external warehouse, information sharing and logistics outsource. In terms of the improved parts, which have been already highlighted in the figure XX.

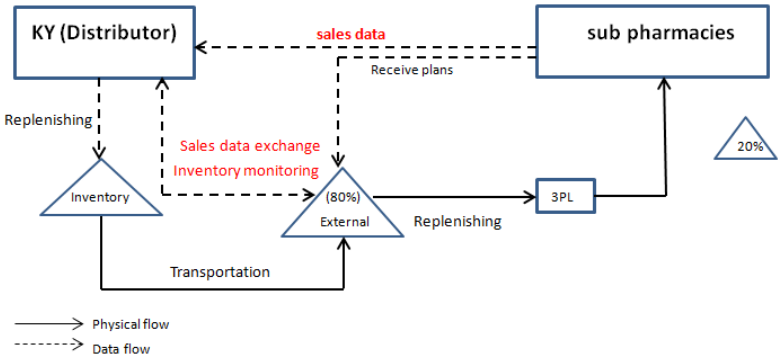


Figure 5.1 KY improved sketch

5.2.1 Establishing external warehouse

From case study, the managed drug by KY only account for 80 per cent of the total drug inventory of 301's pharmacy. That means there are still 20 per cent of drug managed by hospital itself. Thus, it is difficult for KY unified management in 301's warehouse. Besides that, it is less likely that 301 hospital outsources their warehouse to KY, because there might still are other items such as medical equipment. Therefore, establishing external warehouse exclusively for the hospital is an alternative method.

The location of the customized external warehouse must near the hospital, which avoids some traffic problem and allows faster to delivery. This external warehouse operated by KY itself, using a same data management system with the headquarter warehouse. Thus, it is better for inventory monitor and replenishment timely. Moreover, the barrier of sharing inventory information with hospital could be overcome. In other words, KY no longer has to worry about the forecasting delay or inaccurate from the hospital and whether the information communication system or software are compatible. For the current stage, the problem of software development for hospital inventory control has been skipped, meanwhile, obtaining the results which same as achieving inventory data sharing with hospital.

5.2.2 Information sharing

The second improvement is for information sharing. Stank et al. (2001) point that the change from standard business practice, especially from information exchange is the most important requirement for a successful collaboration. In addition, from the literature review Disney and Towell(2003) said that VIM could reduce the bullwhip effect which caused by demand change from downstream, while CPFR allows upstream and downstream sharing information (Danese, 2007). Therefore, one of most suggestion for KY is sharing the inventory data and sales histories of two warehouses both the external and headquarter with suppliers (manufacturers). Thus, manufacturers could control the production planning and make joint decision with

distributor (KY) as well as the up-to-date of sales data promotes the innovation of medicine .

With regard to communication with hospital, due to the establishment of external warehouse, it no longer need forecast from pharmacist, meanwhile achieving real-time monitor. Thence, by far the problem is concerning with the acquiring of sales detail from hospital. Theoretically, it also becomes easier through external warehouse management. Only sales data sharing can be achieved replenishment timely. Moreover, KY has started the developing for the system which connects with financial system of the hospital. According to interview, one system has already been explored which succeeded for drug return, and named HIEP (see figure 5.2).

5.2.3 Logistics outsourcing

The final improvement, it highlighted in figure XX with blue line. Due to one of biggest barrier indicated in the interviews, which is high cost of self-running logistics. KY's manager said that the cost of inventory and logistic expenditure approximately taking account for 65 per cent of their total cost. In addition, Jointown also suggested that it is better for small and medium enterprise to outsource their non-value adding process to the third party logistics company. Quinn and Hilmer (1994) point that outsourcing has advantages of access to economic of scale, flexibility and makes the company focus on its core activity. Razzaque and Sheng (1988) indicate that

outsourcing regarded as a useful approach to lowering costs and gaining competitive advantage worldwide. According to statistics, the companies gain a 9 per cent costs saving and a 15 per cent increase in terms of quality and capacity through outsourcing (Elmuti et al., 1988). With the dramatically development of economy, the transportation and logistics has been the most popular sectors of outsourcing in a widespread diversity of industry (Transport Intelligence, 2004). Therefore, it is proposed that implementing outsourcing of logistics instead of self-running in order to effective control cost.

