CHALMERS

Chemical Information in Two Textile Supply Chains

A case study of producers in China

Master of Science Thesis in the Master Program of Environmental Measurements and Assessments

YUNTAO ZHANG

Department of Energy and Environment
Division of Environment System Analysis
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden, 2009
Report No. 2009:10

REPORT NO. 2009:10

Chemical Information in Two Textile Supply Chains

A case study of the producers in China

Yuntao Zhang

Division of Environmental System Analysis
Department of Energy and Environment

CHALMERS UNIVERSITY OF TECHNOLOGY

Göteborg, Sweden 2009

Chemical Information in Two Textile Supply Chain
-A case study of the producers in China
YUNTAO ZHANG

ESA Report No: 2009:10
ISSN: 1404-8167
Division of Environmental System Analysis
Department of Energy and Environment
Chalmers University of Technology
SE-412 96 Göteborg
Swedn
Telephone: +46 (0)31-7721000

Printed by Chalmers reproservice
Göteborg, Sweden

Acknowledgements

For me, this study is a dream come true: using the knowledge I learned in Sweden to contribute to the environmental improvement in my home country, China, was always my dream. In all my time, this dream keeps me going on. I have to say, this ride is definitely an easy one. That is because the topic is a whole new territory for me. From knowing the topic to draw the final conclusion, I had to go through a lot. However, I find myself improved a lot as well, both in language use and in problem solving.

There are many people I want to thank. Without their help, there was no way for me to accomplish this report. First of all, I would like to thank the Swedish Research Council for Environment, Agricultural Science and Spatial Planning (Formas) and two Swedish companies. Your financial aids and other supports made the research trip possible. Then I want to say “thank you” to my examiner and supervisor Sverker Molander. Your pressure is also the drive for me to move on and I am also grateful for your help of the correction of my report. Without you, there is no way for me to make such a report. Thirdly, I want to thank my supervisor Kristin Fransson. Your patient instruction is the foundation of my report and I learned so much from you. Fourthly, I want to thanks the guys in my office. Although, I still don’t know the names of you all, I definitely spent happy time with you guys. And I want to thank my family as well. Whenever I face problem, I always can find comfort and courage in you. I love you so much. Last but not least, I want to thank all my friends and the people who give me help during my work of this paper.

Never give up your dream!

Abstract

The benefits from chemical use to human life are numerous. Textile industry whose development is driven by the use of various chemicals is one such example. However, chemicals also bring adverse effects to human life and environment when being misused. For instance, it is reported that waste water released during textile production can cause detrimental consequences to ecosystems and the chemical leftovers in textile articles can also harm health and environment. For the purpose of controlling undesirable effects caused by chemicals in textile production, a proper way must be found. It is believed that more information about toxic substances is needed in order to manage chemical use in textile industry (Massey et al 2008).

This paper chooses China as the focus of the investigation. Under the help of two Swedish textiles retailer companies, totally five textile factories in two supply chains located in Guangdong and Shanghai were visited. Interviews of managers in those factories, was performed to find out: (1) how chemical related information is transferred downstream and upstream in textile supply chains and how several corporations work together to cope with chemical risk issues; (2) what kind of information is required by textile importers from their suppliers and how these requirements affect textile producers behavior in terms of chemical use; and (3) how people work with chemical related information within a factory. A comparison of the chemical information management between the two supply chains is made as well.

It is found through the study that two Swedish importers set the standards to control the quality of products manufactured by Chinese textile producers. Moreover, these importers were also dedicated to help textile producers' ability to improve regarding chemical information management. As a result, these producers can follow the demands properly. However, there are also differences between the supply chains' information management: mainly in the way that the two importers collect chemical related information from producers in upstream and the range of importers' contact with textile producers. It is also concluded that importers play major roles for improving manufacturers' awareness on the importance of chemical information and conducting better outcome of chemical management in supply chain.

Keywords: textile supply chain, textile production, Chinese textile producers, chemical information management, supply chain environmental management

Table of Contents

List of figures and tables

1. Introduction

Chemicals play crucial roles in people's daily life. From agriculture to manufacture, from industry to household, practical applications of different kinds of chemicals bring numerous benefits to the life of human beings. But along with all these benefits, the debates about the hazardous effects of chemicals to environment and human health never stop. Many studies have been done to examine the adverse effects and try to find approaches to make chemicals useful in more appropriate ways. In United Nations' Johannesburg Plan of Implementation, "*sound management of chemicals*" was highlighted as one of the sustainable development goals and actions; and what needs to be carried out to achieve the goals are specified for different levels (UN, 2002).

1.1 Textile Industry and Chemicals

Textile is a crucial element in people's life. They offer people various functions for daily use, such as coverings both in day time and at night. The use of different kinds of textile articles is also a unique way for people to express their identities. So, people give high credit to the use of textile products. Yet, the use and production of textile also receive people's concerns because of the possible hazardous effects. That is because regarding the production, textile industry is one of the businesses that heavily rely on chemical use. Chemicals bring diversity, such as different colors and functions of textile products, to that industry; and the benefit of chemical use to textile production is un-doubtable. However, the use of chemical in textile production arouses many environmental and health problems as well. For a long time, the toxic chemical wastes released during textile production and hazardous health effects of textile chemicals to textile workers has been a hot topic for public and academic concerns. But with researches going on, it becomes more and more obvious that through the transfer in supply chains, the toxic chemical residues which may be found in textile articles (e.g. garments and towels) can also have the potential to harm final consumers' health and environment during their usage and disposal. Many works has been done aiming to find ways to reduce the hazard of chemicals in textile industry: some of them focus on end-of-pipe technologies such as the chemicals used or physical methods to clean the effluent release from textile dyeing and printing; some of them try to solve this problem by optimizing the production processes and managing the chemical use in a systematical way, hence cutting off the superfluous chemical use and avoiding chemicals' misuse in textile industry. For example, the European IPPC Bureau (2003) address this issue by recommending "*process integration*" in textile production.

Besides these methods, there are also other valuable attempts. One of them is from Massey et al (2008). They stated that "*availability of information*" is one of the most crucial factors for sound management of toxic substances in the production of articles. They also maintained that without enough information, it is impossible to make "*adequate risk management measures*". This paper adopted Massey's argument and

considered that timely and correct information about chemical use is the basis to make sound decisions for controlling chemical use hence reducing the chemical risk in textile industry. But textile industry has traditionally suffered from poor data dissemination between different actors in the supply chains; and many pre-formulated chemicals are used in the industry without a full knowledge of the details contents. So it is urgent to find ways to ensure efficient information sharing between different actors in textile supply chains. As the purpose of getting to know how chemicals being introduced into the textile products, the very first step to initiate the task of chemical management in textile supply chains is trying to look through the textile supply chain and finding out how the information about chemicals is handled by different actors in the chain and what are the common problems hindering the information sharing processes.

China is the biggest textile articles supplier in the world. The income from textile export makes a significant contribution to China's national economy. Textile products produced in China are leading products, from a quantity point of view, in EU countries' markets. As a member of EU, Sweden imports large volumes of textile products every year. Therefore it is worthwhile to find out how the requirements from Swedish importers, who purchase textile products from China, affect the behavior of Chinese textile manufacturers regarding chemical use and how chemical information is managed in the chain. Moreover, knowing the way chemical related information is managed and handled by Chinese producers in different positions of a supply chain can also be helpful for Swedish importers. Using this knowledge, they can make a better chemical management along their supply chain and reduce the chemical risks associated with their products.

1.2 Supply Chain Environmental Management (SCEM)

In the business world today, no individual or organization can get away from issues regarding the environments. Indeed, besides incorporating environmental management in their own facilities, more and more companies are addressing environmental issues across the whole supply chain (Lippmann, 1999). The practice of supply chain environmental management SCEM can provide useful experience for the chemical information management in textile industry. Handfield et al (2005) gave the definition to SCEM as:

> "*The formal system that integrates strategic, functional and operational procedures and processes for employee training and for monitoring, summarizing and reporting environmental supply chain management information to stakeholders of the firm. The documentation of this environmental information is primarily focused on supplier performance, audits, design, waste minimization, training, reporting to top management and goal setting.*"

Concerning the intention of a corporation, Hall (2000) said the company introduces environmental management into their supply chain management practice because this

company and its supply chain have to face external environmental pressures, aiming at specific issues, from several aspects. These pressures may come from the sources such as regulations, environmental pressures from environmental advocacy groups and consumers and so on. The existence of such pressures sharps the profile of a supply chain and also motivates the supply chain actors to incorporate elements of environment management into their activities such as supplier selection, product design, raw material purchasing and technical assistance.

One basic approach for actors to improve the environmental profile of a supply chain is to control the procurements in accordance with certain "green" policies. Other common activities to complement the green procurement include supplier meetings, surveys and audits, training and technique assistance, collaborative research and development (Lippmann, 1999). Kogg (2003), on the basis of theories proposed by Lippman, further divided the concept of SCEM into three distinct but interlinked tasks: first, *determine the objectives to be achieved;* second, *motivate relevant actors to ensure that reaching the objectives is desirable for all the parties involved;* and third, *devise a system of control*.

The whole process of SCEM is complex. To make a SCEM program working in an effective way, four characteristics are essential, as listed by Lippman (1999):

First: "*Top-level leadership"*. The leader companies in a SCEM program need to understand the value of SCEM, and give their efforts to support the program. It is the base for the success of a SCEM program. The leader companies also need to have clear and strong environmental goals.
Second: "*Cross-function integration"*. Successful SCEM programs often involve cross-functional teams to represent different functions in the supply chain. The actors in the supply chain need to understand different profiles of the management work.
Third: "*Effective communication"*. Companies need to communicate their environmental goals internally, make the people throughout the organization to know what the individual department and person need to do to reach the goals. The leader companies in the supply chain must carry out *clear, consistent and frequent communication* about the environmental issues with other members in the supply chain.
Finally: "*Effective processes for targeting, evaluating, selecting and working with suppliers"*. Leader companies in the supply chain need to incorporate environmental issues into supplier selection and evaluation processes. Some screening programs based on environmental performance are necessary. Last but not least, an effective SCEM program provides the opportunities for different actors in the supply chain to solve problems jointly.

1.3 Problem Description

In European countries, strict laws and legislations as well as wide public concerns and supervisions guarantee that most of the textile producers can handle chemical related

issues in a proper way and try to reduce the contents of chemical residues in final products. But for the imported goods which is produced outside Europe, their quality regarding chemical safety is usually hard to assess. Lagged by its degree of development, the environment related issues still couldn't gain enough concerns in China. The textile producers in China are usually not able to handle chemical related issues efficiently. As a result, several problems are raised, including adverse effects of chemicals to environment and textile workers' health and the problems of final textile articles caused by chemical residues (Wu, 2002).

The general aim of this study is to investigate and understand the ways of chemical related information management in part of two textile supply chains. China is the country where all interviewed factories are located. Hopefully, the results of the study can be used as effective tools to achieve better communication between Chinese textile producers and their customers (foreign importers), and help them to minimize adverse environmental and health effects both for textile workers and final consumers. Through the study, a broad picture about how the information flows between different actors in the supply chain are obtained and the following five questions about textile production in China are answered:

1. How are factories working with chemical related information within the organization?
2. How are the textile producers' behaviors regarding chemical use affected by the demands of their customers?
3. What kinds of chemical information do the importers require from their suppliers?
4. How are several factories or companies working together in the same supply chain to cope with chemical risk related issues?
5. How is the chemical information transferred downstream and upstream in the supply chain?
6. What are the differences between two supply chains regarding chemical information management?

1.4 Scope and Limitation of the Study

China is chosen as the focal country for the study, because its exported products play an important role on the international as well as the Swedish textile market. Through the help of two Swedish retailer companies, five textile producers in their supply chains were visited during a half month. As stated before, the aim of the study is about making case studies of chemical information flow pathways and how the information is managed in two textile supply chains. That means no specific chemical substance or mixture is focused and only the way of chemical information's collection, distribution and management by different actors in textile supply chains are interesting for analysis.

The textile supply chain is a long one, from raw material production to final products

use by consumers. Consequentially, the activities in it and relationship between all supply chain actors are complicated. But the restriction from time and finance limit the scope of the study. As a result, only parts of textile manufacturers in two supply chains are reached. They are two sewing factories, one dyeing factory, one printing factory and one dyeing/printing factory. Chemical suppliers in the supply chains are not included in this study. For textile producers' internal chemical information management, this paper gives more attention to dyeing/printing factories. That is because dyeing/printing factories use most chemicals during textile production and workers in these factories are facing higher chemical risks as well. Finally, one fact must be stated: the result of the study can only partly reflect the on-going condition of chemical information management in China's textile industry. That is because the visited factories are all Chinese suppliers or sub-suppliers (which means immediate supplier's supplier) which have close cooperation with overseas retailer companies. The good environmental profile of these companies has strong influence on the two studied supply chain. So, the interviewed factories probably only present some of the best cases regarding chemical information management in China. To draw a more comprehensive picture, some other further studies and investigations are needed.

1.5 Investigation and Analysis Methodology

For the study, the investigation and analysis units are two Swedish retail companies and their suppliers and sub-suppliers respectively. The collection of the data is governed by the research questions above. Two information collection methods were used in the thesis work. One was literature review and the other was interviews performed during a case study in China. The key of analysis in this paper is comparing the performance of two supply chains in the sense of chemical information management.

1.5.1 Literature Review

Literature review was used as the start-up method to understand the thesis's topic and to know the core problems related to the topic. The literature involved both academic books and journal articles. Since other similar studies related to this topic are relatively few, the literature review was then carried out to understand the basic concept of supply chain, textile industry and the chemical use in textile production, chemical risk in textile production and supply chain environmental management. This work was done before embarking on the field studies. Through connecting these concepts, a broad portrait was gained about which aspects should be covered by the following field studies. Beside books and journals, the reports and documents of two investigated retailer companies' policies about environmental issues and supplier management were also reviewed after the field studies. The information of the two retail companies was approached through on-line search. The purpose of involving that information into the analysis was to get a deeper understanding about the attitude of two companies towards chemical related issues and how they manage their supply chain with regard to chemical use by suppliers and sub-suppliers.

1.5.2 Interviews

Semi-structured interviewing is the other main investigation method in the study. The interviewees involved were people who take care of the chemical related issues in the investigated Chinese textile factories. These factories engage in dyeing/printing and sewing process. And all have business relation with the two Swedish importers. Based on the agreement with two retailer companies, the name of them and their supplier factories will be substituted with different letters. Some details about the factories involved in the study and their relation will be presented as background information in Chapter 3. An interview guide with a series of open-ended questions was prepared beforehand to facilitate the interview, so as to steer the topic of the conversations to be on the right tracks and relevant to the purpose of the study as well. The subjects in the interview guide are developed based on the definition of SCEM and its crucial elements listed in part 1.2. They included textile producers' chemical selection and use, management of customers' chemical related demands by producers, chemical information acquisition from suppliers, textile producers' internal chemical information management and the impact of institutional activities on supply chain chemical information management. Considering the fact that the investigated factories conduct operations of different characters and thus have different chemical use patterns, two different groups of questions were prepared accordingly. One of them is aiming for sewing factories and the other is for dyeing/printing factories. More questions were asked to the interviewees presenting dyeing/printing factories, since these factories have a more complicated chemical use and of course receive more chemical related information than sewing factories. For some particular questions, several follow-up questions were asked to explore in further levels. It is worthwhile to notice that the questions used in the interviews may have some differences with the ones in the interview guides according to different practical situations in interviews. All the interviews were carried out in person, and none of them was longer than 1 hour.

Besides materials from interviews with textile producers, other information gathered from the two importers during the field study is presented in this thesis as well. For one of the importers (Factory B), the person from its purchasing department participated in the two interviews with company's supplier and sub-supplier. For the other (Factory A), information was given by purchasing managers during a presentation. Their information inputs are also valuable materials to help the analysis of the study.

1.5.3 Method of Analysis

It is impossible to comprehensively analyze each supply chain's chemical information management processes against some external benchmark due to lack of similar studies. Beside the analysis of each supply chain's chemical information management, the comparison between the two supply chains is one of the ultimate purposes of the analysis. Furthermore, conclusions from other scholars' research on environmental supply chain management are also used as a reference to partly evaluate the

performance of the information management of the two supply chains'. Figure 1 illustrates the analytical framework used in the study.

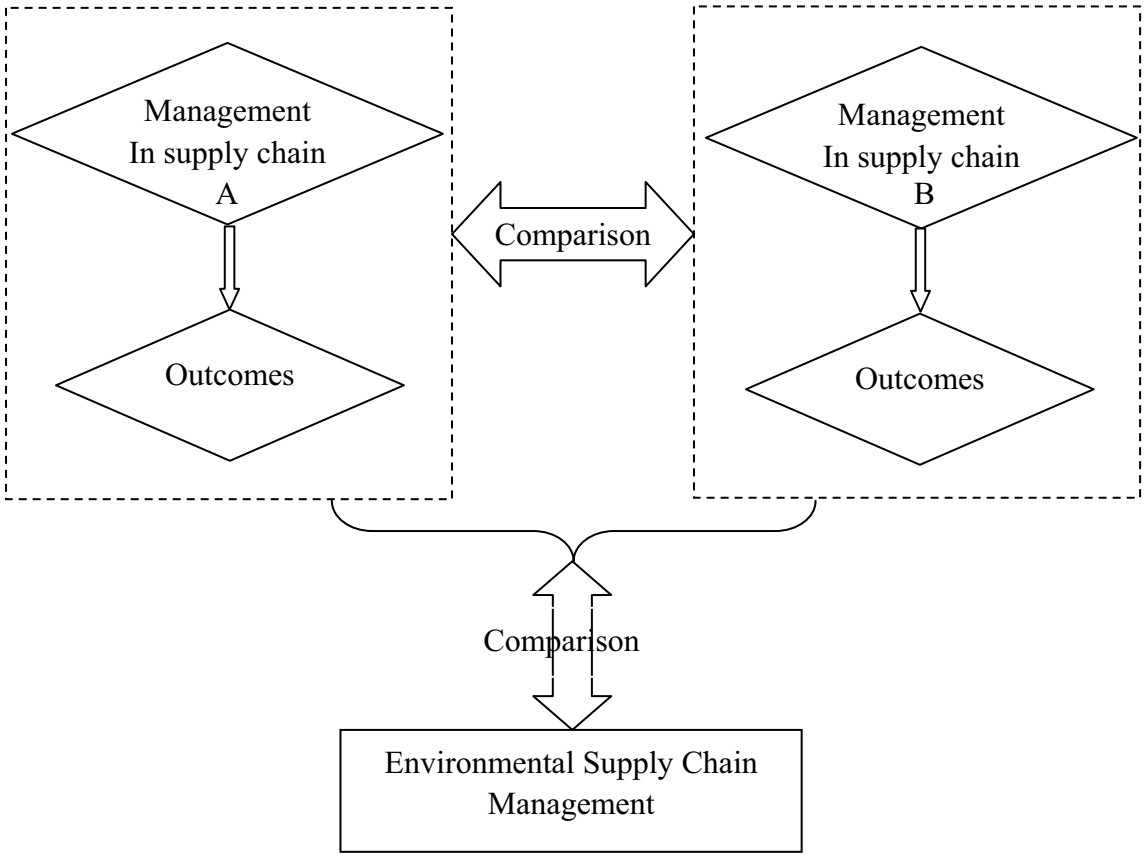

Figure 1: Analysis model of the study

1.6 Structure of the Report

In Chapter 2, background information related to the topic is introduced. This part presents the literature review. The topic is divided into several different subjects.

Chapter 3 gives the background information of the study. There are two parts in this chapter: the state of China's textile products export and the organization of visited supply chains.

Chapter 4 is the main part of the report. It presents the facts of how the chemical related information is managed in the supply chains. Company A's and Company B's supply chain are described separately, because there are many differences between them.

Chapter 5 analyzes the similarities and differences of the functioning of the two

supply chains and the factors influencing the chemical information flows.

Chapter 6 finishes the report with conclusion drawn from the analysis. It answers the six research questions listed in this chapter.

2. Literature Reviews

In this chapter, the general background information related to the study is introduced.

2.1 The Textile Supply Chain

A supply chain is "*a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finance and information from a source to customers*" (Mentzer et al., 2001). To determine the features of a certain supply chain and then manage it, three basic concepts should be clarified (Lambert and Cooper, 2000): firstly, the *actors* in the supply chain; secondly, the *structure dimensions* of the supply chain; and finally, the different types of *processes that link across the supply chain*.

The *actors* of a supply chain are people or organizations that take part in the activities of the supply chain. They are the ones that run and manage the business across a supply chain. The *structure dimensions* of one supply chain includes meanings from three aspects: (1) the horizontal structure, which means the number of tiers in a supply chain (length of the whole supply chain); (2) the vertical structure, which means the number of suppliers/customers in each tier (depth of each tier); (3) and the horizontal position of a focal company between the end point of the supply chain (where a focal actor is relative to other actors). The *processes that link across the supply chain* are activities that keep the business in the supply chain running. They are the interaction between actors in the supply chain, such as procurement, products development and commercialization, manufacturing flow management, customer service and so on. Figure 2 which is modified from Lambert and Cooper (2000), depicts a simplified supply chain structure. The actors shown in the supply chain are linked by goods flows, information flows and finance flows (which is not shown in the figure). In this study, the investigation about goods flows (chemicals) and relevant information flows about chemicals are given higher priorities.

