Risk management in using VMI system
----- Comparative and explorative study of
Chinese and Swedish household appliance
companies
Abstract

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Title: Risk management in using VMI system
----- Researching between Chinese and Swedish household appliance companies

Background & problem discussion:

Due to potential of supply chain management is enormous to improve productivity, customer service and cost reduction, Vendor Managed Inventory (VMI) is one of the supply chain management strategies, by improving the effectively of supply chain to get the competitive advantage for companies. In the Swedish and Chinese household appliance companies have a common agreement about using VMI system in order to reduce operating costs. Some articles believe VMI system has strong potential to be extended to the upstream nodes of the supply chain. However, in using VMI process, there are some risks such as capacity shortages, quality problems, breakdowns, etc. This thesis will be identified the risk of using VMI system in upstream of household appliance company and mitigate their risk problems.

Research question:

What are the differences of risk managing in using VMI system between Chinese and Swedish household appliance companies?

RQ1: Which are the risk factors in Chinese and Swedish household appliance companies when using VMI system?

RQ2: How do Swedish and Chinese household appliance companies manage the risk in using VMI?

Purpose:

The goal of this paper is to find out the risks of using VMI system and analyze the risk managing approaches that are utilized in Chinese and Swedish household appliance companies. By illustrating theoretical data about VMI system and supply chain risk management and empirical data of three Chinese and one Swedish household appliance companies, author would like to develop an analysis model from four dimensions of VMI system and basically supply chain risk management model to identify risk factors in using VMI system and figure out the difference of risk managing method between Chinese and Swedish household appliance companies when they use VMI system.

Method:
This thesis adopted the positivism perspective and the qualitative research. The survey was used in this thesis and focused on based on empirical data such as interviews to answer an open-ended “How” issues. In addition, the analysis is based on primary data from interview Swedish company as well as secondary data from books, articles and internet such as the Chinese company's website.

Conclusions:

The results of the study show that risk management in using VMI system in three Chinese household appliance companies (Haier Logistics Co., Ltd, Hisense Electric Co. and Midea Air-conditioning) and one Swedish household appliance company (Electrolux Laundry System Sweden AB) as well as based on theoretical and empirical data to create an analysis model, which is the integration between four dimensions of VMI system and the basic supply chain risk management model, to assist the analysis of research questions. Through analysis, authors identify seven risk factors:
1. Uncertain production lead time;
2. Long delivery lead time;
3. Confidence crisis;
4. Forecasting level is not high;
5. Less control the decision making;
6. Low information technology system and cooperation;
7. Lack of safety stock.

Authors also illustrate the method of managing risk in using VMI system from four dimensions in Chinese and Swedish household appliance case companies.
Acknowledgments

First of all, we would like to thank the participants we interviewed in the course of this thesis:

- Marcus Larsson (purchasing manager in Electrolux Laundry Systems Sweden AB)

And we would like to thank the authors from books and articles such as the literature about three Chinese household appliance companies.

Furthermore, we would like to thank our examiner Lars-Olof Rask and our supervisor Petra Andersson who always provided us good recommendation in the course of the study. Lastly, we would like to thank our all opposition group.

Växjö, 22th September 2016

Zhang Yaru  Tian Li
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1. Introduction

This chapter gives readers the background knowledge of supply chain risk management, Vendor Managed Inventory (VMI) and household appliance companies. The problem discussion section describes the different risks of using VMI system in household appliance companies. As per the different ways of managing these risks in Chinese and Swedish companies, the research questions are developed and the purpose of this study is initiated. In the last section, it outlines the detail of this paper’s structure.

1.1 Background

Supply chain management (SCM) is a crucial process which has an increasing demanding today. It helps business process to create new revenue opportunities, efficiencies and customer loyalty (Ireland and Crum 2005). Supply chain management mainly focuses on effectively integrating the information and material flows within the demand and supply process (Soroor et al., 2009). According to Gunasekaran et al. (2004), the aim of the supply chain management is improving profitability, organizational productivity and competitive strategy. Moreover, it is a critical element for companies to meet supplier and retailer demand; it has an effective management in supply chain (Elleuch et al., 2013).