5.2.4 Detail explanation

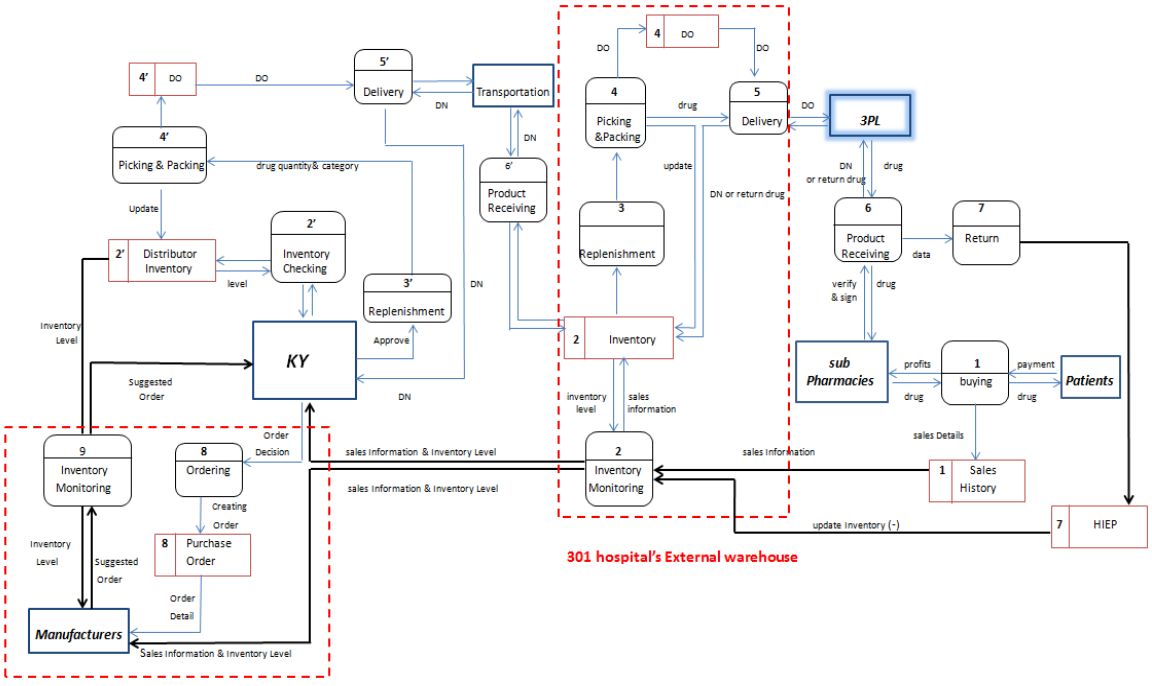


Figure 5.2 KY Improved data flow diagram

A revised data flow diagram for the CIM solution can be seen in figure XX. With this new process, the three improved places were highlighted, two with red dotted boxes and one with blue box. At top of right hand side, it is the outsourcing to third party logistics service. In the middle of the picture, it is 301's hospital external warehouse which established by KY strengthened with red dotted box, while its left is the improvement of information sharing with manufacturers, which surround in another red box. Regarding the order of the replenishment in the figure, should be from right to left, guided by the number in each box.

Firstly, the sales data are transmitted from each sub pharmacy to both external and KY headquarter warehouses through the inventory monitoring system, as well as the manufactures, once the payment of patients finish. With the update of sales, the inventory level should be also fluctuation. If it low behind the safe inventory, the replenishment would be launched automatically and following by the picking and packaging. In the meantime, the delivery order is produced and sending to the logistics service provider to range vehicles, as well as notice sub pharmacy ready to receive products. The third party logistics company delivery the drug as well as the delivery note to sub pharmacies as soon as possible. After the pharmacy staff signed, the copy of the delivery note will return by driver. If there is some damage of package, the refused drugs will brought back with the driver, as well. At the same time, the return detail would back to external warehouse immediately through the system HIEP and achieving real-time inventory update. Due to a same inventory management

system both used in branch and headquarter warehouse of KY, all data are monitored by KY. Therefore, the replenishment of 301's external warehouse is automatically and promptly.

As it was mentioned before, the sales data would be shared with manufacturers as well through the inventory monitoring system of 301's external warehouse, which can be found in the red box at left hand side of figure 5.2. Meanwhile, the inventory data are also shared between KY and manufacturers. Collecting more information of inventory and sales, allows the manufacturers arrange production plan reasonable and make joint market forecasting with KY. As the example of Wal-Mart in the literature reviews, suppliers would offer a suggested order or forecast for Wal-Mart, a little modify after combining with the forecast of themselves. The method could be applied into China pharmaceutical supply chain.

In theory, these three improvements achieve the effective information communication among the whole pharmaceutical supply chain. In addition, the non-value process could be cut off so that reduce the high cost of logistics as well as achieving high efficient distribution. However, there are still some problem when get feedback of this solution.

5.3 Feedback and improvement

In order to make the solution more practical, first of all, the solution must be shown and explained to KY and 301 hospital. At the same time, it is given back to those interviewee companies. Although the solution was generally accepted by most companies, there were still some problems need to consider.

The first and most important problem is exposed by KY, which is about the rental cost of external warehouse. The 301 hospital locates in Beijing, thus, the external warehouse should be established in Beijing, as well. However, the land price in Beijing is too expensive to undertake. However, the solution for short term and urgent is very effective.

With regard to information sharing, almost all feedbacks support the improvement about inventory monitoring which not only through the distributor, but also collaborating with manufacture. However, it makes worries in terms of sharing sales data by real-time. From the aspect of manufacturers, to some extend degree there is risk of secret disclosure if the sales information of all types of drug are opened simultaneously. Because, there may be thousands of types of drug, the difficulty of management is larger than before. The security of data transmission might be affected by an increase in the number of drug. For example, some best-selling drug might be copy though steal information, result in unfair competitive. Especially for the company Astellas that depending on product innovation, there is high risk of

competitiveness loss once important information disclosure. From the aspect of distributors, there is the same worry as manufacturers. However, the loss of distribution channel is the focus of them.

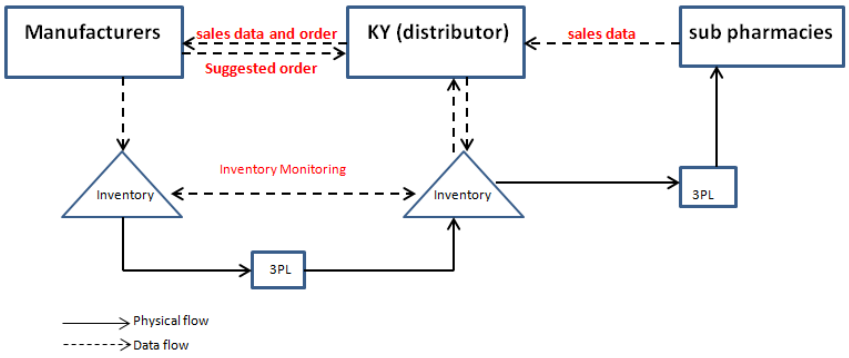


Figure 5.3 the final solution of KY

Combined with the two worries form manufacturers and distributors referred in above section, the solution is improved again in order to be more practical.

Firstly, the improvement for avoiding risk of sales data disclosure is change the form of exchange instead of cancel the sharing of sales data completely, because it is indeed valuable for manufacturer. Thus, an alternative solution could be attempted. The sales data could be disposed by distributor before sharing with each other. For example, the sales data could be collected by weekly with analysis and integration, and sending to the upstream partners.