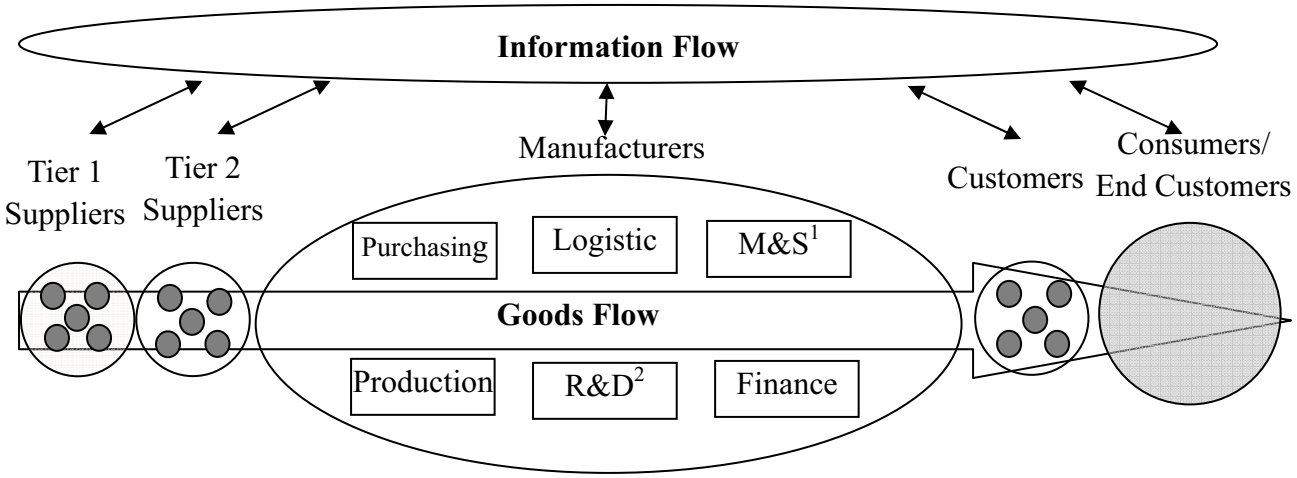

Figure 2: Structure of a supply chain

1: Marketing and Sales; 2: Research and Development.

In a textile supply chain, the actors included are brand owners, raw material supplier, textile producers, "financiers" (banks, for instance), retailer companies and final customers and so on. In textile industries, an independent actor may take the responsibility for more than one supply chain task (Cao et al., 2008). For example, the brand owner and the retailer can be the same company; the brand owner can also have their own in-house production chain. Normally, in a traditional textile-apparel supply chain as argued by Cao et al (2008), the brand owner is the trigger to start the product development process, which include research and design.

2.1.1 Textile Production

Textile production is the most important activity in a textile supply chain. It is the origin for all moves related to material flow in the supply chain. Figure 3 below is a sketch made by Lacasse and Baumann (2004). It is a flow chart that indicates the general procedure of typical textile production process by which man-made or natural fibers are converted to textile products such as garments and household textiles.

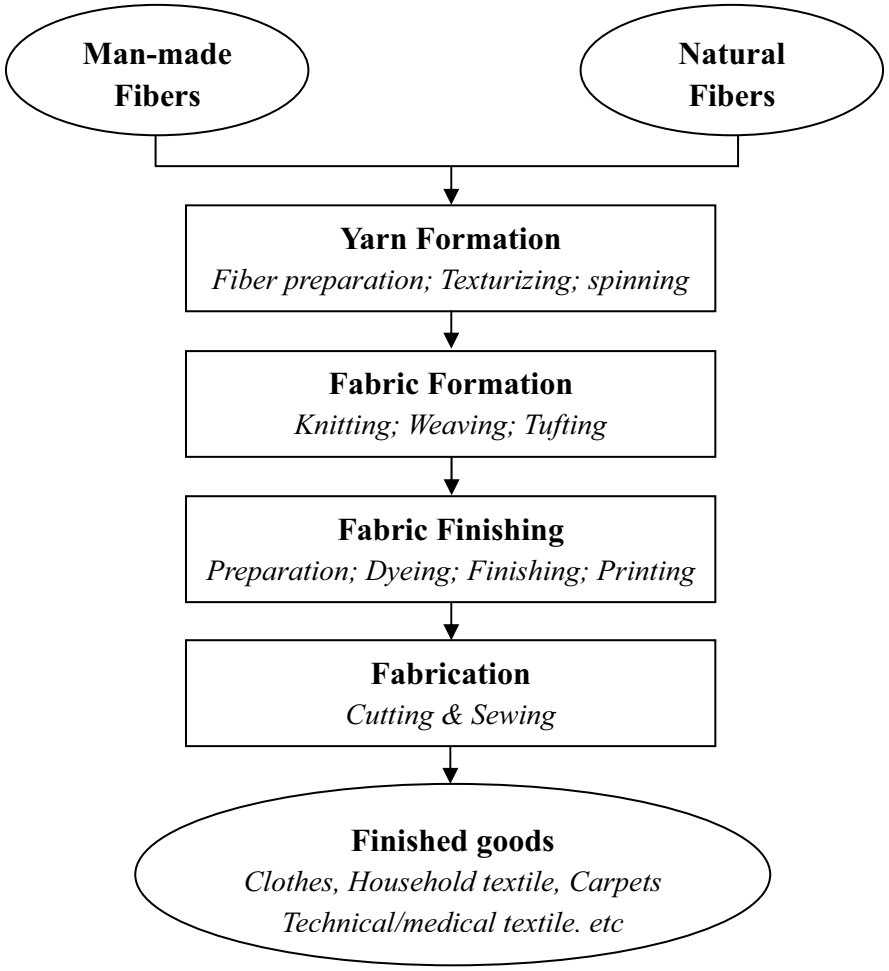

Figure 3: Textile production

As shown in the picture, textile production starts by the production of raw fibers. Based on their distinct natures, textile fibers are categorized into natural fibers (such as cotton and wool) and man-made fibers (or so-called synthetic fibers) which are

mainly produced from chemical-based materials like petrochemicals. The raw fibers are transported to spinning and weaving factories in which the basic structures of textile are formed. At these factories, man-made or natural fibers are undergoing a series of procedures like spinning, weaving and knitting, continuously turning into yarn and then "greige cloth" (which means unfinished cloth). Most of greige cloths still require further finishing such as bleaching, shrinking, dyeing and printing in dying and printing mills. After that, they are delivered to apparel factories or other factories in the same kind. In such plants, finished clothes are cut and assembled into garments or textile products for other use, like towels and bed sheets. Finally, the finished products are sold to final consumers via many retailer companies. As points of connection, packaging, shipment and the maintaining treatment which are used to transport products and keep product quality are also important components to link each individual process within textile production.

Nowadays, the structure of a textile supply chain and production patterns within it are very complicated due to great numbers of actors involving in textile production. Many tiers in a supply chain and branches in each tier extend the structure dimensions horizontally and vertically. For example, besides textile manufacturers and textile retailers who dominate the textile production processes, chemical producers account for a big proportion of actors in a textile supply chain as well. Take a dyeing factory for example. To produce one kind of colored cloth, there must be several different suppliers to provide different raw materials, such as greige cloths and chemicals. For one kind of raw materials, there could also be different suppliers to offer it.

The crossing of geographical boundaries is another important characteristic of modern textile supply chains, which comes as a result of globalization. On one hand, needs of cheap and high-quality raw materials drive the textile manufacturers go across different regions or even different countries to contact with suppliers who can provide desirable raw materials. On the other hand, the production of textile always requires intensive hand labor. To decrease the cost of human labor, companies usually seek to locate their factories or contract with producers in regions or countries where abundant and low-cost labor can be found. For example, most of the textile products on the current European markets are produced by factories in developing countries which are supplied with sufficient cheap hand labor. In the list, countries like China, Bangladesh and India can be seen. This phenomenon makes the production, retail and final consumption of one kind of textile products to take place in different countries. The complexity and difference of actors' location bring challenge to information management along the textile supply chain.

2.1.2 Importance of Information Flow in Textile Supply Chain

Information flows, as well as goods and finance flows, are important components of an integrated supply chain. In a supply chain, there is no material flow going without information flows (Bala et al., 2008). Actors in supply chains share and use the information to manage and facilitate the operations within a supply chain. Valid,

reliable, timely, complete and easy to understand and use are basic requirements for information in a supply chain (Jonsson, 2008, p.421). Continued high quality information flow can help actors in supply chain operate material flows in the best way (Lambert and Cooper, 2000). So, access to high quality information is one of the most crucial bases for the decision makers in a supply chain to make sound decisions about supply chain management and keep the chain from the risk of any sort of disorder.

For a company, the information with which it can manage the material flows in, through and out of the company is achieved both inside and outside the company itself. Accordingly, they are named as internal and external supply chain information (Jonsson, 2008, p.405-406). The external information mainly comes from the suppliers and customers of a company. The internal information is generated from the reaction and feedback of a certain company to the external information. Here, it is worth to consider that besides messages from suppliers and customers, laws, legislation and conventions from national or other international organizations are also important information for actors to follow. The actors in a supply chain have the responsibilities to make sure that they can keep their activities under all kinds of legal frameworks.

Singh (1996) investigate the importance of information flow in a direct sales supply chain. In his mind, the function of information flow in a supply chain can be sorted into six main aspects: *"(a) forecasting to reserve capacity or initiate manufacture to stock*; *(b) customer/purchase orders to initiate manufacture or shipment from stock; (c) inventory management and monitoring of goods movement; (d) financial settlements; (e) field management and (f) management reporting".* Singh (1996) also argues that proper management of the goods movement and associated information flow through the supply chain are two keys to responsiveness to customer demands and overall customer satisfaction. And any kind of information mismanagement (which means "*by being inaccurate or by not being synchronized with the corresponding goods movement or with other items of information*") will raise customers' dissatisfaction.

For a supply chain, successful chain integration depends on the ability of supply chain actors to synchronize and share "real-time" information (Min and Zhou, 2002). Real-time communication between each actor in the supply chain is important for supply chain management. Such a theory is also valid for the textile chain. Cao et al (2008) address the issues for coordination (which means two or more actors in a supply chain work together efficiently and know what the others are doing) in three types of textile supply chain. They claimed that coordination in all kinds of textile supply chain highly relies on the information exchange of every actor. Full information sharing is a primary issue to make a textile supply chain coordinated. To reach this goal, in a chain, there should be a coordinator(s) acting as information center(s) to make the information flow smoothly throughout a textile supply chain's product development, sourcing and buying, production and distribution and retailing.

But, practically, in a textile supply chain, different actors don't have the same accessibility of the same information, which may affect the coordination of a supply chain The study carried out by Perry et al (1999) analyzed the performance and outcomes of the Australian government funded "*Quick Response*" program in the textiles, clothing and footwear industry. They pointed out that, in a textile supply chain, upstream suppliers were easily disadvantaged by getting out of touch with the retailer companies. As a result, with the information being transferred along the supply chain, the accuracy, timeliness and volume of information lost, and guesswork increased. The consequences of such lagged information flow are the order of wrong raw materials and substantial loss for actors in the supply chain. To solve the problem, different actors need to increase the understanding of how their business relates to others in the supply chain. Furthermore, the upstream suppliers prefer to be involved in the discussions which are normally carried out by retailers and their neighbor actors in the chain, and then "*give advice to the group about achievability of particular product material options*".

2.2 Chemical Related Issues in Textile Supply Chains

Textile industry heavily depends on the use of chemicals. From the production of raw fiber to fabrication of final goods, chemicals are applied almost throughout the whole process of textile production. The properties of used chemicals largely determine the performance of the textiles during their using phases. Along with the benefits, chemicals' potential hazards on environment and human health draw more and more social and environmental concerns.

2.2.1 Chemical Use in Textile Production

During the production of textile products, not so many chemicals with toxic natures are applied before the treatment of fabric finishing (Lacasse and Baumann, 2004). Considering the processing processes employed to finish a fabric, two types can be categorized: physical treatment and wet processes. Physical treatment refers to processes such as cutting, brushing and roughing. In those processes, no chemical is actually added; as a result, physical treatment has very little influence on textile products' chemical quality. And except dust and noise during the production, textile's physical treatment brings almost no other environmental load to surroundings. Most of the environmental impacts and chemical consumption happens during the process of textile wet processing (Lacasse and Baumann, 2004).

"Wet processing" gets the name from its close connection to water use. The entire process involve treatments like dyeing, washing and printing etc which must be operated under wet or moist conditions. Fabric finishing, which shown in Figure 3 is the biggest chemical consumer among the entire textile production. Except the chemicals which are being used to produce man-made raw fibers, the large amount of chemicals used in the textile finishing can be divided into three categories: *dyestuffs* for textiles, *textile auxiliaries* and other *textile chemicals* (Lacasse and Baumann, 2004). *Dyestuffs* are chemical mixtures or solutions on the basis of dyes or pigments.

Among them, a dye must be dissolved in water during its use and it is incorporated into the textile fiber to show different colors. According to the natures, dyes can be divided into several sub-categories such as acid dyes, basic dyes, metal-complex dyes, natural dyes and so on. Pigment is a kind of chemicals which is normally insoluble. Pigments can only be fixed to the surface of fiber with the help of other chemicals and form a thin film on the surface of textile. *Textile auxiliaries* are used as assistant agents to facilitate the formation of fabric structures or textile intermediate processing. They attach to the textile during their use to fulfill certain functions. Before the next step of treatment, they may be removed from the textile at subsequent stages; or they sometimes remain on the textile becoming components of a textile product. *Textile chemicals* is another group of chemicals which are crucial for textile production. Comparing to dyestuffs and auxiliaries, the composition of textile chemicals are relatively simple: they are mainly basic chemicals such as acids, bases and salts. The purpose of using them is to adjust the operational environment or remove impurities which come from previous handling during textile treatment. Textile chemicals have lower toxicity than dyestuffs and auxiliaries too. Weight wise, these three kinds of chemicals are not applied equally during textile finishing industry. Castegnaro and Sansone, as cited by Lacasse and Baumann (2004), suggested that the consumption of chemicals in German textile finishing industry is estimated as: 204,000 tons of textile chemicals, 102,000 tons of auxiliaries and 13,000 tons of dyestuffs roughly.

The number of chemicals which can be used in the textile production is very large. Take dyestuffs as an example. A report published by Swedish Chemical Agency (1997), known as Kemi, indicated that in 1996, more than 10,000 dyestuffs existed for use in dyeing and printing processes. Although the number of commonly used ones was more limited, there were still around 3,000 used in Swedish textile production. Of course, for producing one kind of textile product, it is not necessary to use that many chemicals. But those numbers are still good indicators to illuminate that the chemical use in the textile industry can be very complicated and consequentially not easy to regulate. This can also partly explain why it is very hard to maintain and share complete information about chemical use by different producers throughout the whole textile production.

As a business related to fashion, the chemical use pattern in textile industries is becoming more and more complex with consumers' growing expectation to the performance of textile products. In textile production today, a great number of textiles usually go through treatments which are called "end finishing" applied right after textile dyeing and printing. End finishing serves to give the textile consumer-desired end-use properties which normally relate to visual effect, handling and specific features such as waterproofing and non-flammability (Lacasse and Baumann, 2004). Many hazardous chemicals are used in these treatments as well. As a result, they can be potential origins of hazardous chemicals in the finial textile products as described before. For example, IPCC, as cited by Walter et al (2005), suggests that cross-linking agents used in easy-care finishes are the main source of formaldehyde releases from

finished garments. The involvement of end finishing largely increases the complexity both regarding chemicals used in textile production processes and chemicals remaining in the final textile products.

2.2.2 Chemical Health and Environmental Concerns

Health concerns about the chemicals used in the supply chain mainly regard workers who are employed in the textile plants and common consumers who eventually use textile products in their daily life.

Workers, especially the ones who are engaged in dyeing/printing or other textile finishing processing, inevitably make daily routine contacts with a large number of chemical substances. Many of the chemicals they work with are known as having hazardous health effects to the human body. For example, among the total available commonly used dyestuffs, about 4,000 have been tested as having acute toxicity; approximately 10% of those 4,000 dyestuffs are judged as having hazardous properties to human health (Swedish Chemical Agency, 1997). The chemicals contained in them could have serious negative effects to human health. The instruction from Health and Safety Executive (HSE) of UK (2007) indicates that some reactive dyes are respiratory sensitizers which can cause occupational asthma by inhalation; some of the dyestuffs can cause skin allergy; furthermore, a small number of dyes, based on their chemical characters, are believed to have a carcinogenic potential. HSE also points out that, comparing to illness, the more common health problem is caused by the use of textile chemicals which act as irritants, for example formaldehyde-based resins, ammonia, acetic acid, soda ash and so on. They may cause troublesome outcomes such as skin irritation, stuffy noses, sneezing and sore eyes. Once these chemicals used in textile finishing couldn't be properly removed by subsequent processes like washing and heat evaporation, they may directly go to final consumers through the supply chain and harm the health of them.

The environmental concerns about textile production traditionally focus on the toxic wastewater originated from washing and bleaching of natural fibers and also from dyeing and finishing steps. Since a large number of chemicals with different compositions and properties are used in these processes, wastewater from textile production has a great chemical complexity and diversity. Many of the chemicals contained in the textile wastewater have acute and chronic toxicity effects to ecosystem especially aquatic ecosystems (Vandevivere et al., 1998). What makes the situation worse is that most of the conventional wastewater treatment plants and even plants with some improvement don't have the ability to eliminate most of these chemicals from the textile effluents (Vandevivere et al., 1998).

For several studies, it is clear that the chemical substances, which may be added intentionally or may exist as undesirable leftovers, can also be released from textile products during their use phases via people's daily care, for example laundering. Such arguments can be found in Swedish Chemical Agency's report of 1997: "*Chemical in*

Textiles". According to their conclusion, the risks to human health from chemicals in textiles were judged to be small according to hospital statistics, but they cannot be ignored. Recently, Swedish Society for Nature Conservation (Hök, 2007, Prevodnik, 2008) conducted tests aiming to check the level of chemical residues in towels and T-shirts of different brands. Their findings showed that nonylphenol ethoxylate (NPEO) can be found in almost all (18 out of 20 towel samples and 16 out of 17 T-shirt samples) tested products. In one towel sample the level of NPEO was even as high as 1%. And the study of 2007 also pointed out that, except NPEO, other different kinds of chemicals residues (such as heavy metals, azo-dyes and formaldehyde) can be found in towels at different levels.

Another study carried out by Månsson et al (2008) reveals that the toxic substances released during the use phase of textile products can even harm the ecosystem through the release of municipal wastewater. They used material flow analysis to indentify the possible source of alkyphenols and alkyphenol ethoxylate (APEO) in Stockholm, the capital city of Sweden. Since there was no other point source of these organic substances detected in their study area they concluded that the washed-out chemical residues from textile products should largely be blamed for the unexplainable presences of these toxic organic substances in local sewer systems.

Beside the manufacture and use phase of the textile products, toxic substances released from wasted textile products may also, according to Lacasse and Baumann (2004), have negative ecological effects. The authors state that in EU countries, only 25% of discarded textile (1.5 million tons out of 5.8 million tons) is recycled by charities and industrial enterprises. The rest, 4.3 million tons, are sent to landfill or is burnt in municipal waste incinerators. Toxic chemicals in textile products can also be released during these processes.

2.2.3 Categories of Chemical Information

To manage the chemical risk inside a system, different kinds of information are required. According to Ashford and Caldart, as cited in Koch and Ashford (2006), such information can be categorized into three types. They are *scientific* information, *technological* information and *legal* information. Specifically, each category has its own branches as well. *Scientific information* includes: (1) "product ingredient and specific composition of pollution in air, water, soil and waste", (2) "the toxic properties and safety hazard of related chemicals, materials and industry processes", and (3) "information about exposure pathway and target groups of hazardous substance and processes". *Technological information* refers to: (1) "monitoring technologies", (2) "options for controlling and preventing the hazards of certain chemicals", (3) "available substitutes for inputs, final products and processes". *Legal information* is "the notification of the informational and other rights and obligations of producers, employers, consumers, workers and general public". These three types of information have different effects and meanings for a risk control campaign. For example, as said by Koch and Ashford (2006), among all the three types, legal

information is not a fundamental type but the duties to disseminate and the right to know the nature and exposure profiles of chemical for chemical users. In other words, it is an assistance to help the use of the other two types of information. Nevertheless, all the three types of chemical information are useful in identifying and reducing the risk of hazardous chemicals.

2.3 International Chemical Information Control Schemes

Right now, there is no international standard regarding chemical risk information control for articles, including textile products (Massey et al., 2008). However other approaches have already been put in force with the intent to try to regulate chemical use in industries and chemical related information dissemination. Here, in this paper, two such systems that have great impacts on chemical risk information management in the textile industry will be introduced. They are labeling programs and REACH, the new European legislation.

2.3.1 Labeling Programs

The overall objective of all existing labeling programs is to stimulate the market-driven improvements of products' environmental or health performance, another stimulus than through regulation of the supply chain. Labeling programs are all voluntary programs for the manufacturers to join in. Those programs provide "*standardized communication formats that are intended to make the information easier to grasp*", and "*they include the procedures to verify that the information is correct*" as well (Baumann and Tillman, 2004 , p260-261). In labeling programs, the environmental performance and even production processes of a product is evaluated against certain criteria. These criteria contain the "*requirements for chemical composition to a degree that varies between different product groups*" (Massey et al., 2008). Although they don't give the direct information about the contents of chemicals, the requirements are still useful information indicating what kinds of chemicals that are not contained in an article or contained below a certain level. The labeling programs are customer oriented but through the certification process of labeling programs, the companies or factories in the same supply chain can increase the understanding between each other, and they can form some kinds of channels or methods to exchange the chemical related information. The intention of labeling programs is not about regulating information flow processes in the supply chain and they don't have the compelling force as laws and legislation, nevertheless they do provide a platform and opportunity of making chemical risk information communication for the actors in the supply chain.