However, several unexpected variations, such as, capacity shortages, quality problems, breakdowns and even the natural disaster could cause the risks that affect the supply chain management (Diabat et al., 2012). Furthermore, Elleuch (2013) pointed out that the supply chain risks can have significant impact on firm’s short-term and long-term performance. Since the process of supply chain has become longer and complicated because of the uncertainty in supply and demand, short product life cycle and global outsourcing, a supply chain has high risk level could not be efficient (Christopher and Lee, 2004). Supply chain risk could influence in transport service, energy prices and the destruction of infrastructure such as roads, railways, bridges, shops, market centers etc. (Jaffee et al., 2010). Gary and Bob (2001) stated that supply chain is very vulnerable due to operational and external environment (natural and man-made) damage. Vulnerability is identified as a serious disturbing factor in supply chain internal and external risks (Christopher and Peck, 2004). Further, the risk could be divided into two portions; one is external supply chain risks which include demand risk, supply risk, environment risk, business risk and physical plant risks. Another one is internal supply chain risks which include manufacturing risk, business risk, planning and control risk, mitigation and contingency risks and cultural risks (Business and industry portal, 2015). Because of more and more attention to the vulnerable in supply chain, managing risks have become a significant topic in supply chain management (Hatem & Habib, 2011).
In the supply chain management, Vendor Managed Inventory (VMI) is one of strategies, by improving the effectively of supply chain to get the competitive advantage for companies (De Toni & Zamolo 2005). In recently years, Vendor Managed Inventory (VMI) as an updated inventory management is getting more and more attention by the companies. Supply chain has emerged in supply chain management. VMI system facilitates the inventory management model, it reflects the ideas of integrated supply chain management and accommodates changing market demand. Because vendor needs to provide demand information for manufacturer, which is different from that vendor provides purchasing order to manufacturer like traditional way (Yossi, 1998). VMI system is an inventory model, that bases on connotation which to be commissioned decision-making authority of inventory from vendor to manufacturer (Disney & Towill, 2002). Under the VMI model, inventory is owned and managed by manufacturer, vendor monitors and plans inventory. Moreover, the costs of inventory will be declined and the level of customer service will be enhanced through more efficient management of inventory and better forecasting (Achaba et al., 2000; Myers et al., 2000). VMI system can play a role that overcomes the limitations of technology and information systems in the supply chain. For example, information distortion phenomenon will be reduced between manufacturer and vendor, it aims to provide customer demand for ability to respond quickly and minimizing inventory levels (Tyan et al., 2003; Lee et al., 1997). In addition, Waller et al. (1990) pointed out that VMI system is able to bring benefits in improving customer service level; it reduces uncertainty of demand, demand fluctuations and cost of the parties from manufacturer to vendor.

Especially, VMI system which is widely used in the Swedish and Chinese household appliance companies (Zhou Hebin, 2009), because in the last decades the household appliance companies are undergoing substantial changes, which improves the quality of products and innovation capacity. In order to reduce operating costs, manufacturer and vendors of the household appliance companies have a common agreement about the VMI system. And it makes the inventory management has been continuously improved cooperation strategy (Disney & Towill, 2002). However, in the course of using VMI system, there are a number of potential risks in the supply chain of household appliance companies (Waller et al., 1999).