The second solution must be achieved under 301's hospital support. If the hospital agrees to transfer the rest 20 per cent supervision right to KY, and outsourcing the warehouse of hospital to KY. That would be the best solution. However, it is needs

government support and making great effort by KY itself, to gain the trust and keep good relationship with the hospital. Moreover, it is a long term strategy.

5.4 Discussion implementation of CIM in China

Considering the results of interviews, the answers are discussed combined with the current status of China, thus, some suggestions would be given as well.

5.4.1 Drivers

5.4.1.1 Expanding market

The most attractive driver for Chinese pharmaceutical to accept collaborative inventory management is expanding the market, no matter for manufacturers or distributors. It would change the current situation to profits squeeze for distributors. In addition, managing the inventory of hospital allows the operation of distributors more flexible and efficiency depending on their own interest as long as fulfilling the orders (Bhakoo,2012). Under the traditional model, the suppliers (manufacturers) were selected and decided by hospital itself. Compared with the situation before, the distributors are going to control more resources which are not only stocks of hospital, but also the suppliers. It means that distributor could make joint decision with hospital for supplier selection. Meanwhile, it would bring challenges, as well. For example,

developing the supplier's assessment method and the ability of sales data analysis and many aspects need be improved in the future.

In terms of the benefits for manufacturers, more up-to-data information are collected through information sharing and collaborative planning and forecasting with downstream partners, which promote their ability of innovation of product according to customer's requirement (Kamalapurkar,2011). However, Stank et al. (2001) state that not all the information in the same level could be achieved from all the distribution channels. As the study of Bhakoo (2012), it is worth noting that a number of companies would not integrate the received data into their activities.

5.4.1.2 Reduce cost

Another dramatic driver is cost reduced in terms of manufacture, distributor and even hospital. From the literature review, it can be found that collaborative inventory management makes effective communication between upstream and downstream of supply chain, so that reducing the cost which caused by bullwhip effect. On one hand, due to inventory are lessened, the hospital has no more payments of labour salaries, and energy costs for running the warehouse. On the other hand, there are less worries about the product return which caused by backlog stocks in hospital, thus avoiding the unnecessary loss. Meanwhile, the inventory in the warehouse of distributor decreased, as well because of the flexible and high efficiency management, and the inventory cost would shrink without surprise. With regard to manufacturer, from a few

information exchanging to collaborative planning and forecasting, it makes possible for manufacture to arrange production reasonable, especially for the material import of foreign companies. Kamalapurkar (2011) say that it would be more costly at the beginning of the collaborative inventory management because of the establishment of infrastructures and information systems; however, more benefits would be acquired for long term collaboration.

5.4.1.3 Sharing reward and risk

As it been found from interview, a general idea of supporting collaborative inventory management is sharing reward and risk with partners. In fact, many distributors and manufacturers are willing to change initially, but who will undertake the risk and the expenditure for change is the most concerning question among all participants in supply chain. Currently, the pharmaceutical distributor in China has played a role of 'lender'. It means that largest risk from capital turnover is endured by distributors. Therefore, the implementation of collaborative management could accelerate the time of payment of hospital, thus the risk of stock-out could be dramatically minimized. In the meanwhile, the manufacturer is a beneficiary, because there is more investment from distributor for research and development (Danese,2006). Furthermore, through the contract collaboration could share risk when loss occurs, rather than pay it individually like present.

5.4.2 Barriers

5.4.2.1 IT system diversity

Most of people indicate that the low application of information technology is the basic reason (Andy and Mehmet 2010, Cantor 2006). However, in this research, another reason has been found which is caused by the diversity of the information system. According to the interview, although the biggest the barriers is the information sharing, the root causes is the multiple and mass information system. It is difficult to achieve information sharing smoothly because of this diversity. Singh also find that integration of information system is the key to develop supply chain collaboration.

Among the interviewees, there are one hundred per cent applying rate of information system Moreover, almost all companies have their enterprise resource planning (ERP) system expect Beijing Jewim. However, different system developed by variety of developers. Moreover, the more differences are on warehouse inventory management (see figure 5.3). Furthermore, there are about 13,461 distributors, 4678 manufacturer and approximately 20,000 hospitals in China by the end of 2010 according to the statistics form SFDA. Therefore, it is more difficult to uniform the types of the system. However, the eight interviewed enterprises, most of them are large-scale companies, only Beijing Jewim is a SME without ERP system. It is evidence that the application of information communication technology has been not yet universal.

5.4.2.2 Conservative ideas

In general, Chinese enterprises are reluctant to open their information, even if many large-scale companies, which decided by Chinese culture (Chow, Deng, and Ho, 2000). Actually, it is more serious on state-owned organizations, in this research is hospital. Some advanced concepts, technologies, and management system have been locked in China, because of the unwilling to accept. The change of information would certainly bring some influences.

There are many reasons for the reject. The first one is less confidence to the success. From the interview, the foreign companies represent that they worried about the security of the information sharing, while the state-owned manufacturer and small and medium enterprises suspect the trade-off of investment and pay back of software system development.

5.4.2.3 Lack of government guidance

Although the Chinese government has proposed the pharmacy trusteeship since 2011, the detail policies and regulations still have not published. In addition, the business of pharmacy inventory management depends on the negotiation between distributor and hospital themselves, under the current situation. Moreover, the current pharmacy trusteeship just enlarges the amount of supply not truly achieving collaborative inventory management. The most worried from distributor is the changes occur of the

direction of development and who should undertake the risk and loss once the reform fail. Therefore, the factor from government could not be ignored.