2.3.2 REACH

REACH is the abbreviation for a European Union (EU) regulation concerning Registration, Evaluation, Authorization and Restriction of Chemicals. It is a new regulation, aiming to a better protection of human health and environment from risks of chemical use. Not as labeling programs, REACH elevate the necessity of chemical risk information sharing and managing to a specific mandatory level. Before it came

into force in 2007, REACH had already received a large amount of attention as well as critique from the industry world, including textile industry.

REACH puts forward the requirements of registration and notification for chemicals in articles to manufacturers and importers. In *Article 7*, REACH outlines that all the manufacturers or importers need to register the substance used in their productions when this substance in the article has the possibility to be released "*during the normal and foreseeable condition of use*" and "*the substance is present in those articles in quantities totaling over one ton per producer or importer per year".* The notification requirements are focused on articles which contains substances of very high concern (SVHCs). This requirement applies when the presence of substances in the concentration above 0.1% and the total amount of the substance is more than 1 ton per year per producer or importer. *Article 33* aims to ensure that sufficient information about chemicals (especially chemicals with a high level of hazard) in articles is communicated to allow their safe use. In this article, REACH set suppliers' responsibility of providing the recipient of an article with information about the content of dangerous chemicals if the article contains the substances at concentration of 0.1% weight by weight.

In REACH, some requirements related to chemical risk information management in other previous regulations are enclosed. For example, *Article 31* is about the requirements for safety data sheets and the downstream users in the supply chain to consider their safe use of chemical substances. The requirements of chemical registration, notification and authorization listed in REACH force every actor in the supply chain, no matter suppliers or customers, to consider issues about chemical risk information management and dissemination to a deeper level and dedicate themselves more to study on those issues. Those requirements also need people involved in textile industry to develop more efficient and transparent ways to work together, hence facilitating the flow of information along the supply chain. More chemical risk information and better data about how substances are used in the articles can be expected under the implementation of REACH (Massey et al., 2008).

3. Background Information of the Study

This chapter contains information about China's textile export and specifications about the areas of the studied supply chain. Furthermore, the general situation of the visited retailer companies and their suppliers and relationships between them are introduced.

3.1 China's Textile Export

As a result of the adoption of an open policy and economic reform, the textile industry has become a dynamic part of China's economic grow. China's national yearly revenue from textile exporting has increased steadily. In 1980, the annual income from textile export of China was 4.41 billion US dollar; at the same time the share of China's textile and clothing export in world market was 4.6%. In 1995, China became the largest textile export country in the world and maintains the position since then (Qiu, 2005). According to the data from China's General Administration of Customs (2008), in the year of 2007, the total income of China's textile export had grown to 171.2 billion US dollar, accounting for more than 25% of the world market. China plays major role in the world textile market. Among all these products, clothing and accessories are main exporting items with the income of 115.1 billion US dollar. Geographically, the coastal area in Southeast China，including Guangdong, Zhejiang, Jiangsu, Shanghai and Shandong, is the major producing and exporting zone of textile industry.

Around the world, EU is the largest market for textile products produced by Chinese manufacturers, followed by US and Japan. In 2007, 16.4% of China's textile exporting was achieved from the trades with EU countries; and the total income was 28.2 billion US dollar. For EU, China is also the biggest source for the textile products in market. Based on the data from European Commission (2008, shown in Table 1 & 2), in 2007 China is the EU's leading textile products supplier; 37.7% and 26% of imported clothing and other textile products in EU's 27 countries were from China. The data also shown from 2004 to 2007, the share of China's textile products in EU markets kept on growing; especially in clothing sector, sum of business transactions between China and EU increased from 11.53 billion Euros in 2004 to 21.88 billion Euros in 2007, a growth of 89.7%.

Table 1: Top 3 EU-27 clothing exporters (2004-2007)

No.	Origin	Billion Euros				% share	% growth
		2004	2005	2006	2007	2007	2004-2007
	World	45.052	49.305	55.491	58.079	100	28.9
1	China	11.534	16.961	18.883	21.878	37.7	89.7
2	Turkey	7.747	8.089	8.238	8.937	15.4	15.4
3	Bangladesh	3.721	3.538	4.615	4.385	7.6	17.8

From: Eurostat

Table 2: Top 3 EU-27 other textile product exporters (2004-2007)

No.	Origin	Billion Euros				% share	% growth
		2004	2005	2006	2007	2007	2004-2007
	World	17.610	18.074	19.867	20.855	100	18.4
1	China	3.254	4.081	4.885	5.429	26.0	66.9
2	Turkey	3.161	3.328	3.677	3.815	18.3	20.7
3	India	1.971	2.028	2.210	2.389	11.5	21.2

From: Eurostat

As a member of EU, Sweden also has close business relationships of textile trading with China. Many Swedish clothing retailers like H&M, Lindex, Indiska and KappAhl purchase many of their products from China. For instance, in 2007, China's products dominated the imported textile products markets in Sweden with the total share of 24.4%. Among these products, clothing and accessories is the second biggest import category from China to Sweden. The total value is around 4.35 billion SEK, which means 12.2% of China's exporting income from Sweden was achieved by clothing and accessories trade (The Economic and Commercial Counsellor's Office of China's Embassy in Sweden, 2009).

The areas where the visited factories are located are Guangdong and Shanghai. These two provinces are playing major roles in China's textile production. They are two important bases for China's textile export. In 2007, Guangdong and Shanghai were the first and fourth largest textile exporting regions (General Administration of Customs of China, 2008). Their total earnings from textile products exporting were 41.9 billion and 15.6 billion US dollar respectively in that year. More than 30% of the whole country's yearly gross textile exporting income was achieved by the manufacturers in these two areas. So the manufacturers in these two areas could be used as good representatives for Chinese factories and companies who have foreign countries as their main markets.

3.2 The Visited Supply Chains

Five textile producers in two supply chains were investigated for this study. Three of them are located in Guangdong province, while the others have their factories in Shanghai. They are all related to two Swedish textile importers. According to the agreements with the companies and for the sake of keeping companies' business secret, the real names of them are replaced by the letters of A and B. So, they will appear as Company A and Company B accordingly in the following chapters. The real names of visited factories in each supply chain are omitted and substituted with letters as well. Table 3 in next page gives the result of such name substitution.

Table 3: Symbolic name of visited companies and factories

Companies	Company A (Guangdong)		Company B (Shanghai)	
Suppliers & Sub-suppliers	Sewing Factory	A_1	Sewing Factory	B_1
	Printing Factory	A_2	Dyeing and Printing Factory	B_2
	Dyeing Factory	A_3		

One important common character of the two Swedish companies is: they are both brand owners and, at the same time, retailers as well. In their own chain, each company is the chain leader and has great power to influence the decision making processes of other actors along the supply chain.

3.2.1 Company A

Company A is a Swedish fashion company which specializes in apparel and accessories retail. A major part of their products are sold in Nordic countries, and Sweden is their biggest market. Company A doesn't have any in-house manufacturing by their own, so all their production is sub-contract to individual textile companies or factories around the world. Most of their purchasing is from Asian countries, like China and India.

As shown in Table 3**: Symbolic name of visited companies and factories**, Sewing Factory A_1 is a direct supplier of Company A. Garments for kids are their main products. Fabrics which have already been dyed and printed are cut and then assembled into ready-made clothes there. Most of its products are produced under the Company A's direct orders. Printing Factory A_2 and Dyeing Factory A_3 are two sub-suppliers of Company A. Their business is connected with Company A through other direct suppliers. Among them, Factory A_2 has business relation with Factory A_1. The cooperation mode between the two factories is very simple: Factory A_1 sends fabric pieces which have already been cut to Factory A_2 and let Factory A_2 print patterns on those fabrics. After that, Factory A_1 collects these fabrics back for future process. The relationship between Dyeing Factory A_3 and other two factories (A_1 and A_2) is not clear. But as an ordinary sub-supplier, the way that Factory A_3 cooperates with Company A is the same as Factory A_2. It is important to notice that all the three visited factories are small or medium-size enterprises (SMEs) with the number of worker ranging up to several hundreds.

3.2.2 Company B

Company B is a seller of various kinds of household items. Textile products only account for a part of their selling and household textiles are the main category. Their business is spread all around the world. Similar to Company A, Company B's textile goods are purchased by the means of sub-contract production as well.

Two factories in Company B's supply chain were visited. With Company B, a linear business relationship of selling and buying is running among the three organizations:

Dyeing and Printing Factory B_2 sells dyed and printed fabrics they produced to Sewing Factory B_1; and then, Factory B_1 produces textile products, such as household textile articles, under the requirements of Company B. Besides Company B, Factory B_1 is also supplier for several other international garment retailer companies. Factory B_2 both work with dyeing and printing, preferably for processing velveteen materials; and their products are sold to several companies. Compared to Company A, Company B's size is much bigger and they demand much more products. Accordingly, Factory B_1 and Factory B_2, Company B's supplier and sub-supplier, have much bigger sizes than factories in Company A's supply chain. They all have more than 1,500 workers.

3.2.3 Defining the Scope of Study

It is, of course, not appropriate to generalize about Chinese textile manufacturers work with chemical related information from an investigation of only five factories. For such an intention, further studies are needed. However, the visited factories all have the experience of cooperating with foreign companies with high environmental profile and some of them are working with several companies at the same time. So, the result of the study may present same of the best cases among textile producers on handling chemical related issues in China.

Textile supply chains are complex; hence the activities which are related to chemical information exchange and management are also numerous. That makes the attempts of covering all actors' work with chemical information management in the chain impossible for a two-week study. The facts described in the report and the conclusions drawn are merely a glance at a whole supply chain. All the textile producers involved in the study were reached by their connections to the two companies. Other factors, for example, the raw fabric producers and chemical suppliers can't be covered by the study, because of their locations or weak relationship with retailers. The processes of how they work are perceived indirectly from the interviews with textile producers.

4. The Chemical Information Exchange

This chapter presents the results of the interviews with staff of the textile factories in the two supply chains. Besides, some information collected from reports of the two Swedish textile importers is also presented. The contents included regard the way the importers select their suppliers and how chemical information flows downstream and upstream in respective supply chain takes place. Because of the difference in their sizes, different processes carried out by the two importers regarding chemical related information management have been observed. So, the description of the management performance of the actors in the two supply chain is described separately as Company A's and Company B's supply chain.

4.1 Supply Chain of Company A

Company A gives the environmental performance of their products a high credit. Wanting to produce garment without chemicals which may pose hazards to consumers, it employs many measures to address chemical risk control tasks along its supply chain. Generally speaking, these processes can be divided into three steps: supplier selection and monitoring, supplier training and chemical information management.

4.1.1 Supplier Selection and Monitoring

In absence of in-house production, Company A has to find textile producers who have the ability to produce goods under specific requirements as its suppliers. These supplier searching and selection campaigns can be regarded as the very beginning of Company A's chemical risk control program. In this process, textile producers who want to develop business relations with Company A get their very first chances to know Company A's demands on chemical use and management. Supplier selection falls into the responsibilities of Company A's purchasing department in China.

General picture of the processes

Company A establishes tough rules and rigorous procedures for supplier selection, and the whole course of adding a new supplier is time consuming too. Inspection of potential suppliers is carried out following the same checklist that Company A uses for regular inspection of ordinary suppliers[1]. The aim of these arrangements is to find eligible and reliable suppliers, with whom it can develop long-term business relationships. It is known that, for some suppliers, Company A has already maintained businesses relationships with them for more than ten years. From Company A's point of view[2], it is easier to make standard related communication with long-cooperation suppliers than most of the newer ones; moreover long-cooperatation suppliers normally can also better comply with the requirements of Company A. To become an actual supplier, one textile producer must go through a series of inspection and checking processes to prove that it has the ability and will to produce Company A's

[1] From Company A's annual report of "*Environment and Social Responsibility, 2008*".
[2] From presentation of Company A's manager in purchasing department, in 17 March 2009, Hong Kong.

desirable production. These processes are evaluations about the overall performance, including chemical use, of a potential supplier. According to Company A's checklist, factors that may influence its final decision about supplier selection include product price, product quality, supplier's producing ability and its attitude towards standards compliance. Product samples and internal operation of a producer are all concerned categories for Company A to check. To make sure the practical operation of a factory can fulfill requirements, factory tours and interviews with factory owners and employees are essential parts of the supplier selection as well.

Every existing supplier is also constantly monitored by Company A's auditors to ensure the manufacturing processes and product quality can continuously follow all the stipulated criteria. If any kind of non-compliance occurs, the supplier must draft out a plan of improvement and put it in force as quickly as possible. The supplier who often have troubles in following requirements and violating the quality standards several times are eliminated from the supply chain. New suppliers with better performance will be absorbed to fill the vacancies. It is introduced that, every year, 1-2 unqualified suppliers are replaced by 3-4 new suppliers, mostly due to standard compliance problems[3].

The standards for suppliers to follow

Producing hazard-chemical-free and healthy textiles is one of Company A's basic requirements for their producing partners in the supply chain. This requirement is reflected and guaranteed by several standard related documents in which Company A's demands about chemical risk issues for all suppliers are listed. The objective of establishing these demands can be viewed from two aspects: one is limiting the level of chemical residues in final products; the other is preventing textile producers' use of chemical substances which are banned by relevant laws and regulations.

The *Code of Conduct* is Company A's basic and mandatory document which related to their requirements. Company A introduced its very first Code of Conduct in 1997. Since 2004, the document framed by *Business Social Compliance Initiative*[4] (*BSCI*) has substituted the old one and is put into force. This *Code* covers Company A's overall demands of contractors' social responsibilities, working conditions and environmental responsibilities. To become a supplier, any producer must satisfy the requirements in the *Code* or show clear intention to make improvements to follow the *Code*. For an existing supplier, the *Code* gives them not only the obligation to follow the various standards but also the chance to receive constant training, which aims at increasing the suppliers' ability to follow standards of Company A.

"*Focus on chemicals*" is addressed by Company A as an important policy[5]. For checking chemical used in textile production, Company A establishes their own

[3] From presentation of Company A's manager in purchasing department, in 17 March 2009, Hong Kong.
[4] Details of BSCI can be found at its web-site: http://www.bsci-eu.org/index.php
[5] From Company A's annual report of "Environment and Social Responsibility, 2008"

standard file, which is called *Test and Manufacturing Guide.* In this *Guide*, more than 20 different groups of chemicals are considered as having health depletion potential and need fully control in production. Using this *Guide*, whether the suppliers use of banned or restricted chemicals in the products is determined. Furthermore, research and development in the scientific society and new findings in chemicals industry are also important complement to the *Guide*.

Labeling is another important method of Company A's quality assurance. Company A has been using different kinds of *Eco and health labels* for many years. The labels include the Oeko-Tex Standard 100, the EU Flower, Organic Cotton and Organic Linen. 10% of their selling garments (6 million pieces out of 60 million) are labeled with one of these labels, among which the Oeko-Tex Standard 100 label has the largest share. According to Company A's plan, this number will be increased in the years to come. Besides the *Code* and labels, Company A also require suppliers' production and management to follow the *ISO 14001 Environmental Management Standard*[6].

4.1.2 Chemical Information Sharing

Company A's demands about chemicals is the key driver to push the upstream and downstream chemical related information flows in the production section of the supply chain. Company A sets requirement about chemical use and the level of chemicals remains in the products manufactured by contracted textile suppliers; as a consequence, suppliers must present the information about their state of requirements following to Company A.

Chemical information from Company A

As stated before, textile producers first get familiar with Company A's chemical related requirements during the supplier selection phase. That can be regarded as the initial step of Company A's chemical related demands dissemination to its suppliers. After one textile producer has gone through all the selection courses and then became an actual supplier, Company A still actively launches communication with them to send clear messages about what kind of chemicals are not allowed to use in the production and how to avoid the risk from undesirable chemicals.

"We only contact with our direct customers."
"So does that mean you get your final buyers' requirements about chemicals from your direct customers?"
"Yes."

----Interview with managers of Factory A_3, Huizhou

Company A is planning to extend its quality checking procedures and direct communication about chemical use demands to the sub-suppliers level in the coming

[6] This is written in Company A's annual report of "Environment and Social Responsibility, 2008". About the details of ISO 14001, please go to the website of International Organization for Standardization at http://www.iso.org/iso/home.htm

years[7]. But during the time of the interviews, these processes are still only taking place with their first-tier suppliers, namely sewing factories. In the case of this study, as a direct supplier, Sewing Factory A_1 is the only one who gets first hand chemical related information from Company A in the supply chain.

In Factory A_1, substances used in the production are chiefly chemical solvents which are used to clean dirty spots on garments. In this kind of process, problems of chemicals contamination are not perceived as troublesome. The requirements they get from Company A with regard to their own production is mainly about getting rid of chemicals, like NPEO, formaldehyde and heavy metals, which may be found in clean detergents and left in garments as residues after the production processes such as washing. This information from Company A is employed as benchmark for the factory when selecting and controlling the chemical used in the production. To keep the accuracy and maintain the original intention of the high volume of information, Company A gives their standard related documents in the form of paper files in English directly. Factory A_1 needs to translate the documents into Chinese by themselves. Besides, Company A often has meetings and seminars with its immediate suppliers to help them better understand these standards. Such activities sometimes involve experts from external chemical testing labs, such as ITS[8] lab, to facilitate the processes of standard interpretation. And the result of the involvement of external chemical experts is regarded as "*helps a lot*" by the owner of Factory A_1[9].

One important feature of information transfer in this supply chain is that direct suppliers like Factory A_1 play dual roles during the handling of chemical related information. Firstly, they are the information receiver of Company A's demands and have to follow such demands during their own production; furthermore, they also need to act as a "bridge" to pass Company A's chemical related demands to sub-suppliers in the same supply chain. That is because, normally, there is no direct standard related communication between Company A and their sub-suppliers. The impression of Company A about their sub-suppliers' production status mainly builds upon several factory visits and it needs others' help to get the information of suppliers' production. Such a situation calls for suppliers and sub-suppliers to establish direct and strong links to exchange information regarding chemical use. The supplier and sub-supplier communication is performed in the form of paper documents dissemination and face to face contacts as well. Sometimes, telephone is also used to perform standard related discussion. In this specific supply chain, the direct suppliers have the responsibilities to put demands on sub-suppliers' production and monitor sub-suppliers' chemical use and product quality as well.

Chemical information from upstream producers

The information flow in a textile supply chain is a "demand-feedback" system. The

[7] From Company A's annual report of "Environment and Social Responsibility, 2008"

[8] The abbreviation for "Intertek Testing Service". It is a worldwide group which provides testing, inspection and certification works to manufacturers.

[9] From the interview with Factory A_1's owner, Henry Chan. In 2009-03-18. City of Dongguan, Guangdong.

demands from supply chain leader (in this case, it is an importer) are always followed up by feedbacks from its suppliers and sub-suppliers. This information is employed by importers to inspect the quality of the products they order.

From the interviews, it is known that all the three visited factories are involved in the production of labeled (*Oeko-tex standard 100*) products, but the share of labeled products in each factory is not clear. However, it is obvious that the Oeko-tex label application has great influences on the ways factories handle selection and use of chemicals, and their chemical information handling processes.

An important character of the application of Oeko-tex label requirements is the involvement of third-party tests and certification. A product must be proved by external testing as satisfying certain standards in order to receive the label. For one kind of textile product, the application procedure can be simply divided into four steps[10]: first, applicant should fill in an application form about the production process and chemical use information, and then forward the form together with representative sample materials and the raw materials added on each individual production step to the relevant Oeko-tex institute[11]; second, the relevant Oeko-tex institute test the sample material, and based on the result of tests, the decision about if the product is satisfying Oeko-tex requirements is made. Third, if the tests prove that the products meet the requirements, the product is then authorized to use the Oeko-tex standard 100 label for one year. Finally, the applicant must make the declaration about conformity, in which the applicant should state that all other products of the same kind are manufactured in the way that the successfully tested samples are produced; and show evidence of the existence of the necessary quality assurance system. Once the application is approved, intermediate goods which are produced by certificated raw materials can use the label as well.

The procedure of applying the *Oeko-tex standard 100* label can be regarded as a useful means that the downstream importer collects textile production information upstream along the supply chain. As an applicant, to achieve a successful application, Company A at least has to grasp three kinds of information of one product: raw material use in the production, production process and detailed information about each chemical used in every production stage. That requires the importer to develop methods to understand the production process in every related factory.

"We need to consider the environmental performance of the chemicals"

---Interview with manager of Factory A_2, Dongguan

[10] Also check the information from the web-page of Oeko-tex Institutes at http://www.oeko-tex.com/OekoTex100_PUBLIC/content4.asp?area=hauptmenue&site=zertifizierung&cls=02

[11] An Oeko-tex institute is among the institutes belonging to International Association for Research and Testing in the Field of Textile Ecology. Further information for all Oeko-tex institute around the world can be found in: http://www.oekotex.com/OekoTex100_PUBLIC/content.asp?area=hauptmenue&site=institute&cls=02

"We need to consider the size of the manufacturers, because the products of bigger companies normally have more stable quality."

---Interview with managers of Factory A_3, Huizhou

Company A's direct contact is restricted to the first-tier supplier level, correspondingly chemical risk information generated from upstream actors will also be transferred in a hierarchical fashion among the producers in the supply chain: from chemical producers to textile producers, and finally to the importer, Company A. Consequently, the textile producers' selection of chemical supplier becomes a crucial step that they follow up Company A's chemical related demands.