1.2 Problem discussion

Many advantages of VMI are identified by the world of business world and the academic, however, there also exists a lot of challenges in using VMI system as well as result in the failure case in practice (Sari, K., 2008). For example, due to vendors were unable to handle product promotions that Spartan store abandoned VMI system (Simchi-Levi et al., 2003, p. 161). Similarly, Kmart reduce a huge number of VMI contract by disappointing its vendors’ forecasting ability (Fiddis, 1997). Besides, other reasons are happened to lead to failure, such as lack of demand sharing (Blatherwick,
business model changed by attitude of employee, supplier reluctance to hold higher inventory, lack of standard product identification and undeveloped integrated information system (Kapia et al., 2002). On account of these failure cases, companies have begun looking for the way to improve VMI program. And many studies have more concentrated on exploring the effectiveness of VMI under different conditions, rather than focus on successfulness of implementing VMI (Sari, K., 2008).

In 2007, Elvander et al. (2007) published article about four dimensions of VMI system which developed a framework for describing and classifying VMI arrangements between several manufacturing companies in Sweden. These four dimensions of VMI is useful to help a company which starts to build a VMI system, and discover what kind of VMI systems being used in a company (Phattaraporn & Phusit, 2009). In China VMI is just emerging, there is not many of Chinese enterprises adopted VMI system. With increasing implement of VMI in large enterprises, VMI gain attention in china. Meanwhile, some enterprises (such as Lenovo) get initial success by using VMI system, other large and medium enterprises in China are preparing attempt to introduce the VMI system (Xiao Hong, 2007). According to the empirical investigation of four dimensions of VMI comes from Swedish companies. Author would like to choose one Swedish company as sample company to help some developing companies in China.

Nowadays, VMI system is widely used in the grocery, household appliance, and hardware and related industries, as well as in the general merchandise industry (Chen and Wei, 2012). However, there are many studies that analyze VMI mostly regard the apparel, food and grocery sector (Holmström, 1998). Some articles believe VMI system has strong potential to be extended to the upstream nodes of the supply chain (Cardinali, 1999; Carpaneto, 1999). Hence, VMI is also used fine in household appliances sector (De Toni et al., 2005). Author would like to study VMI in household appliance company and also to explore the potential of VMI in upstream nodes of supply chain.

Electrolux VMI provide a good example for company to work well (Paul Randello, 2008). However, Haier, Hisense and Midea which are Chinese household appliance company, both applied VMI system, even so, VMI system is still prematuratiion in China (Xiao Hong, 2007). Comparing Swedish household appliance company Electrolux with Chinese household appliance companies is useful to improve VMI operation of Chinese household appliance companies, and also helps Chinese companies to learn more about the different between these two countries.

Supply chain management main concentrates on fund flow, material flow and information flow. Risk events are regarded as factor to disrupt these flows. Companies require a tool that can investigate and describe the detailed root cause of disrupted flow. Hence, supply chain risk management is used by companies to mitigate their disadvantage circumstance (S. Nurmayaa Musa., 2012). An effective supply chain risk management is vital for companies; however, many companies have yet to develop their capabilities of supply chain risk management. The supply Chain Risk Leadership
Council (SCRLC, 2011), which includes supply chain organizations from more than two dozen world-class manufacturing and services firms and academic institutions, indicate that supply chain risk management should focus on recognizing internal and external environments, risk identification and assessment, risk treatment and continual monitoring and review and treatment of risk. Authors believe that to build a proper supply chain risk management model can help this thesis to identify the risk of using VMI system in household appliance company and mitigate their risk problems.

1.3 Research question

What are the differences of risk managing in using VMI system between Chinese and Swedish household appliance companies?

1. Which are the risk factors in Chinese and Swedish household appliance companies when using VMI system?

2. How do Swedish and Chinese household appliance companies manage the risk in using VMI?

1.4 Purpose

The goal of this paper is to find out the risks of using VMI system and analyze the risk managing approaches that are utilized in Chinese and Swedish household appliance companies. By illustrating theoretical data about VMI system and supply chain risk management and empirical data of three Chinese and one Swedish household appliance companies, author would like to develop an analysis model from four dimensions of VMI system and basically supply chain risk management model to identify risk factors in using VMI system and figure out the difference of risk managing method between Chinese and Swedish household appliance companies when they use VMI system.