5.4.3 Overcoming the barriers of CIM in Chain

5.4.3.1 Supply chain integrating and reduce diversification

The integration of supply chain has been the worldwide topic with significant debate and discussion. It is focus on develop partnership and effective information exchange and sharing with business partners (Power, 2005). From the literature review, in China, although the medical market has dramatically increased recent years, the pharmaceutical supply chain is long and the structure is complex, which will certainly impede the collaboration of supply chain and increase difficulty of information sharing. Therefore, the supply chain integration and narrow differences are the basic solution for accelerating collaborative inventory management.

The so-called integration in China pharmaceutical is to make effort to develop large-scale enterprises according to the report of NEC. From the literature review there were over 13,400 distributors. This is a huge number than American where only has approximately 70 distributors. Hence, it is necessary to decrease the number of competitors in horizontal (Theodore et al., 2001). In details, the large-scale companies could joint together to be strategic partners understanding customer value and demand, making joint operation planning, so that promoting the product and service

capabilities. As a result of this strategic alliance, there is less space for small companies to survival.

With regard to vertical, there were 4678 pharmaceutical manufacturers and more than 20,000 hospitals by the end of 2010. The emphasis of integration for distributors is implementing performances evaluation for suppliers (manufactures) and building long term trust with downstream partners (hospitals) Ellram,1991; Macbeth and Ferguson, 1994). Finally the number of suppliers could be minimized thought performances evaluation and the relationship with customer is more solid, so that building uniform information communication system and achieving collaborative inventory management.

In addition, enterprise should also strengthen the information technology integration. According to the solution that raised by Nippon Electric Company in 2012, the integration information system should be applied within the company, and the data exchange system should be used between enterprises. Furthermore, the portal of the company should base on work platform system. Only enhance the internal integration can achieve the external uniform, thus, achieving information exchange and sharing smoothly among the supply chain partners.

5.4.3.2 Developing trust and Guanxi

From the interview, KY and Jewim refer that the trust and Guanxi are two of most important factors for collaborative inventory management in China; these are the most effective ways to knock on the door of the hospital.

First of all the transaction cost could be reduce base on the trust relationship in supply chain. (Brian et al., 2012) When the trust is high, it is easier and faster to make joint decisions by using the information that from each other. Moreover, it also help product design, activities management and added values creation through the freely and smoothly flow of product, services and ideas, etc (Das and Teng, 1988, 2002). While, when the trust at a low level, even if the alliance still exist the effectiveness would be to some extent blocked (Lewicki et.al., 1998; Kwon and Suh, 2004;). However, Brian et al. (2012) indicates that the trust is valuable for management purposes and helps to improve the performance of supply chain collaboration, but it is still hard to gain the related quantities data. Moreover, Daugherty et al. (2006) emphasizes that trust building is a long term project. Beijing Jewim as a small and medium enterprise has been committed to build good relationship with partner to win more opportunities.

In China, there is an essential factor to build trust, which is Guanxi. Guanxi seems like an individual factor which has played a significant role on gaining trust and establishing collaborative relationship with buyer (Lee and Dawe, 2005 and Leuang et

al., 2005). Sometime, the personal Guanxi could decide whether it succeed or not for a project bidding. Therefore, the distributors could try to build good Guanxi with hospital, so that gain more orders about drug supply and gradually win the trust from hospital achieving pharmacy trusteeship, under the current situation in China. KY also points out that gaining the project of 301hospital pharmacy trusteeship is contribute to keeping long term good relationship with government's organizations.

However, Steidlmeier (1997) asserts that there would be a risk of bribery if over build the Guanxi though gift giving, winning and dining. Therefore, although the Guanxi is an important factor to successful collaboration, the enterprise still needs to enhance its internal service level firstly. Only after that can enterprise build high trust with partners.

5.4.3.3 Developing third party logistics

In China, many enterprises run the logistics by themselves, with low profits and high investment (Rahman and Wu, 2011). In addition, from the aspect of scale of economy, building a modern logistics centre cannot without fixed investment in equipment and the support of advanced technology, information system, automated warehouse and national distribution network, etc. However, it is no doubt a huge challenge for the small and medium enterprises. 3PL (third party logistic) could solve this problem. 3PL (Third party logistic) means that the external logistic organization acts as the connection between company and client to provide logistic services. With the

increased market competitions and customer requirements, more and more companies outsource their logistic activities to third party logistic service providers in order to pay more attentions on their core activities (Vaidyanathan, 2005) and to achieve greater competitiveness (Quinn and Hilmer, 1994; Welson, 1996). Fleischmann and Daganzo (1988) 3PL point out that the transportation costs and performances are highly decided by distribution structure. The professional team of third party logistics could offer customized and high quality service (Rahman and Wu, 2011). Therefore, for the development of SMEs, the 3PL is a good choice.

However, in China the development of pharmaceutical logistics is undergoing a hardship. The primary reason there is extremely high standard of entry this pharmaceutical third party logistics industry (Xu, 2011). Therefore, only a few large-scale commercial groups have their own distribution network, such as Sinopharm, SHP and Jointown in the interview. Hence, the development is very imbalance. However, on the other hand, it contributes to maintain market order and easy to supervision. Moreover, on one hand it must be merged in the competition for some small companies. On the other hand, it is a huge opportunity to enhance market for large-scale companies, so that accelerating the integration of Chinese pharmaceutical supply chain.

In addition, there is another problem fettering the development of pharmaceutical logistics, which is less uniform standard in national wide. From the interview, it is

generally response that the barcode application is not standard in terms of one barcode with multi-purpose and different code size (Liu and Xing, 2011). Due to no uniform coding for all types of drug in Chain, some distributors developed their own barcode for logistics conveniently, as a result the drug is hard to be traced once leave factory. Moreover, it is have a serious effect on information sharing between upstream and downstream partners of supply chain, as well as the product return in healthcare industry (Brian et al., 2012). On the other side, the logistic standard is not also uniform, such as the pharmaceutical logistics containers, pharmaceutical packing box, and medicine storage tray. Therefore, only rapid developing third party logistics can accelerate the integration of pharmaceutical industry

5.5 Conclusion

According to the interview, there are two main problems facing on Chinese wholesaler/distributor companies, which are imbalance inventory and high inventory cost. In addition, from the case, it could be found the relative high product return rate which cause by backlog stock and logistic waste. These problems full reflect the root problem which is inefficiency information communication with partners. In order to solve this problem, a detail and customized solution was come up for KY.