The Oeko-tex system has stringent requirements about the use of dyestuffs and auxiliaries. During the application, every applicant should present the sample of all used dyestuffs and auxiliaries for testing. To simplify products' certification processes and reduce applicant's cost of testing, the Oeko-tex system permits the use of source raw materials which already have certification. If the applicant can show the certificates of certified source materials, no more tests are required. As a consequence (if not direct, it still has big influence) of that principle, Dyeing Factory A_2 and Printing Factory A_3 prefer to purchase dyestuffs and auxiliaries from oversea manufactures (like Dyestar, BASF and Clariant etc) whose products have already been certified in the Oeko-tex system. For other textile chemicals, which are mainly acids, bases and salts, sample testing is not required by the Oeko-tex system, following the requirements of Company A and finding "hazard free" chemicals are the primary criteria for all three factories' textile chemicals selection. They are inclined to choose the chemicals produced by Chinese textile chemical producers who have relatively bigger production capacity and "decent" reputation. "*Stable quality between each group*", which means the chemicals produced at different times have same high quality, is considered as the most important characters that one kind of product should have. When purchasing textile chemicals, the factories set limits to chemical suppliers regarding the content of hazardous chemicals based on thresholds listed by Company A's requirements.

According to the operation of textile suppliers' information gathering, in this supply chain, the input of risk related information is from the upstream chemical producer, and the gathering of this information occurs when the textile producer is purchasing chemicals. That is probably the only channel through which textile producers get risk information about the chemicals they are working with. But the real situation tells that chemical risk information is given less attention by textile suppliers. The dyestuffs and auxiliaries produced by oversea producers have already been approved by Oeko-tex system, so Factory A_2 and Factory A_3 normally focus on the acquirement of instructions for chemical use, for example dyestuffs' preferable operation temperature and the right method to dilute auxiliaries. As long as getting enough instructions for chemical use there are no problems during the manufacturing. However other information is ignored by both of the two factories, including chemical risk

information. For other textile chemicals, all three factories depend on random tests carried out by external labs to confirm if the chemicals can fulfill their quality requirements. Chemical risk information is not a central topic for the textile producers.

A worrisome situation of the chemical information sharing was discovered during the interviews along the supply chain. As an important source for chemical users to get risk related information, the request of chemical's material safety data sheet (MSDS) from chemical suppliers are mentioned during the interviews. All the three factories announced that they require the MSDSs while purchasing chemicals. However, none of them showed any example copy of any MSDS of a chemical used in their productions. This could be another reflection of the weak awareness of chemical risk issues in all the three factories.

Quality assurance system

Supply chain's quality assurance system in the chain is performed in the form of random sample testing which are required by Company A. Company A always tries to pick out the color(s) which may contain the highest level of hazardous chemicals. For every quarter in a year, their head office decides 3 kinds of chemicals the suppliers should test for. For the first quarter of 2009, NPEO, formaldehyde and pH of textile are the target chemical which received high attention. All the tests are executed by external chemical testing labs and all of them chiefly focus on quality checking about level of hazardous chemical residues. The general procedure of the test is as follow: first, the manufacturer receives an e-mail with information of which kind of clothes and product order(s) that need to be tested; then the producer should send a paper form together with the testing materials to Company A and quality check personnel in the company cut pieces of the materials, then forward them to a test lab; after a series of tests, the test report are finally sent back to Company A as well as to the manufacturer. With the whole process, the personnel from Company A will supervise all the steps. Beside the test required by Company A, a supplier also makes some simple tests inside the factory by themselves to assure the products quality. Once the products' chemical quality can fulfill retail company's demands, the requirements about other risk information will be laid aside, including further chemical risk information. There could also be some kind of inspection between textile producers, like Factory A_1 and Factory A_2; and it also was mentioned by the producers. But the detail of such process wasn't found out from finished interviews.

4.1.3 Chemical Risk Information Management inside Factories

Learning how chemical related information is being interpreted and used inside a textile factory is another objective of this study. Dyeing Factory A_2 and Printing Factory A_3 are paid more attention regarding this aspect of the study due to their use of much higher volumes of chemicals than Sewing factory A_1.

It is quite obvious that the original intention of Factory A_2 and Factory A_3's internal

chemical information management is based on the purpose of better following up customers' quality related demands. They share the opinion that for a producer, satisfying the customers' requirement about product quality is the first and ultimate obligation. The passive attitude (more or less) towards following customers demands restricts, in one way or another, the two textile manufacturers' ambitions of internal chemical risk information management and hinders the establishment of their own chemical use strategies. As a result, neither of the two factories frames the individual goals or policies regarding chemical use. And they just simply incorporate the chemical use policy of their customers, especially overseas customers, into their management and adapt to the corresponding requirements.

"We will inform them how to use the protecting equipments during the production".

---Interview with manager of Factory A_2, Dongguan

"Before they start to work in the factory, we give them some lectures and basic training about chemical use and safe production."

---Interview with managers of Factory A_3, Huizhou

"Do the workers have chances to influence the decision of chemical use in the factory?"
"Not really."

--- Interview with managers of Factory A_3, Huizhou

The method used by Factory A_2 and Factory A_3 to manage chemical related information internally is more or less the same. They are not big enough to have individual departments or appointed personnel to carry out the work of environmental or chemical related information management. In Printing Factory A_2 this task is taken by business managers; while in Dyeing Factory A_3, the production managers are responsible for the job. In both factories, paper documents are the major platform for carrying and storing chemical related information. When chemical related information is received, it is just translated and then simply stored by several managers of the company; normally no further interpretation is performed. It is almost not possible for ordinary workers in both of the factories to reach and read this information. Moreover, in both factories workers can do nothing to express their ideas about chemical use and affect the decision-making toward chemical selection. But, all the blame shouldn't be put on managers in the factories: the workers also show little attention to ask the managers for chemical related, especially risk information of the substances they are working with.

In both factories, the training which is carried out before workers embarking on the production lines is performed by factory managers to give workers simple instructions about how to use chemicals safely. Most of the information about chemical handling given to the workers is common knowledge, such as how to use simple protection wears when working with chemicals. If the inputs from factory managers are cut off,

there is no other channel for workers to get this information. The workers seem also to have no objection against the situation.

The lack of systems for handling MSDSs is another common problem in both factories. Poor management and less recognition of the importance of chemical risk information inside the two factories lead to the fact that, as long as the workers start to work in the producing lines, there is e.g. no label or instruction in the workplace that can give the workers specific information about how to handle a given substance in case of any emergency.

4.2 Supply Chain of Company B

Company B is another Swedish importer. Considering the size, Company B is much bigger than Company A. Bringing *"positive impact to people and environment*" is an important producing concept that Company B has preached for a long time. Similar to Company A, Company B also doesn't have any in-house manufacturing，so its production is sub-contracted to individual producers as well. To control the product quality, Company B develops close connections with their suppliers and sub-suppliers.

Company B's supplier selection work is more or less the same as the work done by Company A (see Page 24, part 4.1.1 above). From the point of textile producers' size, Company B's supplier (Factory B_1) and sub-supplier (Factory B_2) are much bigger than Company A's; hence they also have greater producing capacity. That enables the two factories to have the ability to cooperate with more than one customer. Among the two factories, Dyeing and Printing Factory B_2 also collaborate with a university in Shanghai, which has a strong academic background of textile production techniques; moreover that factory has their own research and development teams to study dyeing and printing techniques. These features give several differences of chemical information management courses in this supply chain.

4.2.1 The Standards for Supplier to Follow

As the leader of the supply chain, depending on its large purchasing quantity, Company B can make great influences on the decision of other supply chain actors regarding standard formation. Company B's requirements greatly determine the product quality of its suppliers and sub-suppliers. Similar to other foreign importers in China, Company B sets tough demands about chemicals which couldn't be used in the production process and the level of chemical residues in final products. From this point of view, quality control is the primary target of Company B's chemical information management campaign. Moreover, Company B also provides the requirements to upstream producers about chemicals in its *Code of Conduct*.

Company B's *Code of Conduct* is designed according to its own interests. In that document, basic requirements regarding general chemical handling rules and demands on how chemical information should be managed in the supply chain are specified for

producers. Company B requires a list from every producer of all chemicals used in production and maintenance. In the list, the name of the chemical product, its intention and areas of use and a reference about this chemical's MSDS should be included. The supplier should also have a written procedure for procurement, storage, handling and use of chemicals, and the supplier also must appoint specific personnel for this whole procedure. These demands in the *Code* practically require direct suppliers (who normally only take care of textile sewing) to supervise dyeing/printing factories' production and collect information regarding manufacturing processes. To make sure the producers can make proper management of chemicals, Company B emphasizes the internal training from the suppliers to their employees, which aim at making sure that the handling and use of chemicals inside a factory is carried out by competent people. In the *Code*, some general rules, for instance storage situation and labels on the containers of chemicals, are listed as well. These rules stipulate supplier's responsibility of preventing chemical leakage caused by unfavorable storage and improper handling. Upon the transfer from being a candidate to become an actual supplier, a textile producer must be approved by Company B's auditing against the *Code of Conduct*. The actual suppliers also need to constantly follow the general rules listed in the *Code*. Moreover, as the reference to the *Code,* Company B also made the documents called "*Requirements on Chemical Products and Substances*" to specify their demands on chemicals.

4.2.2 Chemical Information Sharing in the Supply Chain

Similar to the information sharing processes in Company A's supply chain, the work in Company B's supply chain can also be divided into two connected phases: Company B's requirements distribution and producers' information feedback. One important step of chemical information management in Company B's supply chain is the buildup of the producers' abilities. It is stressed by Company B as a crucial factor for a successful chemical information management in the chain.

Chemical information From Company B

Generally speaking, Company B demands that a requirements dissemination process should be composed of two components: chemical related standards distribution and standards explanation. The most significant difference between Company B's process and Company A's is that Company B extends the direct communication about chemical demands further up to sub-supplier level. Sometimes, Company B even reaches chemical suppliers to explain its specification.

(At the very beginning) *"We passed our specification on to Factory B_1 first. For the purpose of keeping business secrets, Factory B_1 only abstracted some important information and gave it to their suppliers. And this kind of abstraction kept from one level to another. The result was some information was lost in each level, or some information was misunderstood by different people. Finally, we decided to give the full original versions of standard documents to our suppliers and even sub-suppliers*."

---Anny Zhao. Purchasing manager from Company B, Shanghai

"*Keeping the original intention of standard related documents*" is considered by Company B as one of the most important principles regarding the distribution of demands on chemicals[12]. The formation of this cognition grew from the lessons of unsatisfied information sharing experiences. Due to the purpose of keeping business secrets, at the very beginning of their cooperation, only Company B's direct contractors (e.g. Sewing Factory B_1) could get the full original version of documents which contained chemical related standards. After interpretation, the direct contractors picked out the most important information from these documents and passed it on to sub-suppliers like Dyeing and Printing Factory B_2. The same "*pick out and pass*" process was continued from one tier of the supply chain to another until all the actors got the respective standards which they should follow up. The result of such an information abstraction operation is, in each tier of the supply chain, that certain amounts of key information are lost. Besides, such "abstracted" information was prone to be misunderstood by upstream producers who are "far" from Company B in the supply chain. Consequentially, the risks of supply chain interruptions due to textile producers' compliance problems were increased.

Such fact induced Company B to change its demand distribution strategy: the decision of giving the full version of standard documents in English to both its suppliers and sub-suppliers was made. Right now, the sub-suppliers even have the right to give these documents to their major chemical suppliers. This practice largely increases the accuracy of distributed demand and facilitates the works of producers' demand following. Even through, according to Company B's opinion, misunderstanding between actors still happens at times. So, other supporting methods are needed to help producers' execution of demands.

"I organize all the training both for Factory B_1 and their suppliers. I also get the support from the chemical companies, get them understand what MSDS is, and how MSDS is used. We have this kind of setup according to the practical situation. We also have the goal such as the standards which we need to reach in each year."
"*So now, they (producers) are quite clear about our requirements. When the chemicals manufacturers sell dyes to the dyeing mill, they will ask dyeing and sewing factories about what kind of ending customers for the fabric, so they can recommend their different products to the users."*

--- Anny Zhao. Purchasing manager from Company B, Shanghai

Meetings with suppliers and sub-suppliers are used by Company B to explain the chemical related demands to other actors in the supply chain. Company B, of course, is the organizer of such meetings. Actors taking part in the meeting include Company B's direct suppliers, sub-suppliers as well as some major chemical suppliers. By these meetings, training which aim to increase textile and chemical producers' abilities of using chemical risk information is achieved. The keystone of the training is making

[12]Anny Zhao, Purchasing manager from Company B, Shanghai. Interview in 2009-3-24, with the Sewing Factory B_1, Shanghai.

the actors in the supply chain understand the importance of chemical risk information and how such information can be handled and used in the production.

Company B's extended communication avoids information's leave-out due to its multi-layer transfer and make sure the its values towards chemical risk control could timely and accurately reach the major actors of the supply chain. Throughout the meetings, the approved chemical residual level and desired performance of products are clearly conveyed to chemical producers. And not only are the existing demands explained but also Company B's chemical control goals in each following year are discussed with textile producers in these meetings. Regarding other smaller chemical suppliers, the explanation of unclear standards is carried out by the main producers in the chain, like Factory B_1 and Factory B_2.

"*Firstly*, *we often invite our chemical suppliers to visit our factories, let them know the requirements of our customers; secondly, our suppliers also ask us about our new requirements or standards on chemical use. In one word, by both come out and come into our factories, and the bilateral communication, we and our chemical suppliers know each other's demands very well.*"

---Mr. Ding, Chief Engineer of Factory B_2, Shanghai

As an extension of the supplier and sub-supplier meetings, the textile producers also invite chemical producers for factory visiting and giving information about how chemicals will be used inside the factory. The most useful outcome of such extended contacts is that even the chemical suppliers get a good sense of Company B's chemical demands, and could recommend different chemicals to textile producers for the different using purposes. In one word, the production in the supply chain is built on all actors' understanding of Company B's quality related requirements.

Chemical information from upstream producers

"For our company, we give the suppliers and sub-suppliers the clear signal that "no MSDS, no purchase". We also try to distinguish chemicals with low risk from the high risk ones, and then we could pay more attention on the ones having higher chemical risk."

--- Anny Zhao. Purchasing manager from Company B, Shanghai

"*Knowing the sources*" and "*pay more attention on high risk chemicals*" are considered as two major guidelines by Company B for supply chain's chemical risk information management. Such principles are actualized by Company B's harsh requirements about chemicals' MSDSs on textile producers and a well organized information collection system.

According to the demands of Company B, providing the information about production processes, name of all chemicals used in production together with valid MSDSs are obligatory tasks for all contracted producers. "*No MSDSs, no purchase*" is used as a

crucial purchasing principle by the company. In this supply chain, each individual actor should supervise the production of upstream neighbor actors and collect relevant chemical use information. Textile producers also give the information about how chemicals will be used in the production to chemical producers, aiming to achieve better understanding between each other.

"For our suppliers, we will go and understand their production techniques. For each chemical used in every working procedure, we ask our suppliers for detailed information, including the information about chemical producers and MSDSs."

--- Zifeng Zhong, Business manager from Sewing Factory B_1, Shanghai

"At the very beginning Factory B_1 mainly controlled the quality by tests; they even built their own lab. But we say no to them. It is impossible to assure the quality of all the products through several random tests. What we need to do is control from the source. The tests can only be used as verifications method."

--- Anny Zhao. Purchasing manager from Company B, Shanghai

To follow Company B's requirements, as direct contractor, sewing factories must present their own chemical use information to Company B, and moreover they need to visit dyeing/printing factories on a routine basis as well. What they should do is collecting the information about dyeing/printing factories' production processes and how chemicals are being introduced into textiles products in each step. Similarly, it is dyeing/printing factories' obligation to turn to all their chemical suppliers for detailed chemical risk information including MSDS for each substance. Textile manufacturers and chemical suppliers should issue compliance letters and supporting documents at the same time to guarantee their compliance with Company B's specification and the accuracy of the information offered by their MSDSs. Tests are used as assistant methods to randomly verify the quality of the products as well as the accuracy of the chemical information.

Besides offering MSDSs of chemicals, textile producers also need to make the pre-notifications about changes in ongoing production processes and chemical uses to Company B. Company B has the intention of being involved in the discussion about the possibility of chemical changes. Any change without the involvement and permission of the importer is considered as not appropriate. For several big chemical suppliers, Company B can make direct communication with them and get some risk information directly. Regarding the smaller ones, Company B is trying to merge them together for easier processes and better outcomes of standard related communication.

4.2.3 Chemical Risk Information Management inside Factories

An important outcome of the cooperation with several overseas textile retailers is that Factory B_2 pays more and more attention on handling chemical risk issues inside the factory. Some of their business partners, for example Company B, consider the inner management and employees' working condition as a vital criterion for qualified

producers. So, Factory B_2 carries out the internal chemical information to better compliance with the importers' requirement and it continually updates its management according to the requirements of the importers.

In Factory B_2, there is a system for applying the information from MSDSs into the chemical use management. In the system, as long as the MSDSs for chemicals from chemical suppliers are received, chief engineers and technicians in every workshop are responsible for the storage and interpretation of them into non-expert information. The risk information which is related to the workplace safety is conveyed to workers through training.

Pre-work training is the routine for every new worker getting to know the brief knowledge of the proper handling of chemicals while working in the factory. This training usually introduces the general information about workplace safety, such as precautions about handling chemicals and the right way to use protective equipments. In each workshop, the technicians also give the workers specific information about how to handle each chemical used in the production. Every time while new chemicals are being introduced, the new risk information is constantly given to workers beforehand. Follow-up investigation is regarded as a vital component of the internal chemical management which is designed to make sure every worker can effectively use the knowledge gotten from the training into practical operation. Once there is any problem or violation of safety production rules during workers' operation, in-time correction is made.

Employees' health influences the chemical selection of the factory. Workers' opinion about which chemicals that can cause discomfort is an effective factor that influences the chemical selection in Factory B_2. The representatives of the employees, although not having a major influence, get the chance to take part in the decision-making meetings about chemical use and express the ideas on the behalf of all workers. In the factory, there was experience of substituting one chemical with another in order to reduce the negative health effect under operations.

5. Analysis and Discussion

The findings of this study are analyzed in this chapter. As a complement to previous chapter, some contents referring to the evolution of the chemical information flows in the two supply chains are also introduced and discussed in this chapter.

5.1 Differences of Chemical Information Flows in Supply Chains

From the interviews, it is quite obvious that the two importers adopt different strategies during their chemical related information's dissemination and collection processes. Company A limits its contacts with textile producers to the first tier level, while Company B expands the communication to sub-suppliers and even to chemical producers (also see Figure 4). Another difference is the media they get chemical information feedback from textile producers: Company A relies on external testing (for example, Oeko-tex standards), but Company B emphasizes the importance of MSDSs in conjunction to internal random tests of compliance.

5.1.1 Contacts with Textile Producers

The range of contacts with textile producers is the most significant difference between the importers, regarding chemical information management. Figure 4 indicates this difference. The dotted lines indicate the requirements about chemical use which are given by the importers to textile producers, while the solid lines mean chemical related information feedback from textile and chemical producers.

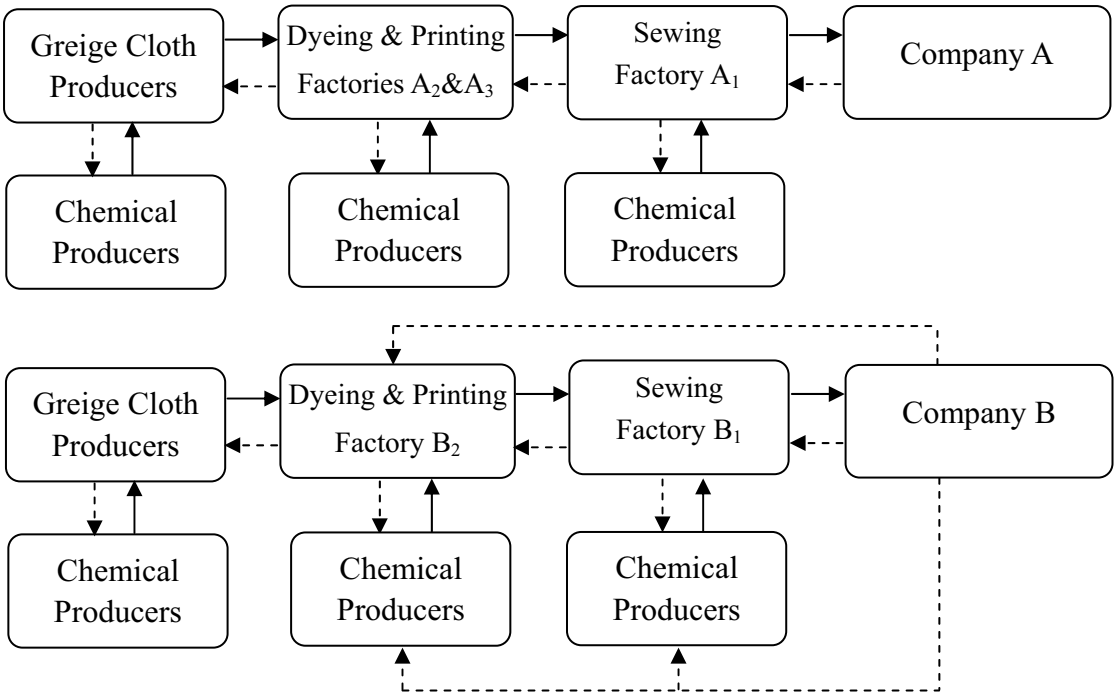

Figure 4: Chemical related information flow in the studied supply chains

Comparing Company A's and Company B's range of supplier communication, including standards distribution and related training, is much wider. Besides direct contractors like Sewing Factory B_1, it still reaches sub-suppliers, sometimes even chemical suppliers in the supply chain. As mentioned by Walton et al (2006), evaluation of second-tier suppliers is a key criterion for successful environmental supply chain management. Such a conclusion is also valid for the result of this study. Through communicating with most of the major actors, Company B spreads their chemical related standards accurately through the supply chain. This practice effectively avoids possible standard violations due to information missing or misunderstanding of crucial information. And also, sub-suppliers' capabilities of using chemical risk information are elevated as a result of Company B's training and also experience accumulation from continuous use of chemical information. This is of particular significance since normally dyeing and printing factories are those that use most of chemicals during textile production.