1.5 Limitations

According to the practical situations of case companies, both of these case companies are used VMI system in their upstream supply chain. In this thesis, case companies are regarded as customers and their manufacturers as suppliers in upstream supply chain. Thus, this thesis only focuses on studying the risk management of using VMI system in the upstream supply chain. And this thesis emphasis on analyzing risk factors which are some household appliance companies faced. However, many references such as second data from three Chinese companies and interview from one Swedish company in the household appliance company did not talk about the risk management in using VMI system between case companies and their retailers. In addition, this thesis will not refer to the effect of risk factors and also not discuss the results of management of VMI risks.
1.6 Structure of thesis

This thesis starts to describe an overview of background from topic, the purpose and research questions of this paper in the chapter 1 as well as the structure of thesis which will reveal a structural explanation for readers. In the chapter 2, the different methods of research will be discussed and the approaches of this thesis will be presented. Theoretical studies of chapter 3 provide an insight into the VMI system and supply chain risk management for further analyzing. Chapter 4 is divided into Chinese perspectives and Swedish perspectives to gets empirical research where the company's feedback concerning VMI system operating in Electrolux, Haier, Midea and Hisense respectively. Thus, the theoretical frame and empirical data are juxtaposed to identify problem solving into analysis in chapter 5. Then, chapter 6 summarizes conclude content of this thesis. There are the references and appendices respectively from chapter 7 and 8.
Figure 2. The structure of thesis [Source: Own creation]
2. Methodology

This chapter discusses how the research was carried out, followed by the scientific perspectives, the scientific approaches, research- and sampling methods, data collection, analysis methods, scientific credibility and ethical considerations to depend on the type of study. The aim of this study is designed as a multi-case study to select the appropriate method. Finally, this chapter will depict an overview of all the selected types of methods.

2.1 Scientific perspective

The scientific perspective is defined as what should be considered acceptable knowledge in a scientific research (Bryman & Bell, 2011). Two concepts that are positivism and hermeneutics will be introduced.

The Positivism perspective

The positivism perspective mainly focuses on empirical data and scientific methods with philosophical position (Hay, Colin, 2002). There is a real world independent of human senses (e.g. hearing, seeing, feeling) in positivism (Bryman & Bell, 2011) and followed by a logical (e.g. if A is true, then A leads to B) (Myers, 2013). According to what Gill and Johnson (2010) pointed out that positivism study uses highly structure approach to improve knowledge, it analyzed in statistical processing and created quantifiable observations. However, the non-quantifiable data gathered in one case, it can also be used in a positivism method. It is important to identify objectives in research (e.g. unbiased) (Saunders et al. 2009). The purpose of using positivism analysis is discussed and investigates solutions to solve issues in practice (Age, 2011).

The Hermeneutics perspective

The hermeneutics perspective primarily focuses on both the first order art and the second order theory, and it explains and understands verbal and nonverbal expression. Hermeneutics is emerged as an important branch of biblical studies. Later, it relates to include history of ancient and classical culture (Bryman & Bell, 2011). The hermeneutics perspective is also focusing on understanding of human behavior and emphasizing the importance of context when interpretation of a situation (Eriksson & Kovalainen, 2008). According to hermeneutics theory, Myers (2013) figured out that. It is not possible for objective interpretations. Moreover, the hermeneutics perspective is mostly used to interpret the data quality.

Scientific perspective of this thesis
This thesis adopted the positivism perspective. Theoretical knowledge about risk in using Vendor Managed Inventory (VMI) system in household appliance company of China and Sweden was gathered through literature research and related to multiple case studies. Then the empirical data and scientific methods were used in this thesis. Interviewee’s experiences and feeling were collected into empirical data and authors used own and general logic to do analysis, both of human senses and logical thinking were referred to lead to that positivism approach obtain positivism results. Thus, this thesis was based on the positivism perspective. Although in this process, subjective knowledge was used, it was based on scientific proofs.