By using the VMI and CPFR, there is a suggestion for KY. It proposes that building an external warehouse for 301 hospital and achieving the real-time sales information sharing with it. In the meanwhile, it suggest that KY should share the real-time sales information with suppliers (manufacturers) as well, and allows the inventory level monitoring by suppliers, so that suppliers and KY could make joint replenishment planning and forecasting. In addition, considering with the high logistics cost, the outsourcing transportation as another suggestion for KY to reduce the cost.

In order to be more practical, the initial suggestions are sent to the interviewee companies. According the feedback, there are two point need to be considered in the future implementation. The first one is the rental of external warehouse, if the hospital agrees outsourcing their warehouse; this problem will be solved in the future. The other problem is the security of information sharing. Almost all companies worried about the risk of information disclosed, so that decreasing their competitiveness.

Therefore, the final modification is that the sales information is analysed and integrated by KY first, and then, send it to them with the form of report instead of sharing the real-time sales information directly.

With regard to implementation, there are still many barriers under the current environment of China. From the literature review, many research reveal that it is because low level application of information technology. However, in this research, the result is slightly different. The reason that block information sharing among supply chain are diversity of the information system and the Conservative ideas of unwilling to change in China, as well as lack of guidance from government. Combining with the current status and culture of China, three suggestions are discussed in the final. They are reducing diversification, developing trust and Guanxi. Another barrier is high cost of self-running logistics from the case study. Therefore, developing third party logistics as a suggestion for China is discussed, as well.

6 Conclusion

6.1 Summary

According to the literature review, it can be known, the supply chain collaboration is an increasing popular concept applying in many industries, such as manufacture and retail. In addition, there are many useful methods for achieving supply chain collaboration such as VIM (vendor-managed inventory), CPFR (Collaborative planning, forecasting and replenishment). They could enhance the relationship and information exchange and sharing between partners, and reduce the general bullwhip effect. However, as a particular industry, the development of collaborative inventory management is still immature compared with other industries.

Moreover, the current status of China pharmaceutical supply chain has also been mentioned in literature review. The number of participants, especially wholesaler/distributor is huge compared with western countries'. Although the number is huge, lack of market integration which reflecting in two aspects: low market share for large-scale companies, a large number of scattered small companies with low margin profits. Many companies develop independently lack of collaboration with upstream and downstream partners. Moreover, the hospital dominates the pharmaceutical market and nearly 70 per cent drug selling in the hospital. However, due to lack of the knowledge of supply chain, less information sharing, the forecasting of demand is frequently inaccurate, which cause large number of backlog inventory in hospital. However, finally it is the wholesaler/distributors and some manufacturers that pay the bill of waste. As a result, it brings huge loss to

wholesale/distributors and manufacturers. Therefore, companies need to find specific strategies to manage their supply chains. In this dissertation, it focused on strategy collaborative inventory management; they are VMI (vendor-managed inventory) and CPFR (collaborative planning forecasting and replenishment). Because VMI could effective reduce the bullwhip effect and enhance the relationship between partners, while the CPFR enhance the centre position of wholesaler/distributor and allows all supply chain partners involved joint planning and forecasting.

6.2 Outcomes

According to the interview, the research question 1 (what are the current issues of hospital pharmacy inventory management in China?) has been answered. There are two main problems facing on Chinese wholesaler/distributor companies, which are imbalance inventory and high inventory and transportation cost.

In addition, the problem existing in the case study is high product return rate, which cause by backlog stock and logistic waste. Combining with the issues from the interviews, these problems full reflect the root barriers of achieving collaborative inventory management. The two main barriers are inefficiency information communication and low logistics capacity in China. Therefore, the research question 2 (what are the drivers and barriers to achieve collaborative inventory management in pharmaceutical supply chain?) has been finished as well.

Finally, the two main barriers divided into several points, such as IT system diversity, conservative ideas and lack of government guidance. Combining the Chinese capacity and culture, the solutions has been discussed at the end. They are integrating supply chain and reduce diversification, developing trust and Guanxi, and developing third party logistics. Therefore, the research question 3 (How to implementing collaborative inventory management in China in the future?) has been answered finally.

6.3 limitations of this research

In terms of limitations of this research, there are two aspects need to be pointed out. The first point is that for the case study there should be more quantitative data explored, such as three months inventory cost analysis. It should be more persuasive. However, due to relating to trade secret, KY has mere provided the replenishment process mapping and general proportion of relevant information, instead of offering specific number about sales and cost. The second limitation is that this research just involved 11 interviewees and one case study. The data is quite limited to show the whole status of whole pharmaceutical. However, it still reflects the main typical issues and barriers of implementing collaborative inventory management.

6.4 Recommendations on future researches

Although this dissertation has indicated the main issues and barriers of implementing collaborative inventory management as well as the suggested solution. However, the effects need to be examined in future practices. In addition, whether the collaborative inventory management suits for SEMs or not need further research.

References

Achabal, D.D., McIntyre, S.H., Smith, S.A. and Kalyanam, K. (2000), “A decision support system for vendor managed inventory”, Journal of Retailing, Vol. 76 No. 4, pp. 430-54.

Aguilar-Savén, R.S. 2004, "BPM: Review and framework", International Journal of Production Economics, vol. 90, no. 2, pp. 129-149.

Alain Halley, Martin Beaulieu, (2009) "Mastery of operational competencies in the context of supply chain management", Supply Chain Management: An International Journal, Vol. 14 : 1, pp.49 – 63

Andy,P. and Mehmet, C.K, Healthcare Supply Chain Leadership and Strategy: How it Can Help Cost Containment in the Healthcare industry. Cost Management. Boston, United States, Boston.