The extended communication raises all actors' recognition about importance of chemical related information in supply chains too. In Company A's supply chain, it can be observed that the direct contacts with importers makes Sewing Factory A_1 give enough attention to Company A's demands on chemical use; and it is able to follow these demands self-consciously too. But through the indirect pass, Company A's intentions of chemical risk control is weakened, in comparison with the ones received by first-tier suppliers. Printing Factory A_2 and Dyeing Factory A_3, for instance, just simply follow Company A's demands and seem to not think about why such chemical risk must be controlled and how to achieve a better compliance to the scheme. Moreover, the power of supervision to second-tier suppliers from first-tier suppliers is normally weaker than the one from Company A. These facts all increase the possibility of supply chain breakdown (although it didn't happen) caused by standard violation in this case. From these points of view, Company B's way of supply chain chemical risk information distribution and quality supervision are more successful than Company A's.

5.1.2 Chemical Information Acquisition of Importers

In the two cases, different strategies on chemical related information acquisition are used by the two Swedish importers. Company A takes external lab tests as a main tool to get and communicate chemical related information with other actors in the supply chain. Similar to Company A, tests are also important media for Company B to know the quality of its order; but it also emphasizes the importance of chemical substances' MSDSs and information regarding suppliers' production processes on chemical related communication between actors along the supply chain.

Company A's use of testing system to get chemical information may relate, to a large extent, to the size of textile producers in the supply chain. Ohashi et al (2005) argued that the involvement of small and medium enterprises, who normally have problems of collecting, managing and providing information, is one of the most important

reasons that chemical related information disappear in a supply chain. In Company A's supply chain, the involved textile producers are mainly such small or middle size factories; so theoretically, the risk of losing crucial chemical related information during information transfer is relatively high. The use of third bodies' tests partly solves the problem by reducing the amount of information needed and hence the work of interpretation and management for the textile producers. The textile producers in the chain only need to provide the information about their production processes and the name as well as the producers of used chemicals. The desired chemical related information for Company A is achieved through independent external labs' tests. After tests, the results about all sample materials are given back to producers and importers in very integrated forms, mainly in terms of the contents of hazardous chemicals in the final products or what chemicals are not contained in textile materials; and they can make the decision about if the products fulfill relevant requirements. When such information is transferred in the supply chain, it is not necessary for textile producers to spend much time on information interpretation and management. The sharing process is relatively easy to regulate too as the volume of information being greatly compressed into several easy-understood indicators (e.g. the contents of chemicals under or above certain threshold values).

But the interviews show the flip side of such a system. Use of the testing depended system greatly induces the tendency among the producers that they only care for information related to the products' quality, for example the name and concentration of regular hazardous chemicals in products. The emission and exposure information of chemicals (normally get from chemical producers) which should be used by the producers to manage chemical risk in the workplace and handle the occupational chemical hazards is neglected by the managers in factories and then maybe lost, since such information category normally falls outside of the testing categories. Sometimes it may be just simply ignored by the producers due to the weak demands from downstream buyers and importer. Moreover, through the operation of this chemical information management system, the improvement of producers' ability on handling chemical related issues, such as risk information interpretation, is quite limited. That partly explains the poor inner management of chemical risk information in all the three visited factories in Company A's supply chain.

Chemical risk information communication based on MSDSs is regarded as one of the major methods for chemical users in industry to know about the properties of chemicals and then prevent the health risk in workplace and adverse environmental consequences of chemical use. In China, as stated before, the establishment of MSDSs based chemical risk management system is hindered by the poor practice of sharing and use of MSDSs among chemical users. Without the strong influence from overseas importers, it is uncommon for Chinese producers to carry out such a system alteration spontaneously, from their old ones (if they have some) to a MSDS dependent system. This fact means much work must be done beforehand by importers in order to let the producers to know the importance of MSDSs and how to use them.

That can be seen through the formation of Company B's chemical information collection system. Before MSDSs being the valid platform for risk communication, a lot of work related to training and technical assistance has been done by Company B and other actors (especially the one who use many chemicals) in the supply chain. The whole process, as mentioned by purchasing manager from Company B, could be time and money consuming both for it and its producers. It may become burdens for manufacturers, especially for small and middle sized ones. That maybe an important reason that factories in Company A's supply chain don't use MSDSs for chemical information management.

But the introduction of MSDS into the system gives the possibility that producers get more information to manage the chemical risk along the product line inside their own infrastructures and to protect workers from potential harms during textile production. Furthermore, through the interpretation and use of MSDSs and other risk information, the rise of textile producers' capacities and change of attitude on chemical information management are evident. These changes are probably more meaningful than the information sharing causes itself for forming a self-motivated chemical risk information management system. From this point of view, building a communication system in which supply chain actors share chemical information through MSDSs or other similar chemical information carriers, and then using testing to confirm the reliability of information offered by upstream producers, could be a better solution for chemical management in the supply chain.

5.2 The Reasons of Chemical Related Information Disappearance

The loss of chemical related information during the information transfer is a major problem obstructing the chemical risk management in the supply chain. This problem exists in both supply chains, but in different degrees. For one textile producer, it happens both internally and externally and relates directly to its weak ability on chemical information management.

5.2.1 Internal Reasons

Worries about the ability of Chinese managers in textile factories were expressed during the proceeding of interview with Company A. As commented by its purchasing manager in China[13], the owners or top-level managers of the contracted producers are all well-educated and easy to communicate with; but regarding the middle level manager from local areas in those factories, the situation is not so promising. The problem of standard execution is normally raised when the ideas about management are transferred to middle level managers who often lack certain skills to properly handle the chemical related information. The interviews with factories in Company A's supply chain reveal that the awareness and the knowledge of the factory managers in two factories (A_2 and A_3) are far from sufficient to deal with large amounts of chemical related information. This can partly be proved by the fact that the

[13] The manager of Company A's purchasing department. Interview in 2009-03-16, in office of Company A's purchasing department.

interviewed manager in Printing Factory A_2 doesn't exactly know what chemical risk is and why chemical risk must be controlled. Moreover, the management of MSDSs in that factory seems to be unstructured: when being asked for the examples of dyestuffs' MSDSs, the managers in the factory couldn't present any correct copy. The situation in Dyeing Factory A_3 is better than in Factory A_2, but still the concept of "chemical risk" is not so clear for the managers. They mix the two works of "chemical risk control" and "environmental protection" and can't realize the harm caused by failure in chemical risk control. Such conditions constrain the formation of motivation of the textile producers to collect and storage chemical risk information, hence the volume and accuracy of the information is lost as a result.

5.2.2 External Reasons

The study carried out by Ohashi et al (2005) argues that chemical information normally "*disappears or loses its accuracy when raw materials or preparations are converted to articles*" and "*transmitted at downstream stages*". In the two studied supply chain, these kinds of information loss also happen. According to their differences, two types are witnessed: information flows from chemical suppliers to textile producers, and information flows between textile producers.

From chemical suppliers to textile producers

The flow of information from chemical suppliers to textile producers, according to the interviews, is probably the biggest reason that chemical related information disappears in the textile supply chain in China. This kind of information loss is partly linked with the way that Chinese textile producers purchase their chemical raw materials. In China, when chemical users purchase chemical substances from overseas chemical producers, the trading agencies (or traders) who act as intermediates are usually involved in the buying-selling processes. From the textile producers' point of view, the involvement of traders can facilitate their financial turnover. But the loss of information in the purchase process, at the same time, is considerable.

Information loss caused by trader involvement trouble both supply chains. Although taking part in the goods and financial flows of a supply chain, the traders usually don't have any responsibility or couldn't get strong pressure from supply chain leading organizations (in this case, they are importers) to join in the course of chemical information flow which may cost extra money or labeling. If the chemical users don't give special requirements to those traders and ask for risk information, this information is prone to be lost. In Company A's supply chain, Printing Factory A_2 mainly receive the chemical information through traders, and it is hard for them (or they don't see the necessity) to get direct communication with the producers of the chemical substance. In the other supply chain, the problem happened in the beginning of the cooperation between each actor. At that time, to meet Company B's demands on chemical information, a textile producer just let traders issue MSDSs. Or they might only download MSDSs of chemicals which were similar to their used materials from internet; and in this case there might be a bad correspondence between their materials

and information found on internet.

Another kind of information loss happens when the textile producers purchase chemical substances from China's local chemical producers. The comments from Mr. Ding in Factory B_2 presented a common idea of people from interviewed factories on the difference between the information provided by China's local producers and by overseas producers:

"The information from big foreign companies is normative; it is formed in a systematic and scientific way. It can introduce the chemical risk in detail, and gives you the information about both the hazards and the way to keep these hazards away. Compared to the information given by foreign companies, the domestic producers normally provide very simple information; and it is mainly about how to use the chemicals."

---Mr. Ding, Chief Engineer of Factory B_2. Shanghai

This problem is grown from the loose local legislation requirements and the lack of tradition and awareness regarding chemical risk information, which lead to Chinese chemical producers only pay attention to their selling, offering chemical related information never be a part of a deal according to their idea. Even when chemical users ask them for chemical related information, they are still reluctant to present it. Company B had this experience when starting the business in China.

Information flows between textile producers

According to the interviews, information flows from one textile producer (upstream) to another textile producer (downstream) are also important points where chemical related information can be lost in a textile supply chain. This type of information loss is directly related to the low ability of Chinese textile producers on information management. As stated in the previous chapter, setting demands regarding to quality is a common instrument of foreign importers to ensure that Chinese producers can provide eligible products that comply with importers' requirements. As supply chain leaders, importers' emphasis on quality related indicators induces the trend that textile producers also think a lot of obtaining the information concerning product quality. Apparently, this tendency makes no matter upstream or downstream producers couldn't pay enough attention to other chemical related information: on one hand, downstream producers never ask for non-quality chemical information; on the other hand, without the pressures from downstream, the upstream producers don't have any impetus to provide extra chemical risk information. The chemical related information is then lost under the "no-one-care" situation. That kind of information loss can be observed in the Company A's supply chain.

5.2.3 Training and technical assistance for better outcomes

Training and technical assistance are crucial elements for a successful supply chain environmental management program (Lippmann, 1999). Training and technical assistance which are performed by supply chain leaders (such as two retailer

companies in this study) are especially important for Chinese textile manufacturers. That is because most textile producers in China still can't handle chemical information appropriately. The study carried out by Zhu et al (2005) indicates that Chinese producing enterprises are still in the "*learning stages*" of corporate environmental programs and practices and they also need to be "*better educated*". Practically, it can be concluded that the training and technical assistance launched by Company B help the supply chain to conduct in a better way regarding chemical related information sharing.

Comparing the situation in Company B's supply chain with that in Company A's, the middle managers in the former not only can share and use chemical risk information into the production more proactively, but also they had deeper recognition about the importance of chemical information. Of course, the bigger size of Factory B_1 and B_2 make them initially have a better ability of handling environmental issues, but their increased ability after the cooperation with Company B and other international importers is evident. As mentioned by a manager from Company B, at the beginning of cooperation with producers in the supply chain, most of them couldn't accept the chemical information management idea they presented. It is considered by Company B that the leverage of purchasing can be used to force the producers start to run a better chemical information management; but only with the continuing training and technical assistance, the ability of the producers can be raised; a system composed by capable actors is a prerequisite for systems to be effective and sustainable.

5.3 Influence of Regulations on Chemical Information Flows

In business today, the supply chain needs to response to an array of external pressures. Regulation is one of the most important factors that influence the supply chain decision-making (Paquette, 2005). Because of the short study time, it is very difficult to make a detailed analysis about how regulations, Chinese and international ones, influence the way that supply chain actors processing chemical related information. Below follow just a very brief account of the influence of China's regulations and REACH on chemical information management, which originates from the results of the study.

5.3.1 China's Regulation

The Chinese regulatory system is composed by legislations and relevant standards. Standards are used as technical supports which facilitate the implementation of legislations. In China, the regulations that influence the chemical use and chemical risk management of a textile factory mostly come from three areas: industry wastewater control, hazard chemical management and products quality assurance.

Among regulations from all the three aspects, the one that aims to control wastewater discharge from industry has the most significant impacts on the chemical selection of textile producers. That is mainly because China's environmental protection regulations give high priority to prevent water pollution caused by textile wet

processing. National or local government set high standards to regulate the contents of chemicals in wastewater. Such regulations influence the producers', especially dyeing/printing factories', choice of chemical use by an end-of-pipe fashion: restricting the chemical load of wastewater discharge. The visited factories all have a common view about using low toxic chemicals and thereby lowering the concentration of hazardous substances in wastewater. The high content of hazardous substance in wastewater may rise the producers investment by higher cost on wastewater treatment; and the discharge of untreated wastewater may bring the monetary penalty from government departments. Both of them are regarded as unwanted business losses. Another interesting phenomenon is the influence of wastewater discharge regulation on the regional distribution of China's textile industry[14]: more and more big dyeing/printing factories are moving the facilities out of southeast China, since following the stricter standards in those regions means that big dyeing/printing factories with large volume of wastewater discharge have to invest more money in wastewater treatment than for similar factories located somewhere else. Factory moving is however not an ultimate solution after all. It can be predicted that with higher environmental standards regarding water pollution put into effects all over China (although this will take some time) textile producers will probably consider more chemical related control strategies; and use less toxic chemicals in the productions, which is an inevitable trend.

China has relatively integrated regulation systems regarding management of hazardous chemicals. Legislations cover the authorization, registration, monitoring, production, transportation, storage and safe use of chemicals; relevant standards refer to the list of hazardous chemicals, chemicals' classification and labeling, composing MSDS, storage and the factory owners obligation to communicate chemical risk with workers (China's Academy of Safety Production, 2005). Besides all the regulation established by government, China has also signed agreements to follow international conventions about chemical use. For example, China passed Chemical Convention No. 170, which concern safety in the use of chemical at work. But the existing chemical hazard management regulation all aim to regulate the behaviors of individual manufacturers and few regulations or instructions from governmental bodies are available to give advice to chemical users about the requirements of chemical risk information from chemical producers. This is the direct reason why some textile producers chronically ignore MSDSs for chemicals when they do the purchases. Furthermore, the state of implementation of these regulations is not promising too. According to the overall impression of the factory visits, these regulations hardly play any direct role to influence textile factories' chemical use. Moreover, all the factories receive little or, in some cases, no instructions or help for chemical use and chemical risk management from local governments or related authorities. The weak awareness of producers on chemical related issues may account for some reasons: they are reluctant to implement any regulation which may increase their production cost. However, the weak institutional capacities and lack of experience in management of

[14] The following content came from the interview with Factory A_3 and B_1, in 2009-3-24.

government bodies on environmental issues should be blamed for most parts (Zhang and Wen, 2007).

Last but not least, China's chemical related standard itself also blocks the change of Chinese textile producers' behavior related to chemical use. China has its own standards and tests systems to ensure the quality of textile products. But most of the chemical related standards set in China are lower than the similar standards to the same chemicals established by most EU countries. And recognition and accession of new hazardous chemicals into China's standard system are relatively slower than the same processes carried out in EU. In China, some chemicals which have already been banned in European countries are still used in textile production without violating any national standard. These standards are normally used by local textile producers and retailers whose products mainly sell inside China, but they don't have any actual influence to the quality of products which are produced under the supervision of overseas retailers, like Company A and Company B, from Europe or North America. Such standard gaps between China and EU countries bring difficulties to the initial communication about standards between Chinese textile producers and European textile retailers. Most of the Chinese textile producers, especially those who make the first contacts with foreign customers, think that the EU standards are too harsh to reach. Sometimes they even harbor emotional resistance to execute the standards. So, for one textile retailer who is willing to develop their business in China, narrowing down the understanding gaps about different standards among contracted Chinese textile producers is the primary task that needs to be completed

5.3.2 REACH

The influence of the new European legislation REACH is interesting for the study because both supply chains aim at mainly serving the EU market. As the result of interviews show, REACH has already brought pressure, more or less, to the two Swedish importers; but for the other actors, textile factories, their investigation on REACH is still in the initial steps and they still don't give as much attention to this new European chemical legislation as the retail companies do. The conditions in small factories are even worse. For example, even all three interviewed manufacturers in Company A's supply chain heard about REACH, but they have little knowledge of what the legislation is about and how to follow it. Likely, there are mainly two reasons that make REACH not effective in Chinese textile supply chains. First, REACH is not a regulation that specifically aim at textile production and the chemicals used in textile production and exist in the textile products are normally lower than the REACH stated registration and notification level: more than 1 ton per year and concentration higher than 0.1% weight by weight. Second, REACH is a European legislation after all. For the products produced in China, the only obligation of the manufacturers is to comply with the rules related to substances contained in products. In the case of textile products, the obligation is limited to notification of substances with very high concerns. Moreover, REACH needs time to spread its

influence to the industries around the world.

6. Conclusion

The number of supply chains and factories involved in this study were sparse, so it is very hard to make any comprehensive and definitive conclusion based on the results of the interviews. However, this study gives information about the general trend of how chemical information is handled by Chinese textile producers and it can also be used as useful clue for possible studies in the future.

According to this study, it can be concluded that as the biggest base of textile production around the globe, China's textile producers are still in the initial phase to actively use and share chemical information within the supply chain. Considering the work done by different interviewed producers and also the results of other scholars, it can be concluded that supply chains composed by big enterprises have better overall performance than the ones formed by small and medium size enterprises.

Overseas importers' demands on chemical use and chemical information seem to have major effect to influence the behavior of Chinese textile producers regarding chemical use. For those importers who order products from Chinese producers, the chemical risk combined with the final textile articles, for example the contents of chemical residues, is the issue they concern most. Their common approach for avoiding this kind of risk is setting standards about the permissive level of chemical residues in the final textile articles and giving manufacturers the instructions about what chemicals can't be used in the processes. They also use third party tests to supervise the states of textile producers' standard observance. Besides setting up requirements, for some importers, label programs are additional tools to enhance the quality of their goods; labels are also considered as a valuable instrument to increase the competitive power of the products by China's textile producers. For other importers, they ensure the products quality through asking for more chemical related information, such as material safety data sheets and detailed production processes. Once the demands being established, the producers in the chain can follow them well, although sometimes the producers may have little knowledge about reasons for the necessity to following such demands. The direct outcome of establishing harsh demands and their implementation is stable product quality.

The standard related communication and dissemination between importers (retailer companies) and first-tier suppliers (sewing factories) is not a problem for chemical information management in a textile supply chain. Through the contacts, between importers and direct suppliers, close relationships are built up. Importers often launch training and technical assistance to help direct suppliers to better implement chemical related requirements during production. For facilitating the processes of chemical related information flow, in some supply chains, chain leaders (importers) also extend their connection with producers to the whole chain level; but in some other cases, normally supply chain composed by SMEs, such a connection is hard to see. When leading companies couldn't reach the whole supply chain, the risk of standard

misrepresentation and misunderstanding may be increased. That is especially harmful for textile supply chains where second-tier suppliers (dying and printing factories) are using most of chemicals in the entire production process. Moreover, the outcomes of neighbor supervision between textile producers are also questionable. So, for getting better outcomes of chemical risk management, importers' wide range contact with more supply chain actors is highly recommended.

The internal management of chemical related information is in an infantile stage. The system of chemical information interpretation and notification inside textile factories is not well developed. The situation can be even worse in SMEs with no specific personnel to take charge of these tasks. But in all the factories, no matter big or small, "one-way" information flow in which workers get the chemical related information passively through training is the common condition. But in the bigger factories, the involvement of employees in chemical risk management seems to increase, although they couldn't play major roles. Considering the truth that Chinese loose legislation implementation has nothing to do with factories' internal chemical management, importers' harsh requirements and help may become the hope for an improvement.

Reference

BALA, A., MUÑOZ, P., RIERADEVALL, J. & YSERN, P. (2008) Experiences with Greening Suppliers. The Universitat Autònoma de Barcelona *Journal of Cleaner Production,* 16**,** 1610-1619.

BAUMANN, H. & TILLMAN, A. (2004) *The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Application,* Lund Studentlitteratur AB.

CAO, N., ZHANG, Z., KIN, M. T. & KENG, P. N. (2008) How Are Supply Chains Coordinated? - An empirical observation in textile-apparel businesses. *Journal of Fashion Marketing and Management,* 12**,** 384-397.

CHINA'S ACADEMY OF SAFETY PRODUCTION (2005) *Selection of Regulations about Hazard Chemicals,* (In Chinese). Beijing, Chemical Industry Press

EUROPEAN COMMISSION (2008) "Statistics about Textile and Clothing Trade". [online]. (Updated 17 June 2008).

EUROPEAN IPPC BUREAU (2003) Reference Document on Best Available Techniques for the Textiles Industry.

GENERAL ADMINISTRATION OF CUSTOMS OF CHINA (2008) "China's Textile and Clothing Export in 2007". (In Chinese) [online]. (Updated 7 April 2008).

HALL, J. (2000) Environmental supply chain dynamics. *Journal of Cleaner Production,* 8**,** 455-471.

HANDFIELD, R., SROUFE, R. & WALTON, S. (2005) Integrating Environmental Management and Supply Chain Strategies. *Business Strategy and the Environment,* 14**,** 1-19.

HEALTH AND SAFETY EXECUTIVE OF UK (2007) "Dyes and Chemicals in Textile Finishing: An Introduction". [Online]. (Updated 29 May 2008).

HÖK, F. (2007) Towels with a Dirty Past. a report by Swedish Society for Nature Conservation.

JONSSON, P. (2008) *Logistics And Supply Chain Management* Maidenhead, McGraw-Hill Education.

KOCH, L. & ASHFORD, N. (2006) Rethinking The Role of Information in Chemical Policy: implication for TSCA and REACH. *Journal of Cleaner Production,* 14**,** 31-46.