2.2 Scientific approach

A scientific approach describes the relation between the theory and reality, it is classified into two types: deductive and inductive (Bryman & Bell, 2011). First, the deductive approach means the researchers develop a theory or hypotheses and designs a research strategy to test the formulated theory. Whereas, the inductive approach contributes to designing new theory and generalizations (Ary et al., 2010). Saunders et al (2007) identified the main differences between deductive and inductive research approaches in the following sheet:

<table>
<thead>
<tr>
<th>Deductive</th>
<th>Inductive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Base on scientific principles;</td>
<td>1. Aim to explore events;</td>
</tr>
<tr>
<td>2. Explain the relationships between variables;</td>
<td>2. Research to understand in deeply;</td>
</tr>
<tr>
<td>3. Quantitative type of data is mainly collected;</td>
<td>3. Qualitative type of data is collected;</td>
</tr>
<tr>
<td>4. Control measures to ensure data effectively;</td>
<td>4. Flexible research approach to ensure provisions for changes during the research;</td>
</tr>
<tr>
<td>5. Concepts are operationalized in order to ensure the clarity of definition;</td>
<td>5. Researcher is a part of research process;</td>
</tr>
<tr>
<td>6. High structured approach;</td>
<td>6. Research findings are not generalized.</td>
</tr>
<tr>
<td>7. Researcher is independent from the research process;</td>
<td></td>
</tr>
<tr>
<td>8. Sufficient size of samples to generalize research conclusions.</td>
<td></td>
</tr>
</tbody>
</table>

Sheet 1. The main differences between deductive and inductive research approaches
[Source: Saunders et al., 2007]

Scientific approach of this thesis

This thesis adopted the deductive. In this thesis were: (1) risk problem in using VMI exists in household appliance companies. (2) the way to manage risk in Swedish company and Chinese companies (3) analyzing how to improve the efficiency of VMI system in two countries. Authors relied on scientific and reasonable theory of VMI
system and risk in household appliance companies. And collecting quantitative type of empirical data to analysis aimed to find our conclusion. In addition, authors would like to develop a supply chain risk management model that was easily to find out the main risk in household appliance companies by using VMI system as well as the cause of risk.

2.3 Research method

2.3.1 Quantitative and qualitative approach

The quantitative research regarding to ask people for their opinions in a structured manner, it produces hard facts and statistical data to gain knowledge. It is important to ensure that they are a representative sample in your market target (Bell, 2010). Likewise, object of study must be measurable and quantifiable, including market value and revenue (Saunders et al., 2009). There are two methods used in collecting quantitative data, including investigation and structured interview with pre-set questions (Bryman & Bell, 2011).

The qualitative research mainly focuses on non-numerical data (O’Leary, 2009). The non-numerical data is collected from interviews and observations are in many cases by researchers (Levy & Lemeshow, 2008). Qualitative approach based on subjective opinion for research object (Zikmund et al. 2012). Furthermore, this method is generally carried out on a smaller scale such as conducting in a specified time period and administering a precise vision to analyze relevant circumstances (Levy & Lemeshow, 2008; O’Leary, 2009).

The quantitative research and qualitative research can work together (Saunders et al., 2007). They provide a deeper understanding of situation (Bryman & Bell, 2011; O’Leary, 2009; Zikmund et al., 2012).

Research method of this thesis

Qualitative research could be used as the research method of this thesis. And one interview would be placed for this thesis. Interviewees’ experiences and attitudes were also considered into this thesis and influence the result of research. Through this approach, a deeper understanding in what kind of risk factors by using VMI system, how investigating companies manage the risk was useful to this thesis.