Augulo, A., Nachtmann, H. and Waller, M.A. (2004), “Supply Chain Information Sharing in a Vendor Managed Inventory Partnership”, Journal of Business Logistics, Vol. 25 No. 1, pp. 101-20.

Australian Government (2012): Department of Health and Ageing, “The state of our public hospitals”, report, June, available at: www.health.gov.au [accessed 12 September 2012].

Aviv, Yossi, (2002)"Gaining benefits from joint forecasting and replenishment processes: The case of auto-correlated demand," Manufacturing & Service Operations Management, 4, 1, 55-74.

NEC (2012) Chinese pharmaceutical distribution enterprise supply chain systems integration solutions Profile.Available from http://wenku.baidu.com/view/db183f8f84868762caaed56c.html [access on 16 September 2012]

Baltacioglu Tuncdan., Ada Erhan., Kaplan, Melike D., Yurt, Oznur., & Kaplan, Y. Cem. (2007). A New Framework for Service Supply Chains. The Service Industries Journal, 27(2), 105-124.

Barratt, M.A. and Oliveira, A. (2001), “Exploring the experiences of collaborative planning initiatives”, International Journal of Physical Distribution & Logistics Management, Vol. 31 No. 4, pp. 266-89.

Boone, Tonya and Ram Ganeshan, (2000) "CPFR in the supply chain: The new

paradigm in forecasting," Working paper, School of Business College of William and Mary Williamsburg, VA, 1-14.

Bozarth, C.C., and Handfield ,R.B. (2006), "Introduction to Operations and Supply Chain Management", 1stedition, Upper Saddle River, N.J. : Pearson Prentice Hall.

Brian, K. S., Heather, N. & Edward, A. P. (2012) Improving Healthcare Supply Chain Processes Via Data Standardization. Engineering Management Journal. Rolla, United States, Rolla.

Burnard, P (1991), A Method of analysing interview transcripts in qualitative research, Nurse Education Today , Vol., 11 PP461-466.

Burns, Lawton R. (2002), The Health Care Value Chain: Producers, Purchasers, and Providers.

Cantor, D. E. (2006) Risk mitigation in the supply chain: Examining the role of IT investment to manage safety performance. ProQuest Dissertations and Theses. United States -- Maryland, University of Maryland, College Park.

Cetinkaya, Sila and Chung-Yee Lee, (2000) "Stock replenishment and shipment scheduling for vendor-managed inventory systems," Management Science, 46, 2, 217-232.

Chen, Frank, Zvi Drezner, Jennifer K Ryan and David Simchi-Lev i (2000), "Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times, and information," Management Science, 46, 3, 436-443.

Chow, C.W., Deng, F.J., and Ho, J.L. (2000), "The openness of knowledge sharing within organisation: a comparative study of the United States and the Peo*ple's* Republic and China", Journal of Management Accounting research, Vol.12, pp.65-95.

Cohen, L. & Manion, L. (1994). Research Methods in Education. Routledge: London.

Crum, C. and Palmatier, G.E. (2004), "Demand collaboration: what's holding us back", Supply Chain Management Review, January/February, pp. 54-61.

Danese, P. (2006), "The extended VMI for Coordinating the Whole Supply Network", Journal of Manufacturing Technology Management, Vol. 17 No. 7, pp. 888-907.

Danese, P. (2007), "Designing CPFR collaborations: insights from seven case studies", International Journal of Operations & Production Management, Vol. 27 No. 2, pp. 181-204.

Damien, P. (2005) Supply chain management integration and implementation: a literature review. Supply Chain Management, 10**,** 252-263.

Dan, K. (2004) The State Of Pharmaceutical Industry Supply Planning And Demand Forecasting. The Journal of Business Forecasting Methods & Systems, 23**,** 20-22.

Das, T. K., & Teng, B. (1998). Between trust and control: Developing Confidence In Partner Cooperation In Alliances. Academy of Management Review, 23, 491--512.

Disney, S.M., Holmstr.om, J., Kaipia, R., Towill, D.R., (2001). Implementation Of A VMI Production And Distribution Control System. International Symposium of Logistics, Salzburg, Austria.

Disney, S.M., Naim, M.M., Towill, D.R.,(1997). Dynamic Simulation Modellingfor Lean Logistics. International Journal of Physical Distribution and Logistics Management 27 (3), 174–196.

Disney, S. M. & Towill, D. R. (2003) The effect of vendor managed inventory (VMI) dynamics on the Bullwhip Effect in supply chains. International Journal of Production Economics. Amsterdam, Switzerland, Amsterdam.

Dougherty, E.M., N. Narang, M. Leob, D.E. Lynn and M. Shapiro,(2006). Fluorescent Brightener Inhibits Apoptosis In Baculovirus-Infected Gypsy Moth Larval Midgut

Cells in vitro. Biocontrol Sci. Technol., 16: 157-168.

Dong, Y., Xu, K. & Dresner, M. (2007) Environmental determinants of VMI adoption: An exploratory analysis. Transportation Review. Part E: Logistics and Transportation Review, 43**,** 355-369.

Elmuti, D., Kathawala, Y., Monippallil, M. (1998 May). Outsourcing to gain a competitive advantage. Industrial Management 40(3), 20-24.

Ellram, L. (1991), "A Managerial Guideline For The Development And Implementation Of Purchasing Partnerships", International Journal of Purchasing and Materials Management, Vol. 27 No. 3, pp. 2-8.

Fliedner, Gene, (2003) "CPFR: An emerging supply chain tool," Industrial Management Data Systems, 103, 1/2, 14-21.

Forrester, J. W. (1958). 'Industrial Dynamics: A Major Breakthrough for Decision Makers.' Harvard Business Review Vol. 36 No. 4, pp37-66.