KOGG, B. (2003) Greening a Cotton-textile Supply Chain: A Case Study of the Transition toward Production without a Powerful Focal Company *Greener Management International* 53-64.

LACASSE, K. & BAUMANN, W. (2004) *Textile Chemicals: Environmental Data and Facts,* Berlin, London, Springer.

LAMBERT, D. M. & COOPER, M. C. (2000) Issues in Supply Chain Management. *Industrial Marketing Management,* 29**,** 65-83.

LIPPMANN, S. (1999) Supply Chain Environmental Management: Elements for Success. *Environmental Management* 6**,** 175-182.

MASSEY, R., HUTCHINS, J., BECKER, M. & TICKNER, J. A. (2008) Toxic Substances in Articles: The Need for Information. Copenhagen, Nordic

Council of Ministers.
MENTZER, J. T., DEWITT, W., KEEBLER, J. S., MIN, S., NIX, N. W., SMITH, C. D. & ZACHARIA, Z. G. (2001) Defining Supply Chain Management. *Journal of Business Logistics,* 22**,** 1-25.
MIN, H. & ZHOU, G. (2002) Supply Chain Modeling: Past, Present and Future *Computers and Industrial Engineering,* 43**,** 231-249.
MÅNSSON, N., SÖRME, L., WAHLBERG, C. & BERGBÄCK, B. (2008) Sources of Alkylphenols and Alkylphenol Ethoxylates in Wastewater—A Substance Flow Analysis in Stockholm, Sweden. *Water, Air and Soil Pollution: Focus,* 8**,** 445-456.
OHASHI, T., KASAGI, K. & NIIHARA, T. (2005) Identification of Problem Associated With Exchanging Information Across A Product Supply Chain for Chemical Risk Management. *Fourth International Symposium On Environmentally Conscious Design And Inverse Manufacturing*
PAQUETTE, J. (2005) The Supply Chain Response to Environmental Pressures. Cambridge, Massachusetts Institute of Technology.
PERRY, M., SOHAL, A. & RUMPF, P. (1999) Quick Response Supply Chain Alliances in the Australian Textiles, Clothing and Footwear Industry *International Journal of Production Economics,* 62**,** 119-132.
PREVODNIK, A. (2008) T-shirts With a Murky Past. a report by Swedish Society for Nature Conservation.
QIU, L. D. (2005) China's Textile and Clothing Industry. Hong Kong, Department of Economic, Hong Kong University of Science and Technology.
SINGH, J. (1996) The Importance of Information Flow within the Supply Chain. *Logistics Information Management,* 9**,** 28-30.
SWEDISH CHEMICAL AGENCY (1997) Chemical in Textiles. Solna, Swedish Chemical Agency.
THE ECONOMIC AND COMMERCIAL COUNSELLOR'S OFFICE OF CHINA'S EMBASSY IN SWEDEN (2009) "How China Increases Its Export to Sweden". (In Chinese) [Online]. (Updated Feb 21 2009).
UN (2002) Report of the World Summit on Sustainable Development. Johannesburg, United Nations.
WALTERS, A., SANTILLO, D. & JOHNSTON, P. (2005) An Overview of Textiles Processing and Related Environmental Concerns. Greenpeace Research Laboratories, Department of Biological Sciences, University of Exeter.
WALTON, S. V., HANDFIELD, R. B. & MELNYK, S. A. (2006) The Green Supply Chain: Integrating Suppliers into Environmental Management Processes. *Journal of Supply Chain Management,* 34**,** 2-11.
VANDEVIVERE, P. C., BIANCHI, R. & VERSTRAETE, W. (1998) Treatment and Reuse of Wastewater from the Textile Wet-Processing Industry:Review of Emerging Technologies. *Journal of Chemical Technology and Biotechnology,* 72**,** 289-302.
WU, D. (2002) China's Textile Industry Needs Green Production (Chinese) *Journal of Textile Research,* 23**,** 23-25.

ZHANG, K. & WEN, Z. (2007) Review and Challenges of Policies of Environmental Protection and Sustainable Development in China. *Journal of Environmental Management* 88**,** 1294-1261.

ZHU, Q., SARKIS, J. & GENG, Y. (2005) Green Supply Chain Management in China: Pressures, Practices and Performance. *International Journal of Operations &Production Management,* 25**,** 449-468.

Appendix 1 – Interview Guides (English)

Note: The interview guides are composed by parts, namely A and B in the appendix. The first one (A) is for sewing factories and the second one (B) is for dyeing /printing factories.

For the interview with sewing factories

Introduction

- Tell me something about the factory.
    - How old is the factory?
    - Are the owner(s) of the factory Chinese or from other countries?
    - How many employees do you have?
    - How long have you been involved in textiles exporting? Where is your main export destination?
    - Is there a specific department or person in your factory that takes care of environmental issues?
- What is your role in the factory?
    - How long have you been in this field?
    - What have you done before? What is your background?

Chemicals

- Are there goals or policies regarding chemical use in your factory?
- What is your intention by making these goals and policies?
- Are there lists of chemicals that should not be used?
    - Are some chemicals more prioritized than other?

Suppliers

- Tell me some about your suppliers.
    - In which countries/regions are they located?
    - What are the sizes about them?
    - Approximately, how many are they?
- What information regarding chemicals do you achieve from your suppliers?
    - What information do you ask for?
    - Is the information relevant and easy to understand?
- What demands regarding chemicals do you set on your suppliers?
    - What are the bases for you to make these demands?
    - How do the suppliers think about your demands?
    - How do you make sure that the suppliers can follow your demands?

Your customers

- Approximately, how many customers do you have?
    - Are the majority Chinese or international?
- Do your customers set demands on the chemical contents of the final products, or on what chemicals that may be used or not in the production process?
- What other information or demands regarding chemicals do you get from your customers?
    - What is your opinion on this information? Do you think it is relevant and easy to understand?
    - Is there something regarding this information that you would like to change?
    - How do you exchange ideas and information about chemicals with your customers?
- Do your different customers have different demands regarding chemicals?
- How do you handle your customer's demands?
    - Do you separate them or use the highest demands for the whole production and all products?
- Do your customers require risk information about your products?
    - What is the information about?
    - How do you communicate the information with them?
- How do you prefer to give information to the costumer?

Information within the company

- Do your employees regard it a risk to handle the cloths?
- How is chemical information handled within your factory?
- Is there someone in the company responsible for chemical risk information?

Chemicals in the product

- Do you test your products for chemical residues (before or after sewing)?
    - Which standard do you use (national, European)?

Information from the government, laws and regulations

- What kind of information regarding chemicals do you get from the government?
    - What is your opinion on this information? Is it relevant and easy to understand?
    - How often do you get this kind of information from the government?
    - Is there something regarding this information you would like to change?
- What kinds of laws or legislation regarding chemicals influence your production?

    - Have your business been affected by REACH (the European chemical legislation) or by any other international legislation?
- What advantages and disadvantages can you see about international legislation within your product area?

Labels

- What are your general opinions on labeling programs?
- Do some of your customers require any eco- or health-labeling? (Oeko-tex, EU-flower or other)
- Do you think that labeling might help you promote the selling of your products?

Responsibility

- Who do you think should be responsible for minimizing the use of hazardous chemicals in the textile industry?

Remaining questions

- Do you have anything to add?

For the interview with dyeing/printing factories

Introduction

- Could you tell me something about the factory?
    - How old is the factory?
    - Are the owner(s) of the factory Chinese or international?
    - How many employees do you have?
    - For how long have you been exporting textiles? Where is your main export destination?
    - Is there a specific department or person that takes care of environmental issues in your factory?
- What is your position in the factory?
    - How long have you been in this field?
    - What have you done before? What is your background?

Chemicals used during production

- Are there chemicals that you have decided not to be used in your factory?
    - What kinds of chemicals?
    - What is (are) the main reason(s) for making these prohibitions?
- Are there goals or policies regarding the chemical use in your factory?
    - What is your intention by making these goals and policies?

- Where do you buy the chemicals you use in the production process?
    - China or other countries?
    - Large or small companies?
    - What characteristics of a chemical producer do you consider before purchasing a chemical from them?
- Do you always use readymade chemicals or is it usual that you make mixtures on your own?
    - What is the main reason by doing this?
- How do you achieve risk information about the chemicals you use in the production process?
    - How does this information look like? Is it material safety data sheets?
    - Is this information relevant?
    - Is this information enough for your purposes?
    - How do you interpret the chemical information?
- Can you get the information you request or is it usual that relevant risk information is missing?
    - Regarding to the risk information, is there any difference between chemicals produced in different countries/continents or by large/small companies?
- Is it usual that you request further information from chemical suppliers? Maybe you have an example.
- Do you get a complete list of contents of the mixed chemicals you use?
    - Do you request it? Why/Why not?
- Do you set demands on the producers regarding chemicals you do not allow in the mixed chemicals?
    - What kinds of demands?
    - How did the suppliers think about your demands?
- Do you know the environmental and health effects of the chemicals you use in the production processes?
- Do the chemical suppliers know how you use the chemical?
    - Have you ever cooperated with a chemical supplier to change a chemical to another one which has less dangerous to the health and the environment? Could you give me some examples?
    - Did it occur that a chemical supplier make suggestion to you about change a specific chemical?
- When you have changed a chemical to another one, what has been the major reason?
    - Demands from authorities/regulations?
    - Demands from your customers?

- Suggestion from the chemical supplier?
- Your company's environmental and security policy?
- Demands from your employees regarding their work environment?
- Price of chemicals?

- If you want to replace a chemical how do you work on that process?

Chemicals in the product

- Do you test your products for chemical residues? Why/why not?
  - Which standard do you use (national, European)?

Information within the factory

- How is chemical information handled within your factory?
  - Is there a system for safety data sheets in your factory?
  - Do you use computer software to handle the chemical information?
  - Are there any other routines to handle chemical information? Give examples.
- Is there someone in the factory responsible for the chemical risk information?
- How do the production personnel get the information about chemical risks?
  - Education?
  - Routines?
  - Information about safety equipment?
- Do the workers understand and know how to handle the chemical risk information?
  - If not, do you reformulate the information to make it easier for them to understand?
- Do the employees have any possibility to influence what chemicals they are going to work with? (How?)
  - Can you give some example of when a chemical has been replaced follow the requests from the employees?
- When you are informed that a specific chemical may affect the health of your employees, how do you react?

Your customers

- Approximately, how many customers do you have?
  - Are the majority Chinese or international?
- Do the customers set demands regarding the chemical contents of your product, or regarding what chemicals you may use or not use in the process?
- Do you get other information or demands regarding chemicals from your customers?

- What is your opinion on this information? Do you think it is relevant and easy to understand?
- Do you think this information can help you to improve the environmental performance of your production process? How?
- Is there something regarding this information you would like to change?
- How do you exchange ideas and information about chemical use with your customers? Can you describe how it works? Do you do this on a regular basis?

- Do your customers have different demands regarding chemicals?
- How do you handle customers' different demands?
  - Do you separate them or use the same demands for the whole production?
- Do your customers require chemical risk information about your products?
  - What information?
  - How do you communicate the information with them?
- How do you prefer to give information to your costumers?

Raw material

- What is (are) your main raw material(s)?
- Do you test the raw materials for hazardous substances before use?
- Do you achieve risk related information with the raw material?
  - How does the information look like?
  - Is the information enough for your needs?
  - Have you at some occasion contacted the raw material supplier for more information?

Information from the government, laws and regulations

- What information regarding chemicals do you get from the government?
  - What is your opinion on this information? Is it relevant and easy to understand?
  - How often do you get this kind of information from the government?
  - Is there something regarding this information that you would like to change?
  - Do you get information on national or international standards?
- What kinds of laws or legislation influence your chemical use?
  - Have your business been affected by REACH (the European chemical legislation) or by any other international legislation?
- What advantages and disadvantages can you see with the implementation of international legislation within your product area?

Responsibility

- Who do you think should be responsible for minimizing the use of hazardous chemicals in the textile industry?

Labels

- Do some of your customers require eco- or health-labeling? (Oeko-tex, EU-flower, other)
- What are your general opinions on labeling?
- Do you think that labeling might help you promote your products?

Remaining questions

- Do you have anything to add?

Appendix 2 – Interview Transcripts (English)

1. Interview in Sewing Factory A_1, 2009-03-18. City of Dongguan, Guangdong.

Interviewees: Henry Chan (Owner of the factory, As HC), and Quality Control of the factory (QC);
Interviewers: Yuntao Zhang (As YT); Kristin Fransson (As KF)

YT: Are there goals and policies regarding chemical use in your factory?
QC: Yes**.** We make our goals according to the requirements listed in BSCI.
YT: Is there a list of chemicals that should not be used?
QC: Yes. We make the list according to the demands of our customers. Right now we pay more attention on NPEO and formaldehyde. (*Show the list gotent from Company A*)
YT: Do you translate Company A's documents into Chinese by yourself?
QC: Yes.
YT: Where are the main exporting destinations of your products?
QC: Mainly European countries, like Sweden, Norway, Finland and Poland.
YT: Where are your suppliers located?
QC: Most of them are Chinese companies.
YT: What about their size?
QC: Most of them are mid-size companies.
YT: Approximately, how many are they?
QC: Around 12.
YT: What information regarding chemicals do you get from your supplies?
QC: They give us material safety data sheets about chemicals.
YT: Could you show us some example?
(QC *shows the example of the sheets about detergent and some acid*)
YT: What about the fabrics? Is there any chemical information about them?
HC: About the fabrics, there is no chemical information. That is because the fabric suppliers are required to produce fabrics according to our demands. And we also have spot check for the fabric to ensure the quality.
YT: So that means you will give your specific requirements to your suppliers to clarify what kinds of chemicals are not allowed to use in your goods?
HC: Yes. There is commitment about chemical use between us.
YT: Is the information relevant and easy to understand? Do you think you get enough information to know the harm of the chemicals?
HC: Yes. They are easy to understand and enough.
YT: Besides spot-checks, do you have any other measures to make sure your suppliers producing the materials according to your requirements?
HC: Of course. We often visit their factories with appointments to check their production processes.
YT: Do you get some other chemical information?
QC: Company A often has meetings with us, telling us something about their standards.

HC: Yes, we often have meetings and seminars with Company A and ITS lab in Hong Kong.

YT: Do you think the information given by the meetings and seminars is helpful for your production?

HC: Yes, it helps us a lot.

YT: Do you think this information is easy to understand and relevant?

HC: Yes. Our customers and the people from lab always try to give us the information by words which are easy to understand, so we can understand them well. Of course, about the expert chemical information, like the detailed composition of substances, we couldn't totally understand it. But by attending these meetings and seminars, we can know where these chemicals exist in the production process and how to prevent their hazard and eliminate them from the production processes.

YT: Do you have regular meetings with your customers?

HC: No. If our customers don't change their standards, there should be no problem. If they change their standards, they will inform us and make the test processes all over again, checking if there is any hazard chemical.

YT: Do you mean if they change their standards, they will inform you immediately?

HC: Normally, they don't change their standards. The chemicals we pay attention to are chemicals highly focused by European countries. What we take care are chemicals our customers focus on.

YT: Do you think the communication is necessary?

HC: Yes. It is very necessary.

YT: For the workers, do you inform the risk of the chemicals they use in the produce?

HC: Before the workers start their works in our factory, we always tell them the hazards during work beforehand, and tell them how to protect themselves from these hazards. They can choose to work for the factory or not.

YT: Do you test your products for chemical residues?

HC: Yes. But we can only do some simple test, like tests for PVC, nickel and formaldehyde.

YT: So for the rest, I mean complicated ones, you need to send them to external lab?

HC: Yes. Labs like ITS lab in Hong Kong.

YT: What kind of information do you get from government departments regarding chemicals use?

HC: Not so many. But we can use Internet to get some information about Chinese legislations and laws.

YT: Do you think this information can help you on the chemical use in your production?

HC: We only use it as reference.

YT: So that means the customers' requirements are more important?

HC: Yes. That is because the requirements in Chinese national legislation are lower or looser than our customers'.

YT: Do you know REACH?
HC: Yes.
YT: Do you think REACH affects your production?
MC: Not yet. That is because we don't use a lot of chemicals in our production.
YT: Do your products have some labels?
HC: We use Oeko-tex, which is offered by our suppliers. Some of our products in some styles need to have this label.
YT: What are your opinions about the labeling program?
HC: For the business point of view, it helps us promote the competitive strength of our products. From another side, we also want to do some for environment protection.
YT: Do your customers have some requirements regarding labeling?
HC: They encourage us using materials that have labels.
YT: Who do you think should be responsible for minimizing the use of hazardous chemicals in the textile industry?
HC: I think it is both for buyers and suppliers. For the suppliers, if we want to use less hazardous chemicals and higher standards, our cost will be raised and the competitive strength of our products will lose. So that means for buyers, they have the responsibility to set higher standard for the products they need and let different suppliers to compete under the same context.
KF: Who attend the training hold by Company A and lab?
HC: Me and my brother.
KF: Do you find it helpful?
HC: Very useful.
KF: So do you use it in your daily work?
HC: Yes, we can take more care. We don't know much of chemicals. In the seminar, they tell us, in which point the chemical can exist in the chain, we can pay more attention.
KF: About your other customers, do they demand the similar as Company A?
HC: We mainly work for Company A, so Company A's standard is our standard.
KF: For the Oeko-tex, are there many of your clothes that have this label? How many percent?
HC: The buyer will pick some styles to use this label, but not every style.
KF: So is it a few?
HC: It depends on the style of the products.
KF: Is there something you think could be done in a better way?
HC: We want and need to have more information about chemicals. Maybe by seminars, maybe by training, give us some more risk information about chemicals. We can be aware before use. Sometime, it is hard to get such information.
KF: About the local government, they don't give you any information?
HC: No.
YT: Does the government department come to your factory, having some communication with you about chemical use?
HC: Never.

YT: When you get the demands from Company A about which chemicals that are not allowed to exist in the products, but you don't use the chemical directly in your production. How do you give this information to you suppliers, like dying mills and printing mills?

HC： We will translate the testing standards given by Company A into Chinese, then send them to our suppliers and let them analyze. Then after that, they will tell us if they can achieve these requirements, and then of course we need to make some random check.

YT: When you sent you requirement to your suppliers, do they sometimes think your requirements are too strict, and don't understand why they should reach such high standards?

HC: Not really. Our suppliers have already had cooperation with other European customers, so they know the similar requirements and know the European standard very well and that make us easy to communicate with them.

YT: So that means all your suppliers have the business relation with European companies?

HC: Yes. It is very hard to communicate with the suppliers whose markets are only located in China. They use totally different standards.

KF: About your sub-suppliers, are most of them located in this area?

HC: Some of them are, some of them not. But they are all Chinese companies.

YT: One more question. How do you manage this chemical risk information? Do you have computer system or other ways?

HC: No. Only some paper works.

YT: So you think the paper documents are enough to store the information?

HC: Yes, because we don't use a lot of chemicals in the production.

2. Interview in Printing Factory A_2, 2009-03-19. City of Dongguan, Guangdong.

Interviewees: Mr. Zhong (general manager in painting department, as MZ); Mr. Chen (manager who is in charge of raw materials, as MC).
Interviewer: *Yuntao Zhang (As YT).*

YT: When the factory was founded?
MZ: It was founded in 1990.
YT: Where does the investment come from?
MZ: The owner of the factory comes from Hong Kong, so does the investment.
YT: How many employees do you have?
MZ: The total employees in the whole group are 4000. For this factory, the number is about 500.
YT: Where is your main export destination?
MZ: US and European countries.
YT: Is there a specific department in your factory that takes care of the environmental issues?
MZ: Not yet.
YT: What is your position in the factory?
MZ: I am a general manager in the printing department.
YT: Many chemicals, such as dyestuffs and textile auxiliaries, are used in your factory. So is there any chemical that is not allowed being use in the production?
MZ: There are many such chemicals.
YT: Can you show me some example?
MZ: For example the dyestuffs and auxiliaries contain heavy metal and formaldehyde. And also azo-dyes are not allowed using.
YT: Are there goals or polices regarding the chemical use in your factory?
MZ: Not yet. To decide which chemical we can use in the production, we do just as our customers' require. Once our customers change their requirements, they will inform us in time.
YT: From where you buy the chemicals you used in the production?
MZ: We buy the chemicals through the selling agency in China, but their producers are all foreigner companies.
YT: What about the scales of these chemical producers?
MZ: They are all big companies. Like BASF, Clariant and Dyestar from Germany. And there are also products from some Japanese companies used in our production. Their products have good environment performance that is the main reason we choose them instead of the products produced by companies from China.
YT: So you consider the environmental performance first before you make the purchases?
MZ: Yes. Of course.
YT: For the dyestuffs and other chemicals used in your production, do you always use readymade chemicals or is it usual that you make mixture by yourselves?
MZ: For dyestuffs, we need to match the color by ourselves. For other kinds of chemicals, we use the readymade ones.

YT: During the production, how do you get the information about chemicals you use in the production processes?

MZ: This information is provided by chemical suppliers, because only the chemical producers know the composition of the chemicals, so they also need to provide the information about the chemical risk.

YT: Is this information relevant and enough for your purpose?

MZ: It is hard to say. We don't know much about the chemicals.

YT: Besides all the information given by chemical suppliers, do you ask them for other information when you think it is necessary?

MZ: Normally we don't ask any other information.

YT: Are there differences between the information provided by different chemical suppliers?

MZ: I don't know much about that.

YT: Do you have some communication with chemical manufacturers?

MZ: No we don't. This kind of communication is impossible for us. We can only make the communication with some selling agencies. (*Note: The information here is conflictive with the information given by MC later.*)

YT: Besides these general introductions about chemicals, do you get complete lists of the contents about the mixed chemicals you use?