Gane, C., Sarson, T. (1977). Structured Systems Analysis:--Tools and Techniques. Unpublished document: McDonnell Douglas Corporation.

Glaser BG (1967), Strauss A. Discovery of Grounded Theory. Strategies for Qualitative Research. Sociology Press [3],

Goble,G.G, and J.Berger,(1994).”Soil resistance Factors for LRFP of Driven Piles.” International conference on design and construction of Deep Foundations. Vol.11. Federal Highway Administration. Washington, D.C.

Haavik, S. (2000) Building a demand-driven, vendor-managed supply chain. Healthcare Financial Management, 54**,** 56-61.

Holweg, M., Disney, S., Holmstrom, J. & Smaros, J. (2005) Supply chain collaboration: making sense of the strategy continuum. European management journal, 23**,** 170-181.

Hu chun, (2007). Market channel management, Beijing Jiaotong University Press. Beijing.

Hu.Jianq.J ,Dai.yue,Gu.Kevin (2010) Pharmaceutical Supply Chain in China: Challenges and Opportunities. CAPS research

IMS: (2012) Jan-Willem Eleveld , Vice President, Consulting & Services, Asia Pacific. China and the New Harbingers of Change. Available from：
http://www.imshealth.com/ims/Global/Content/Insights/Featured%20Topics/Launch%

20Excellence/Harberingers.pdf [access on 19 September 2012].

Jarrett, P.G. (1998), “Logistics in the health care industry”, International Journal of & Physical Distribution and Logistics Management, Vol. 28 Nos 9/10, pp. 741-72.

John, S., Naim, M.M., Towill, D.R.,(1994). Dynamic Analysis Of A WIP Compensated Decision Support System. International Journal Of Manufacturingsystem S Design 1 (4), 283–297.

Huang Y. Z. (2001) The Economic Analysis of high Drug Price, China Economist vol5.

Kamalapurkar, D. Benefits of CPFR and VMI collaboration strategies in a variable demand environment. ProQuest Dissertations and Theses. United States -- Michigan, Western Michigan University.

Kathleen, E. M.-S., Paul, H. & Susan, B. W. (2005) The Ailing Healthcare Supply Chain: A Prescription for Change. Journal of Supply Chain Management. Wheat Ridge, United Kingdom, Wheat Ridge.

Kerlinger, F.N. (1986). Foundations of behavioral research (3rd. ed.). Fort Worth, TX : Holt, Rinehart, and Winston.

Kim, D. (2005), "An integrated supply chain management system: a case study in healthcare sector", Proceedings of 6th International Conference, EC-Web 2005, Copenhagen, Springer, Berlin.

Kowalski, J. (2009), "Need: a strategic approach to supply chain management", Healthcare Financial Management, pp. 90-98.

Kufang (2005) How pharmaceutical companies out of the initial stage of the information technology, available from http://www.kufang.cn/showinfo.asp?id=3472 [access on 12 September 2012].

Kvale, Steinar(1996) InterviewsL An introduction to qualitative research interviewing..:SAGE,Capter 7: The Interview Situation,pp.124-135.

Lang cheng lin (2009) Barcode anti-counterfeit and failed in China. Available form http://cj.39.net/cjyczl/lcl/096/24/908551.html [access on 17 September 2012].

Lauer, C. (2004), "Excellence in supply chain management", Modern Healthcare, Vol. 34 No. 50, pp. 29-32.

Lee, D.Y., and Dawes, P.L. (2005), “Guanxi, trust and long-term orientation in Chinese business markets”, Journal of International Marketing, Vol. 13, No. 2, pp. 28-56

Lee, Hau L, V Padmanabhan and Seugjin Whang, (1997a) "Information distortion in a supply chain: The bullwhip effect," Management Science, 43, 4, 546-558.

Liu tao and Xing hua (2011), Barcode application in the field of medicicin.available from: http://www.cqvip.com [access on 8 September 2012]

Mark Barratt, (2004) "Understanding the meaning of collaboration in the supply chain", Supply Chain Management: An International Journal, Vol. 9: 1, pp.30 - 42

Lewicki, R.J., Mcallister, D.J. and Bies, R.J. (1998), “Trust and distrust: new relationships and realities”, Academy of Management Review, Vol. 23 No. 3, pp. 438-58.

Macbeth, D. and Ferguson, N. (1994), Partnership Sourcing: An Integrated Supply Chain Approach, Pitman, London.

Ma Xin, Huang Yi-qian, (2010) “Analysis for the Status Quo of Pharmaceutical supply chain in China”.

McKone-Sweet, K.E., Hamilton, P., Willis, S.B. (2005), "The ailing healthcare supply chain: a prescription for change", Journal of Supply Chain Management, Vol. 41 No.1, pp.4-17.

Nachtmann, Heather, and Edward A. Pohl, (2009) “The State of Healthcare Logistics: Cost and Quality Improvement Opportunities,” Center for Innovation in Healthcare Logistics, University of Arkansas.

Mingzhi, L., Yulin, T., Xiao chen, W. & KAI, R. (2005) Transforming Inter-Organizational Information Systems into Electronic Commerce Marketplaces: Development of B2B Electronic Commerce in China's Pharmaceutical Industry*. International Journal of Management Science, 11**,** 61-78,155-156.

Naim, M.M., Towill, D.R., (1995). What’s in the pipeline? Proceedings of the Second International Symposium on Logistics, Nottingham, UK, 11–12 July, pp. 135–142.

Noorfa Haszlinna, M. & Andrew, P. (2009) Healthcare supply chain management in Malaysia: a case study. Supply Chain Management, 14**,** 234-243.

Outlook weely (2007) available from http://lw.xinhuanet.com/htm/content_851.htm

[access on 12 September 2012]

Pamela, D. (2007) Designing CPFR collaborations: insights from seven case studies. International Journal of Operations & Production Management, 27**,** 181-304.

Perry, A. & Kocakulah, M. C(2010). Healthcare Supply Chain Leadership And Strategy: How It Can Help Cost Containment In The Healthcare Industry. Cost Management. Boston, United States, Boston.

Quinn, J.B. and Hilmer, F.G. (1994), "Strategic outsourcing", Sloan Management Review, Vol. 35 No. 4, pp. 43-55.

Razzaque, MA and Sheng, CC. (1998). Outsourcing of logistics functions: A literature survey. International Journal of Physical Distribution and Logistics Management 28: 89–107.

Rich, N. & Hines, P. (1997) Supply-chain management and time-based competition: the role of the supplier association. International Journal of Physical Distribution & Logistics Management, 27**,** 210-225.

Ryu, C. (2006) An investigation of impacts of advanced coordination mechanisms on supply chain performance: Consignment, VMI I, VMI II, and CPFR. ProQuest

Dissertations and Theses. United States -- New York, State University of New York at Buffalo.

Sandra, S. L. & Michael, C. (2000) Toward a framework for entering China's pharmaceutical market. Marketing Intelligence & Planning, 18**,** 227-235.

Scheller, E.S. and Smeltzer, L.R. (2006), Strategic Management of the Health Care Supply Chain, 1st ed.,Wiley, San Francisco, CA.

Seifert, D. (2003), Collaborative Planning, Forecasting and Replenishment: How To Create A Supply Chain Advantage, Amacom, New York, NY.

Shah, N. (2004) Pharmaceutical supply chains: key issues and strategies for optimisation. Computers & Chemical Engineering, 28**,** 929-941.

Shams Rahman, Yen-Chun Jim Wu, (2011),"Logistics outsourcing in China: the manufacturer-cum-supplier perspective", Supply Chain Management: An International Journal, Vol. 16: 6 pp. 462 - 473

Sherman, R., (1998). Collaborative planning, forecasting & replenishment (CPFR): realizing the promise of efficient consumer response through collaborative technology. Journal of Marketing Theory and Practice 6 (4), 6–9.

Simchi-Levi, David, Philip Kaminsky and Edith Simchi-Levi(2000), Designing and Managing the Supply Chain; Concepts, strategies, and case studies, McGraw-Hill Higher Education.

Singh, M., Rice, J. and Riquier, D. (2006), Transforming the Global Health Care Supply Chain, MIT Center for Transportation and Logistics, Cambridge, MA.

SPDA report (2011) Drug terminal change in the situation under the new health care reform. Qingcheng mountain.

Stank, T.P., Keller, S. and Daugherty, P.J. (2001), "Supply chain collaboration & logistical service performance", Journal of Business Logistics, Vol. 22 No. 1, pp. 29-48.

Steidlmeier,P. (1997), "Gift giving, bribery and corruption: ethical management of business relationships in China", Journal of Business ethics, Vol.20, No. 2, pp.121-132.

Stock, G., McFadden, K. and Gowen, C. III (2007), "Organisational culture, critical success factors, and the reduction of hospital errors", International Journal of

Production Economics, Vol. 106 No. 2, pp. 368-92.

Stank, T.P., Keller, S. and Daugherty, P.J. (2001), "Supply chain collaboration & logistical service performance", Journal of Business Logistics, Vol. 22 No. 1, pp. 29-48.

Statistical report (2010): SFDA available from http://www.sda.gov.cn/WS01/CL0108/66530.html [access on 15 September 2012].

Sun, Q., Santoro, M. A., Meng, Q., Liu, C. & Eggleston, K. (2008) Pharmaceutical Policy In China. Health Affairs. Chevy Chase, United States, Chevy Chase.

Vaidyanathan, G. (2005), "A framework for evaluating third-party logistics", Communications of the ACM, Vol. 48 No. 1, pp. 89-94.

VICS (1998): www.cpfr.org ,CPFR Guidelines, Voluntary Inter-industry Commerce Standards, Lawrenceville, NJ.

Vigtil, A. (2007), "Information exchange in vendor managed inventory", International Journal of Physical Distribution & Logistics Management, Vol. 27 No. 2, pp. 131-47.

Vaidyanathan, G. (2005), "A framework for evaluating third-party logistics", Communications of the ACM, Vol. 48 No. 1, pp. 89-94.

Vikram, B., Prakash, S. & Amrik, S. Collaborative management of inventory in Australian hospital supply chains: practices and issues. Supply Chain Management, 17**,** 217-230.

Welson, R. (1996), "It's hard to buck the outsourcing tide", PC Week, 15 July, p. 1.

Wolcott, H. F. (1994). Transforming qualitative data: Description, analysis, and interpretation. Thousand Oaks, CA: Sage.

Xu yongzhou (2011), "Third-party logistics 'through'" available from http://wenku.baidu.com/view/04c62367caaedd3383c4d343.html [access on 16 September 2012].

Yang Shu-jie, Liu Hao(2010)," Medicine distribution channels management based on supply chain management", World Clinical Drugs, Vol.31 No.7 PP.443-446.

Yao, Yuliang (2002) , "Measuring impacts of electronic commerce on supply chain management,"185.

Yin, R. K. (1984). Case study research: Design and methods (1st ed.). Beverly Hills,

CA: Sage Publications.

Yin, R. (1994). Case study research: Design and methods (2nd ed.). Beverly Hills, CA: Sage Publishing.

Yin, R. K. (2003). Case study research: Design and methods (3rd ed.). Thousand Oaks, CA: Sage

Yin, G. (2009). “Bayesian Generalized Method of Moments.” Bayesian Analysis, 4(1):1-17.

Zhang Guangjing,(2008) Research and Discussion on the Development of Logistics for Medicine, Supply Engineering & Logistics, pp80-82.

Zhi Yan consulting company (2012) Operational situation and development prospects of China's pharmaceutical distribution market report for 2012-2016.