MZ: Getting the detailed component information of chemicals is impossible for us. The contents of the chemicals are business secret for these manufacturers, so we can only know very rough contents.

YT: Do the suppliers give you some information about chemical risk information or ask you about how you use the chemicals?

MZ: No, it doesn't work in that way. The real situation is that they provide the chemicals we use according to their use instructions. If we have some problems during the usage, we should come to them and ask for resolution.

YT: Does it occur that a chemical supplier gave you suggestions that you should change a specific chemical? Or you decide to substitute one chemical with another, based on their environmental and health performance?

MZ: No. The selection of chemicals is based on the requirements of our customers. We need to know our customers' requirements about chemicals. All we need to do is find the right chemicals to fulfill our customers' requirements. We don't need to change the chemical use by ourselves.

YT: Do you test your products for chemical residues?

MC: Yes. But we can only do some simple test, like test for formaldehyde. For other complicated ones, we need to send the samples of our products to external testing lab.

YT: Do your materials have material safety data sheets? Do you have a system for MSDSs?

MZ: We have MSDSs, but we don't have the system for it.

YT: Do you use computer software to handle the chemical information?

MZ: No.

YT: Before the workers start to work in the factory, do you inform them about the health risk the may face in the production?

MZ: Yes. We will inform them how to use the protecting equipments during the production.

YT: Do the workers realize it is a risk when they handle the chemicals during the process?

MZ: Yes. There are strong smells in the workshops, so I think they know that.

YT: Do you know the average education background of the workers in your factory?

MZ: I can't tell it exactly. But I think it should be about middle school level.

YT: Do you have regular training for the workers to tell them how to use the chemicals safely?

MZ: Yes, we do.

YT: When the workers have difficulties on understanding the chemical risk information, do you try to rearrange the information to help them understand?

MZ: No. That never happens.

YT: If the workers feel uncomfortable when they contact with certain chemicals, do they ask the company for changing the chemical for another one?

MZ: If there is this kind of situation, we will contact the chemical suppliers, and let them help us solve the problem.

YT: What about your customers? Are they Chinese companies or foreign companies?

MZ: All our customers are Chinese companies. But all their products are exported to US and European countries.

YT: Do your customers set demands on your chemical use?

MZ: At first, we give samples of our in-use chemicals to our customers for tests to see if the chemicals we use can fulfill their requirements. The sewing factories and their customers have discussion about their requirements every year, and then tell us if there is something new or changes for their requirements. We just follow their requirements in the production.

YT: Do different customers have different demands regarding chemicals?

MZ: Yes, they have different standards. But we use the highest requirement or standard for all of our products. It is easier for us to manage the production in this way.

YT: Except all the information you give, do your customers ask for future information about chemical risk?

MZ: If there were quality problems with our products, they will ask. But normally they don't ask.

YT: Do you think the discussion and communication about chemical use between you and your customers help you in chemical use and improve the quality of your products?

MZ: Yes. That is the reason why we cooperate actively with our customers to reach their requirements.

YT: What about the fabrics? Do you get chemical information about them?

MZ: We don't know much about that, because all the dyed fabric we used is provided by the sewing factories, we just print patterns on them and then we send them back to

those factories. It is not our responsibilities to know the chemical information of fabrics. This information should be provided by the dyeing mill.

YT: Do you get information about chemical use from government departments?

MZ: No, they never give us information about those. They only care about waste water discharge. They never ask the management about issues inside our companies.

YT: How many products in your company are applied for labeling?

MZ: (*Show the Oeko-tex standard 100 label*). Do you ask for this? We don't ask our suppliers for labeling of their products. As long as their products don't have any hazard substances, it will be fine. What we need are the hazard-chemical-free guarantees from the suppliers. And we also make assistant tests to ensure the quality of the products they provided.

(*The following contents is the transcript from complementary interview with Mr. Chen*)

YT: Indeed, does your factory have direct contact with the chemical manufacturers?

MC: Yes, we can. Only the money flows of buying chemicals are through the purchasing agencies. We have direct communication with manufacturers to get the chemical risk information.

YT: Besides the introduction about the chemicals, you can also get chemical risk information?

MC: Yes.

YT: Could you make a short description about such information?

MC: For example, some of the chemicals are in very high concentration, so the information tells us how much water we need to dilute them with certain volume of water.

YT: Is there any other information about the health and environmental risk among this information?

MC: Yes.

YT: How do you manage the chemical risk information?

MC: Some of them are stored in the computer; for some of them we use paper document to manage.

YT: Do you have safety data with every purchasing group of your materials?

MC: Not every purchasing group, but with every kind of material.

YT: Regarding the chemical risk information, is there any difference between the chemicals produced by different suppliers?

MC: They are almost the same.

YT: Do you require some further risk information from the suppliers beside the information they provide?

MC: We do not require. But every year our chemical suppliers invite us to their new products promotion conference, we can get some information there.

YT: Do you have meetings with your chemical suppliers about the chemical risk information and other chemical related issues?

MC: Yes, they often visit our company and find out if there are some problems with their products we use.

YT: Does somebody in your company take care of the interpretation of chemical risk information?

MC: Yes. I do this job.

3. Interview in Dyeing Factory A_3, 2009-03-20. City of Huizhou, Guangdong

Interviewees: Mr. Jiang (As MJ) and Mr. Li (As MLE) - Engineers; Mr. Li (As ML) - Communicator; Mr. Zhong (As MZ) - Manager of the factory.
Interviewer: Yuntao Zhang (As YT); Kristin Fransson (As KF)

(*The following question is for communicator Mr. Li*)
YT: Could you make a short introduction of your factory?
ML: this dyeing mill has opened 20 years ago, our products are mainly provided to the garment factories who export their products to foreign countries.
YT: Where is the source of the investment?
ML: The investment is from Hong Kong.
YT: Are your fabrics directly exported?
ML: A few of them export to Hong Kong, most of them are sold to the factories in Pearl River Delta.
YT: Are there people in your company responsible for environmental and chemical risk issues?
ML: Yes. Mr. Jiang and Mr. Li are the chief engineers in the company who taking care of these issues.

(*The following question is for the two engineers*)
YT: How long have you been in the area of textile dyeing?
MJ: For me, it is about 20 years.
MLE: me to, 20 years.
YT: Could you tell me what are your main responsibilities in the factory?
MLE: I mainly take care of the environmental issues, such as waste water treatment.
MJ: I mainly take care of the internal management of the factory.
YT: What are the main chemicals you used in the factory?
MJ: Mainly reactive dyes and auxiliaries.
YT: Are there chemicals you have decided not to use in your factory?
MJ: The dyestuffs and assistant agents that are banned by national legislation and hazardous chemicals. All the chemicals we use in factory are proved by tests as of no harm.
YT: Are there goals and policies regarding chemicals use in your company?
MJ: No. But when the new employees start to work in the factory we have introduction for them about how to use the chemicals and the how to protect themselves from the harm of the chemicals.
YT: Where do you buy the chemicals? From China or from foreign countries?
MJ: Both from China and other countries, like Japan, India. Also from Taiwan.
YT: What about their size?
MJ: All of them are big companies.
YT: What the characteristic of a chemical company do you consider before your purchase?
ML: The main issue we think about is if their products quality can fulfill our requirements or demands. We will make some tests by ourselves and sent them to the

lab as well, checking if the chemical match the requirements of our customers. Moreover, we need to consider the size of the manufacturers, because the products of bigger companies normally have more stable quality.

YT: Do you always use the readymade chemicals or is it usually that you make mixtures by your own?

MJ: We mainly use the products which we buy directly. We normally don't mix chemicals by our own.

YT: Why do you operate like that?

ML: That is because we want to simplify the operational processes and guarantee the quality of our products. After all, the chemical suppliers know these chemicals better than we do. Of course, for the dyestuffs we need to make and adjust the right color by ourselves.

YT: How do you achieve the risk information about the chemicals you use in your production process?

ML: we will make some evaluation of the chemicals.

YT: Could you tell me something about the process of the evaluation?

ML: For example, when using hydrogen peroxide which has causticity to skin, we need to make sure to inform about the ways by which the workers can use it safely. Similarly, for some dyestuffs, we need to use the safe dosage. The safe operation method is also the issue we have to address.

YT: Do the chemicals used in your company have MSDSs?

MJ: Yes. And in the packages of the chemicals, there are instructions about the harm of chemicals.

YT: Do you think the chemical risk information given by the chemical suppliers is relevant and easy to understand?

MJ: Yes, they are.

YT: How do you manage and store this information?

MLE: We make different copies of the information. The company lab, chief engineers and the manager of the company keep one copy each.

YT: Do you think you can get the chemical information you need smoothly?

ML: Yes, of course.

YT: Is there any difference between the information provided by different chemical suppliers?

ML: The general information they give is more or less the same. There are only a few differences in detail.

YT: Is it usual that you request future information from the chemical suppliers besides the information they provide?

ML: When the chemicals arrive to our company, we will use small amount of the chemicals at very first time and test the performance, once if there are some problems, we will contact the suppliers and let them help us solve the problems.

YT: Do you get a complete list of the mixed chemicals you use?

ML: No. We can only get the rough composition of them.

YT: Do the workers know the hazard of chemicals they work with? Do you keep copies of risk information of the chemicals?

ML: Yes. We must keep the chemical risk information by ourselves. For workers, only when they know how to work with the chemicals safely, they can start to work.

YT: When you know the harm of the chemicals, do you try to find ways to lower the harm, for example, try to use other chemical instead?

MLE: Of course. Because we use chemicals with high toxicity and harm, not only for their harm when using, also rise our cost of subsequent treatment of waste**.**

YT: Do the suppliers know how you will use the chemicals?

MJ: Yes. After the use, we will have communication with the suppliers, they also come to use for instruction and demonstration.

YT: Besides how to use the chemical, if you have other problem like some workers are allergic to some of the chemical, do chemical suppliers help you solve?

ML: Of course, they do.

MJ: But until now, we haven't had such problem yet.

YT: Do you set demands to your chemical suppliers on chemicals?

ML: Yes. We do not allow using chemicals which content components are banned by the national laws. And that is not allowed by our customers also.

YT: Have you ever cooperated with your chemical suppliers to change one chemical to another that is less dangerous to the health and environment?

ML: Yes. We used to use the one kind of powder calcined soda before. The content of effective component of this chemical is low; moreover when being used, the powder flows everywhere. Then the suppliers recommended us changing to another kind of particle soda which also has high purity. It doesn't cause the problem of small airborne particles' runaway.

YT: When you decide to change a chemical, what are the main reasons?

MJ: One reason is from the point of their environmental performance; the other is the normal upgrade of the chemicals. And the requirements by legislation are also reasons for changing our chemical use.

YT: Could you tell me the process of these kinds of changes?

MJ: Chemical suppliers will give us some samples, and we will test these samples for their performance. And we also send them to the lab, to check out their environmental performance and if there are any hazard chemicals in them. Only when both of the two sides go well, we can use the new one.

YT: Do you test your final products for chemical residues?

MJ: Yes. But we can only test some simple indicators, like doing the tests for pH and formaldehyde. For some other complicated tests, we have to send samples to external lab.

YT: How do the workers know the risk information about the chemicals which they work with?

ML: Before they start to work in the factory, we give them some lectures and basic training about chemical use and safe production.

YT: When you decide to use a new chemical, do you make some specific instruction for the workers?

MJ: Yes. We have regulations about this kind of instruction. Every time we change a chemical, we will inform our workers first and then give them some training about the chemical.

YT: Workers have different education background, if they don't understand the chemical risk information you give, do you try to reformulate this information in order to facilitate their understanding?

ML: When we select the workers, we will choose the person who is clever. Moreover, the workers who have some working experience are preferred. For the new workers just starting to working in the factory, we normally don't let them work in the production line and make direct contact with chemicals. After a while of training, only when they know the processes of working with chemicals, they can start working in the production line.

YT: Do the workers have chances to influence the decision of chemical use in the factory?

MJ: Not really.

YT: Do your customers set demand on the chemical contents of the final products?

ML: Yes. The products we produced must fulfill the requirements of our customers. The final buyers (*Note: which means "customer's customer", like Company A*) give their requirements to us. The quality of our products must reach the final buyers' demands. At the same time, we also send our products to external testing labs, seeing if they can fulfill the requirements of our customers. When lab tests finish, we will send the report and samples of products to our customers. Our customers may also test our products once again. Only when every party feels satisfied about the products, our companies can say the quality of our products is fine.

YT: Do you have communication with your final buyers?

ML: No communication. We only contact our direct customers.

YT: So does that mean you get your final buyers' requirements about chemical from your direct customers?

ML: Yes.

YT: What other demands or information regarding chemicals do you get from your customers?

ML: Our customers often update their information about chemical use and give the new information to us in time. The related legislation in our final buyers' countries will be changed, and the quality of our products will be changed accordingly. We have very close communication with our customers.

YT: What is the way you and your customers make the communications?

ML: Mainly, we often visit our customers, making communication about their requirements and demands. Of course we also make the communication by phone.

YT: Do you think this information can help you improve the environmental performance of your production process? How?

ML: Of course. With higher requirements, the quality of our products is also going higher.

YT: What do you think about the information your customers give to you? Is

there something that needs to change?
ML: Not many things need to change. I think their information is relevant and easy to understand, as well as relatively complete.
YT: Do your different customers set different demands on your products?
ML: Yes.
YT: How do you handle them? Together or separately?
ML: We handle them according to different customers' different requirements.
YT: Do your customers require risk information about your products?
ML: Yes. They require this information constantly. Furthermore, they check our products' quality regularly, and some of the check is without appointment.
YT: What is this information all about?
ML: Mainly about if the products contain hazardous substances, such as azo dyes, heavy metals, NPEO and so on. They also give us some advice about our auxiliaries' selection.
YT: Do they also recommend you some chemicals with less environmental effects?
ML: Yes.
YT: Do you like to make the communications with your customers? What form of the communication do you prefer?
ML: Yes, we think they are very necessary. We prefer the face to face communication. We usually send our technician to the customers.
YT: What are the raw materials of the company?
ML: Mainly knitted fabrics, dyestuffs and assistant agents.
YT: Where do you buy you material of knitted fabrics? Do you get the chemical information with the knitted fabrics?
ML: We buy them directly from our suppliers. Because of there are not so many chemicals used in the production of grey cloth, so we normally don't ask the chemical information for them. But we make a fine selection about the grey cloth suppliers. We also test the grey cloth in our factory.
YT: Test for what?
ML: Mainly pesticides.
YT: Do you get chemical use related information from governmental departments?
ML: We get some information from ministry of environmental protection.
YT: Do you think the information is relevant and helpful?
ML: Yes. But this information and requirements given by government are looser than the requirement by our customers. So, for us, only following the national legislation is not enough.
YT: Do governmental departments come to your factory and check the chemical use in the process?
ML: Yes.
MJ: They often make irregular checks without any appointment. We are the first factory which fulfills the clean production requirement in this city.
YT: Do you think any other legislation affect your chemical use?

ML: The external ones are all we mentioned before. But we have the regulations established by our own, which can also be a kind of restriction to our production.

YT: Do you know REACH?

ML: We heard it before, but we don't know much about it. We are still in the phase of information collection.

YT: What do you think about labeling?

ML: It can help us improve the quality of our products, and promote our products' competitive strength.

YT: Do your customers require labeling for your products?

ML: Yes. Mostly, our customers require that our products can fulfill Oeko-tex standard 100 standards.

YT: Who do you think it should be a responsible for minimizing the use of hazard chemicals in the textile industry?

ML: I think it is a sensitive question. We couldn't simply say it is the responsibility of government or the factories. Right now it should be the response for every part.

YT: You set the standards of chemicals in your final products, what is the purpose of doing that? Don't use them in the process or decrease the concentration in the end?

MJ: The purpose of having the standards is making a restriction to us. The goal is decreasing the use to the lowest level and finally not using hazardous chemicals in the process.

YT: What is the percent of your products has the label?

ML: Almost all of them.

YT: Do you have the instructional labels about how to take and store the chemicals outside containers?

MJ: Yes. We only use the containers which originally contain the chemicals and we never change chemicals' container as long as they are going into our factory.

KF: Do you get the MSDSs when you buy the chemicals?

MZ: Yes, we do. I can tell to you what we said before: when we have some new workers, they will be told and explained about safety standards of the dyestuff. We need to make sure they have some simply knowledge about how to use those dyestuffs. The Chinese government also keeps updating the internal standards, and they also have checks in our factory whether we can meet the standards. Also, our customer will send us new information about chemical use standards. As you can see, a lot of our products get certification. It is not easy to get and we do a lot of jobs

KF: When you get the certificate, are your products easy to sell?

MZ: Yes. Nowadays, the European customers always require Oeko-tex standard. Not all the Chinese factories can follow the standard. So that means our products' quality is promoted to a higher level. (Shows the paper about the label.) Here is something about how we get the certificate, it based on all the testing from ITS. These tests are about our materials. Not only chemicals, even the water need to be tested.

KF: About the MSDSs, you keep the copies, if someone wants to see them, they can read?

MZ: Yes. They can.

YT: Do you keep the information by computer?
MZ: Yes.

4. Interview in Sewing Factory B_1, 2009-03-24. Municipality of Shanghai.

Interviewees：Zifeng Zhong (Business manager from Sewing Factory B_1, As ZF); Anny Zhao (From Company B, As AZ);
Interviewer: Yuntao Zhang (YT).

A short introduction by Anny Zhao: Besides this factory, the group which the factory belongs to also have dyeing and painting mills in An Hui province. They also have sportswear factory in city of Tongling, AnHui. Overall, there are roughly ten factories in this group, and the total employees are 7000. In this factory, there are about 1800 workers. Their main markets are Europe, Japan and US. Their investments are both from Hong Kong's and local source.

YT: Are there chemicals that are not allowed to use during your factory's production?
ZF: There are a lot of such chemicals. Beside the chemicals don't allowed to use according to the national legislation, we also make the list of prohibitive chemicals according to our customers' demands. For example, cancerogenic and allergy-causing dyestuff, formaldehyde, APEO, organic solvent, pentachlorophenol, tetrachlorophenol, some organic chloride carriers, and some heavy metal are all in the list.
YT: Does that mean your factory makes the chemical related standards based on their harm to human and environment, and also the national and European legislation?
ZF: The products of us are both exported to foreign markets and sold inside China. We must make sure that the products we provide to our consumers are safe to be used. At the same time, making these higher standards can also facilitate our sale when competing with our opponents. We must make sure the materials we use can comply with the local requirements in each country. In addition, consumers don't have the professional knowledge to tell the state of chemical safety of products, so the producers should hold the responsibilities to control the product quality, and be responsible to the health of consumers.
YT: Are there goals and policies regarding the chemical use in your company?
ZF: There are people in our factory taking care of the chemical safety issues in purchasing part, also there are people take care of chemical safety inside the factory. Collectively, there are two aspects of the task. On one hand, we control the quality of the chemicals which are provided by the chemical suppliers; on the other hand, when we make communications with the dyeing and painting mills, we will come to a common idea with them, letting them realize the importance of chemical risk control. That means changing their essential understanding of chemical risk, making them know the environment belongs to everyone, instead of letting them follow our demands passively.
YT: Can you make a short description about how you control the chemical use of your suppliers?
ZF: We need to make the evaluations about if one company has the qualification to become our supplier. This includes three aspects: first, we must evaluate their

products, what kind of products they can produce and how about their products' quality; second, do they have the right competence to become our supplier; third, we will do some investigation about their inner management. That is because if the management inside one factory is in the state of chaos, of course we can't rely on them and make any further cooperation with them. At the same time, we also communicate with our existing suppliers, helping them improve their ability of management. By doing so, we can find some producers which we can have long-term cooperation with. For these suppliers, we only need some periodic supervision and spot-check to assure the quality of suppliers' products, instead of check every single point in their production chain. All our company need is partners who can do self control.

YT: Can you tell me where do you buy the chemicals you use in the process? In China or overseas areas?

ZF: Both. We don't have some worshiping kind of believes, so to speak, about overseas companies. The chemical industry in China has developed rapidly recently. As long as Chinese chemical producers can fulfill the requirements of our production, we will buy their products. Compared to foreign products, local products of the same quality are cheaper actually.

YT: What about their scale?

ZF: Generally, most of the dye producers are big companies, because their products are stable between each set; but when it comes to auxiliaries, the normal scale producers and domestic producers can fulfill our requirements well.

YT: Do you always make evaluation about the suppliers before you made the purchase?

ZF: Definitely.

YT: Do you always use readymade chemicals or is it usual that you make mixtures by your own?

ZF: Normally we don't mix chemicals by our own.

YT: How do you achieve risk information about the chemicals you use in the process?

ZF: We will ask the chemical suppliers for MSDSs. But in China, normally the chemicals suppliers are not asked for MSDS, they only need to provide instruction of using. Chemical safety is the issue which is rarely considered in China right now.

YT: But our company is an exception?

ZF: Yes.

YT: What about Chinese legislation on chemicals' MSDSs?

AZ: The situation in China now is although the national standards have the criteria about making MSDSs and also require the chemical suppliers provide MSDSs with their products, but the most buyers don't ask for this information. They only care about how to use the chemicals.

ZF: For our suppliers (*Note: here mean fabric suppliers*), we will go and understand their production techniques. For each chemical used in every working procedure, we ask our suppliers for detailed information, including the information about chemical producer and MSDS. If the suppliers can reach our demands, they don't need to

change their techniques. After all, it is necessary to maintain the stability of the techniques.

YT: About the information given by the suppliers, are they easy to understand and relevant?

ZF: It depends on which company. Some of the suppliers don't understand why they should give such kind of information; they think if the user wants to know the detailed information of the chemical you can do the tests by yourself. But, we know as a user the acquisition of chemical risk cannot simply rely on some tests. There should be more communication between our suppliers and us, let them know more clearly about our intention.

YT: So that is to say, in China there are many companies that still don't understand why they are bothered to give such chemical risk information like MSDS.

ZF: Yes, there are many. A lot of chemical suppliers don't have direct connection with our factory. They have direct relation with dyeing and painting mills, but the products of the dyeing and painting mills don't export. So we need to make communication with the dyeing and painting mill, thereby coming to the common ideas about chemicals use.

YT: How do you interpret the chemical information?

ZF: It is not difficult for us to understand such information. But we have nothing to do to distinguish the right or wrong of the information.

AZ：Factory B_1 only responses for sewing; and the quality control of ready-made clothes, ensuring all the workmanship is fine. But I am responsible for Company B's chemicals control, and I organize all the training both for Factory B_1 and their suppliers (*Note: means dyeing and painting factories*). I also get the support from the chemical companies, get them understand what MSDS is, and how MSDS is used. We have this kind of setup according to the practical situation. We also have the goals, such as the standards which we need to reach in each year. So we start from a blank paper where nobody knew what MSDS is, who need offer this. At the very beginning, MSDSs were used to be issue by the trader, because of a lot of chemicals are sold indirectly by the trading agencies instead of manufacturers. But now we can get the MSDS from chemical manufacturers and we also can have the direct communication with them. So now, they are quite clear about our requirements. When the chemicals manufacturers sell dyes to the dyeing mill, they will ask dyeing and sewing factories about the kind of end customers for the fabric, so they can recommend their different products to the users.

YT (*question to Anny Zhao*): So that means you not only contact with your suppliers, but also your suppliers' suppliers.

AZ: Yes. Because this is related to the chemical use, we need to know the sources of the chemicals. Where is the main part, and where is our partner in the production chain and who can help us reach our requirements.

YT: So this means, for important chemical risk information, both Company B and Factory B_1 can get it from chemical suppliers, right?

AZ: Yes. But three years ago, it was not an easy task. At that time, our sub-suppliers all signed the papers to declare their products fulfill our chemical requirements. But when we asked them the questions such as "how did you reach these goals", "how did your reach these APEO requirements", "how were these fabrics were made" and "what kind of chemicals were applied in the production", they didn't know. So three years ago, we started a heavy work. (*Then Anny Zhao and Zifeng Zhong show the example required documents for one kind of fabric. They are: the producing processes; in each process what kind of chemicals are used and the suppliers of the chemicals; when the MSDS of chemicals such as dyestuff was issued; the confirmation letter of the fabric manufacture for their compliance of Company B's specification; and the supporting document for each chemical from both chemical suppliers and dyeing and painting*).

YT: For every kind of fabric you do this?

AZ: Yes. Even for zippers and accessories. We also have the meeting with the chemical manufacturers and do get a lot of useful information. Since the chemical suppliers have also known our requirements, they can even give suggestions to the dyeing and painting factories about proper chemical selection. At the very beginning Factory B_1 mainly controlled the quality by tests, they even built their own lab. But we say no to them. It is impossible to assure the quality of all the products through several random tests. What we need to do is control from the source. The tests can be only used as verifications method.

YT: How can you make sure all the declarations made by the suppliers are trustful?

ZF: First, all the self declarations is based on the MSDSs. But if the MSDSs are not reliable, we can do nothing. Secondly, we will make tests.

YT: What are the differences between domestic and foreigner suppliers in providing the chemical safety information?

ZF: Foreigner suppliers' information is accurate and complete as well. The large companies in China can almost reach the some level of foreign companies. But the small and middle size companies usually only sell their products, lacking of chemical risk information, including MSDSs. Me and the people from Company B often reach the chemical suppliers, and have discussions with them, letting them know and accept the concept of our chemical safety standards.

AZ：For our company, we give the suppliers and sub-suppliers the clear signal that "no MSDS, no purchase". We also try to distinguish chemicals with low risk from the high risk ones, and then we could pay more attention on the ones having higher chemical risk. We also have started another work to concentrate our chemical suppliers: now we have direct communication with several big chemical suppliers; for the smaller ones, we really want to merge them together, it will be easier for us to communicate and control.

YT: What is the composition of your (*Factory B_1*) customers?

ZF: 90% of our customers are overseas customers, the rest are domestic customers.

YT: Do the customers set demands on the chemicals of the final products?

ZF: Yes. But we know that the limit level of chemicals doesn't mean we can use the chemical until it reaches this level. The purpose of set these demands or limits are to totally get away from the pollution of these chemicals when being used.
AZ: We set CLV, which means *concentration limit volume;* they are normally in PPG level. The main purpose of setting is to not use them and not appear in our fabric at all.
YT (*question to Zifang Zhong*): What do you think about the chemical limitation set by your customers? Are they relevant and easy to use, helping you control the quality of your products?
ZF: From a producer's point of view, the more limits set by the customers the harder we need to work. At the beginning, it is easy for us to regard these limits as hurdles or barriers which may bring more difficulties to our production. In China, it is a difficult thing to make any change in some in-using techniques, and no one really wants to. But when we finally made these changes and reach our customers' requirements, these limits do become the advantages of our factory and products in business competition. For the long-run, these limits can also help the society protect the environment.
YT: So you think they are helpful?
ZF: Yes. At first we are reluctant to accept these requirements, but now we are their supporter.
YT: Do you think there are any improvements needed for the information?
ZF: It depends on which customer. If some of our customers give us the information or requirements we never face before, they can be very good for us to improve.
YT: Could you again specify the process in which you and your customers exchange the chemical risk information?
ZF: First, we will make a face to face discussion about the requirements for chemical use. In the discussion, we will reach every detail. Before we contract with our suppliers, we also discuss about the requirements set by our customers and let them know these requirements clearly. The purpose of doing like this is to avoid any risk.
YT: It seems like you and your customers have very tight communication.
ZF: Yes. Sometimes our customers and we will go together to the dyeing and painting mills, and even the factories of auxiliaries' suppliers.
YT: Do your different customers set different requirements about chemicals?
ZF: Yes, they do.
YT: How do you handle these differences?
ZF: All of our products need to follow the most rigorous demands. Actually, we adopt the most rigorous demands as the standards of our own specification.
YT: Inside the factories, do your employees regard it a risk to handle the cloth?
ZF: Yes. We have regular training for the workers. We also have plans to handle any kind of emergency.
YT: Would the workers be told about the risk before they start to work on the producing lines?

ZF: Yes. We must make sure they know the risk and how to handle emergency before they go to the production lines. Our management of the lines follows the requirements of ISO 9000 Quality Management System.

YT: By which standards you use, when you test the level of chemical residues?

ZF: Both by national standard and the demands of customers.

YT: Which information regarding chemicals do you get from the government?

ZF: When there are new requirements about chemical use, General Administration of Quality Supervision, Inspection and Quarantine of P. R. China will inform the companies.

YT: Do you think there are differences between China's national standards and European standards?

ZZF: Yes. The establishment of national standard is relatively delayed. Some chemicals which have already been regarded as hazardous and are banned in Europe can still be used in China without violating any national legislation.

YT: Is there something regarding this information that you would like to change?

ZF: Of course. But the most important thing is not about changing the contents. They need to increase the implementation capacity of existing legislations and laws.

YT: Has your business been affected by REACH or by any other international legislation?

ZF: Right now, I think the influence of REACH still mainly stays on the raw material suppliers; the influence for us is not so big yet. But I am afraid with further implementation of REACH, our production will be directly affected.

YT: What advantage and disadvantage can you see with international legislation within your products area?

ZF: There are the two sides of the same thing. If you couldn't reach or fulfill these legislations and standards, of course they are a disadvantage; but once you can breakthrough, they will become an advantage, become a competitive strength in market.

YT: Do some of your customers require any eco- or health-labeling?

ZF: Yes.

YT: What are your general opinions on labeling?

ZF: The labels such Oeko-tex need to make authentication on each part of the product chain and each component of the cloth. It is too hard for us to imply. With the same money and work load to apply some label, we can do a lot of other things. We try to apply, but fail.

YT: Who do you think should be responsible for minimizing the use of hazardous chemicals used in the textile industry?

ZF: I think the government and cloth producer should. But the dyeing and painting mills should change their techniques to reduce the chemical use.

5. Interview in Dyeing and Printing Factory B_2, 2009-03-24. Municipality of Shanghai.

Interviewees：Mr. Ding (Chief Engineer, from Factory B_2, As MD); Anny Zhao (Local purchasing manager from Company B, As AZ);
Interviewer: Yuntao Zhang (YT)

A short introduction from Mr. Ding:
MD: Since my graduation from university, I have paid attention to the development of printing and dyeing techniques in textile production and also the management of those techniques. Now, I mainly take care of the management of the whole factory, which includes producing techniques and its development. Compared to other companies in the market, we set relatively higher requirements about environmental standards. To reach the high environmental demands of our final products, we investigate our chemical suppliers and also other raw materials suppliers. First, we check if they have the right manufacturing ability; second, we will take constant inspection on their products. We check all the dyestuff and auxiliaries both regularly and irregularly. We also need our suppliers make pledge to ensure their products not contain APEO, formaldehyde, heavy metal ions and other hazardous substances. We have routine training for the workers to make sure they know the requirements of our customers on chemicals. We also need to make sure the workers know how to work with chemicals safely. We believe we share the same interests with our customers. Although we couldn't make sure we can 100% control all chemicals in the production, we try our best to reach the hazard-free goal and make everyone in the company know the importance of chemical control and environment protection.

YT: Is there any chemical is not allowed to use in your factories?
MD: Yes. For example, as I said before, we can't use chemicals contain APEO, pentachlorophenol, heavy metal ions, formaldehyde, organotin and so on**.**
YT: So, what is the reason to make this prohibition?
MD: Because all of these chemicals have hazardous effects to human body. Some of them have negative effects to respiratory tracts; some of them have negative effects to skins. Some of the effects will appear after a while. Moreover, all of them have negative effects to eco-system.
YT: Are there goals or policies regarding chemicals use in your company?
MD: Yes. First, we require there should be no dyestuffs and auxiliaries which have negative effects to environment and human body used in the production process. Based on these requirements, the dyestuffs we use mainly come from big foreign companies. For the auxiliaries, we have strict selection before we decide which ones we can use. And we also tell the suppliers which substances are not allowed to be contained in the raw materials we order.
YT: What characteristics of a chemical supplier do you consider before you purchase chemicals from it?
MD: First of all, we need to make sure the company has the manufacturing ability we require; second, the company must be trustful and also have sense of holding

responsibilities for the whole society; thirdly, we evaluate their producing operation against certain criteria; finally, we also need to know if the leaders of the company have the ideas about environmental protection. If a company leader doesn't know the importance of protecting environment, it is hard to guarantee the quality of their products.

YT: Do you always use readymade chemicals or is it usually that you make mixtures by your own?

MD: All the dyestuffs we used in the production can be divided into two broad categories: one is the imported dyestuffs the other is dyestuffs which is produced by domestic factories. The imported dyestuffs come from the world famous companies such as Dyestar and Ciba, the domestic ones all come from big companies in China. For the auxiliaries, a little part of them is imported; the rest is produced by big Chinese chemical companies.

YT: So, that means you don't mix the chemicals by your own?

MD: Yes.

YT: How do you achieve risk information about the chemicals you use in the production process?

MD：First, we can get this information from the academic literature about dyeing and printing; Second, the information from some national departments; third, the technique communication with some big foreign companies is also an important channel.

YT: Do MSDSs always come with every purchasing group of chemicals you used in the factory?

MD: Not with every group. We have the MSDSs of all kinds of chemicals. And all of the chemicals will be sent to test regularly, to make sure they can meet the standards set by our customers.

YT: Can you get the information you request from the chemicals suppliers?

MD: Yes. First, we often invite our chemical suppliers to visit our factories, let them know the requirements of our customers; second, our suppliers also ask us about our new requirements or standards on chemical use. In one word, by both coming out and coming into our factories, and the bilateral communication, we and our chemical suppliers know each other's demands very well.

YT: About the information the suppliers give, is there any difference between chemicals produced inside and outside of China, and big and small or moderate scale companies?

MD: The information from big foreign companies is normative; it is formed in a systematic and scientific way. It can introduce the chemical risk in detail, and gives you the information about both the hazards and the way to keep these hazards away. Comparing to the information given by foreign companies, the domestic producers normally provide very simple information; and it is mainly about how to use the chemicals.

YT: Besides the information provided by the chemical suppliers, do you usually request future information from the chemical suppliers?

MD: Yes, of course. For example, the producers' production capacity, how the producers' quality control systems work, as well as the personnel turnover of their

quality inspection group.

YT: Do you get a complete list of the mixed chemicals you use?

MD: For the basic list, we can get. For the dyestuff the complete lists are business secrets, and it is impossible to get. For the auxiliaries, the suppliers provide us the basic component list, and we also roughly know their contents. What we worry about is some impurities or hazardous substances that are mixed with the material chemicals by mistake. We often remind our chemical suppliers to avoid such mistakes.

YT: Do you set demands to the suppliers on chemicals about what chemicals you don't allow in the products?

MD: Yes. We follow the requirements of our customers and pass this information to our suppliers. We sent the original copies of our customers' demands to the chemicals suppliers. If they don't understand some parts, we do the interpretation for them. If there are some parts we also couldn't clearly understand, we need to come to our customers (*Note: like Factory B_1*) for explanation, even our customer's customer (*Note: like Company B*). The thing we must make sure is that we can and do transfer the requirements about chemical use of our customers to our suppliers from beginning to end.

AZ: For the standard related communication, there were some misunderstandings before: We passed our specification on to Factory B_1 first. For the purpose of keeping business secrets, Factory B_1 only abstracted some important information and gave it to their suppliers. And this kind of abstraction kept from one level to another. The result was some information was lost in each level, or some information was misunderstood by different people. Finally, we decided to give the full original versions of standard documents to our suppliers and even sub-suppliers. But sometime even when we try hard to make the information to be passed through different factories word by word, the misunderstanding is unavoidable.

MD: Yes. That is why we need to make sure all the original information can reach our suppliers timely. Even when it is in English, we never translate it. Furthermore, as I said before, we need to make face to face communication with our chemical suppliers.

YT: For the chemical suppliers, do they know what the chemicals are used for?

MD: Yes, they should know. There is only one circumstance that can cause misunderstand between us and our suppliers. That happens when our chemical suppliers change their quality inspection personnel. So always involve them in these procedures. The purpose of doing so is to make sure the new quality-inspectors know how we use the chemicals and our requirements. What we need is the continuity of our demands and requirements to suppliers.

YT: Did you have the experience of changing one chemical with another one?

MD: Yes, we do.

YT: What was the main reason?

MD: When the cost of purchasing one kind of auxiliary is too high we will consider change it with another. When we do the change, three aspects must be checked: first, quality of the new auxiliary; second, the environmental performance of it; third, the price of the new chemical.

AZ: Also we, as a customer, need to know the procedure of any chemical chang.

MD: Of course. During the last three years we only changed one domestic produced auxiliary to another imported one. The reason was to cut down the energy and water consumption during the production.

YT: Could you tell me something detail about the change?

MD: Normally we don't change chemicals we use in the production. We have deals with our customers and their customers, like Company B and Factory B_1, we need to keep the stability of our chemical use. Many changes of chemical use will cause the instability of products' quality**.**

AZ: We encourage all the changes which lead to good results, but we need to know any possible change first, and know the whole changing process.

YT: Do you test the products for chemical residues?

MD: Yes. That is one important requirement from our customers, and it is also a way to ensure the quality of our products.

YT: What are the standards you use during these tests?

MD: Mainly the customers' requirements and also requirements from customers' customer. For example, the requirements of Company B are as important as Factory B_1's to for us

YT: How is chemical information handled within your factory?

MD: It is the responsibility for the *Office of Chief Engineer*. First, our workers at *purchasing department* sent our requirements to our suppliers. Suppliers need to send their products for testing; the results of tests will be hand to our company's *techniques department* for evaluation. The result of evaluation will be finally checked by *Office of Chief Engineer* and saved for further use.

YT: Is there a system for MSDSs in your company?

MD: Yes. First, in every part of the factory there are people who take care of chemical related issues and MSDSs. And these people need to take care of the quality of the dyestuffs and auxiliaries, as well as the use of them. They make routine reports to chief engineer. If there were any problem, they will inform that to me as soon as possible.

YT: Do you use computer to store and manage the chemical information?

MD: Not yet. Right now we still use paper documents.

YT: Workers in the factory, especially the ones working in the production lines, how do they get the information about the risk of chemicals they work with?

MD: Mainly from two ways: first, it is regular training courses for all workers; second way is all the technicians in each workshop hold meetings with the worker every week and tell them the information about the new chemicals.

YT: Do the workers understand this information and know how to handle the information?

MD: Yes. I think we do well at this part.

YT: If workers have the problem of understanding this information, do you want to reformulate the information to make it easier for them to understand?

MD: This problem often happens with new workers. Before the new workers first work in the product line, we will make explanation for them about all the chemical risk information. If it doesn't work well at the first time, we will teach them again. We also have follow-up investigations, to make sure everybody can work according to safety

requirements. If there was any problem of chemical use or violation of the rules, we will make in-time correction.

YT: Do the workers have any possibility to influence what chemicals they are going to work with?

MD: Yes. When we have meeting to decide which chemicals we will use in the production, the representatives of workers will take part in the meeting. Their opinions are very important.

YT: If you know one kind of chemical may have negative effects to workers health, how do you react?

MD: For example, we used sulfur-containg dyestuff before, when we realize they have negative effects to workers health and environment, we would rather raise our cost to change them than harm the workers' health.

YT: Do your customers set demands on the chemical content of the final products, or on what chemicals you may use or not use in the process? Are these demands from different customers similar?

MD: Yes, they do. Until now, their requirements are almost the same. To handle these demands, at first we sorted them into different degrees or levels before. For example, the requirements Company B and Factory B_1 are relatively high, so they are in the first level; for the customers from Hong Kong, they have relatively lower requirements, they are in the second level; and the domestic customers' demands are in third level. For the customers in first level we use highest standards and best dyestuffs and auxiliaries. The problem of this arrangement was that it was hard to operate and workers often made mistakes, hence that affect the quality of our products. So, right now, we use the highest, namely first level requirements as the only requirements in the production.

YT: Do you think this information of demands is relevant and easy to understand?

MD: Some of them are, some of them are not.

YT: Do you think this information can help you improve the environmental performance of your production process?

MD: Of course. The way we try our best to meet our customers' higher demands is also a way of our products' quality promotion. All the requirements promote the grade and reputation of our products.

YT: Is there something regarding this information that you would like to change?

MD: Not the contents. The contents of the information are OK for use. But we need to get more information. We hope our customers can give us the information about their purchasing more transparently and timely.

YT: Do your customers require risk information about your products?

MD: Yes.

YT: What kind of information they ask for?

MD: Mainly the information about the hazardous chemicals.

YT: What are your main raw materials?

MD: One is dyestuffs, the other is auxiliaries.

YT: Do you test the raw materials for hazardous substance before use?

MD: Yes

YT: Do you achieve risk-related information with raw materials?
MD: Yes.
YT: Do you think if the information is enough?
MD: It is ok. But I think suppliers should give us something more about the chemical risk information of their raw materials. We need to make sure the quality of from the very beginning.
YT: **Does that mean that you require your suppliers to go further to their raw material suppliers for more chemical risk information?**
MD: Yes. We need to make our joint efforts.
YT: Have you contacted the raw material suppliers for more information?
MD: Yes.
YT: What information regarding chemicals do you get from government?
MD: Mainly from CHINA COMMODITY INSPECTION AND TESTING BUREAU and China's Ministry of Environmental Protection. This information is mainly about national standards.
YT: Is it relevant and easy to understand?
MD: Yes.
YT: How often do you get this information?
MD: Normally once per month.
YT: Do you think there are needs of change regarding this information?
MD: Right now, the government departments deliver this information mainly by paper documents; we hope they can arrange some face to face communications with us regularly. It will be easier for us to understand the demands.
YT: Do you get information on national and international standards?
MD: Yes. For example, eco-labels.
YT: What kinds of laws or legislation influence your chemical use?
MD: Many.
YT: Have your business been affected by REACH?
MD: Not so many influences yet.
YT: Do you think there will be some influences?
MD: Yes, I think so. The major influence would be the rise of our cost. We need to test all the materials we use in the production, even when the quality of our products can meet every standard. Right now, we couldn't afford the cost to fulfill the request of REACH. Compare to other countries, the profit of China's textile industry is very low. For example, the profit for every meter's textile is 0.35-0.4 RMB. The number for European, including Japanese and Korean, companies is 2 to 3 RMB. We can't afford huge amount of authentication required by REACH.
YT: Who do you think should be responsible for minimizing the use of hazardous chemicals used in the textile industry?
MD: I think the producers of chemicals should take 70% of the responsibility, and textile producers should take 30%. Because all the chemicals used in the textile industry come from the chemical suppliers, they need to make sure the dyestuffs and assistant agents they produce are most suitable for the industry. For the chemical suppliers, dyestuffs' producers should take 30% of the responsibility, and assistant

agents' producers should take 70%.

YT: What about the government, chemical suppliers, the chemical users and final customers?

MD: All parties should take the responsibility together. It is not only the task for factories. For example, if our customers set higher demands on chemical use to us, of course we will produce products with less hazardous chemicals. So, that is why I say it is the responsibility for all parties.

YT: Could you tell me something about your opinions on eco-label?

MD: For one side, the requirements of eco-labeling make difficulties for the textile export. For the other, it does have positive effects on environmental protection and saving of nature resources.

YT: Is there any of you customers that ask for labeling of your products?

MD: Not yet.

YT: Do think using eco-label can promote your products?

MD: Comparing to the cost for eco-labeling application, its promotion effects are very low. If some of our customers ask for eco-label of our products, we prefer to turn to other customers.