2.3.2 Survey and case study

Yin (2014) pointed out that there are two types of method in a research project, which are survey and case study.
Since the 19th century, a survey has been used as a tool to study the issue. It focuses on using a quantitative approach in research projects (Nardi, 2006). According to Bryman & Bell, 2011; Saunders et al (2009) the survey has an advantage and a disadvantage in this process. The advantage is that survey needs fewer resources, in order to get a large amount of data (mostly quantitative). However, the disadvantage is that it lacks the depth compared with other methods by setting in advance issue. On the other hand, in the case study, there are single and multiple case studies to research (Saunders et al., 2009). There is an advantage and a disadvantage in this process. Advantage is that case study provides a deeper understanding and an insight into object of study (Creswell, 2014). However, disadvantage means it may lack of the generalization capability because of the small number of object of study typically (Saunders et al., 2009).

Research method of this thesis

In general, authors believed that survey was available for this thesis. This thesis focused on based on empirical data such as interviews to answer an open-ended “How” issues.

The purpose of this thesis was to give a deep insight into the risk factors by using VMI system and the ways investigating companies manage the risk. Moreover, survey was used to obtain more information and compare the strengths or weaknesses in risk crisis management in two countries household appliance company. Because of the authors could focus on the topic and finished in limitation period of time, interview Chinese household appliance companies were imitating, so in this area, using resource from interview and secondary data explained the importance of reducing risk when using VMI system.

2.4 Sampling method

Kothari (2004) indicated sampling approach are probability (random selection) and non-probability (purposive). The participants of probability sampling are selected at random. The randomness makes sure that all members in the group have an equal chance. However the participants in the non-probability sampling are predetermined that related to the study subject. There are different types of sampling between probability sampling and non-probability showed in the following sheet:

<table>
<thead>
<tr>
<th>Sampling approach</th>
<th>Type of sampling</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>1. Simple random</td>
<td>1. Equal chance to be selected for every member</td>
</tr>
<tr>
<td></td>
<td>2. Systematic selection</td>
<td>2. To a random starting point and a fixed, periodic interval</td>
</tr>
<tr>
<td></td>
<td>3. Stratified</td>
<td>3. Non-overlapping groups and samples</td>
</tr>
</tbody>
</table>
Sampling method of this thesis

This thesis was carried out mainly based on non-probability sampling. Convenience sampling was used to find Chinese household appliance companies. Authors also used the method of snowball sampling to get phone number or e-mail address of potential participants. This method had higher possibility to get interviews with potential participants. Additionally, for Swedish company, authors used quota sampling to contact the fixed companies in local service center, nearby offices and headquarter offices and ask if the company is interested in topic and we interviewed them in order to complete our research work. The following section was an overview of the selected sample companies:

**Electrolux Laundry Systems Sweden AB**

Background: Electrolux is the second-largest appliance manufacturing company in the world. It mainly produces major appliances and vacuum cleaners for variety of brand including its own. There are three main divisions in Electrolux, which are Electrolux major appliances (EMA), small appliances and Electrolux professional (EPR). Electrolux Laundry Systems Sweden AB, part of Electrolux Professional AB, engaged in the production, research and development of professional solutions for washing. The headquarter is located in Ljungby, Sweden.

Interviewee: Purchasing manager (Marcus Larsson)

**Midea Air-conditioning**

Background: Midea is a Chinese appliances manufacturer which sells products domestically under its own name. It is located in Guangdong province of China. Midea Air-conditioning, belonging to Midea Group, is in the air-conditioning company ‘top three’ list in China.

**Haier Logistics Co., Ltd**

Background: Haier Group is a multinational appliances company headquartered in Qingdao, Shandong province, China. Its business activities include designing, developing, manufacturing and selling electronics and household appliances. According to Euro monitor reported in 2014, Haier is the leader of market share for major appliances in the worldwide. Haier Logistics Co., Ltd., belonging to Haier group, is establishment in 1999. Relying on advanced management concepts of the Haier Group and logistics technology applications, it develops in socialized business and satisfied internal logistics services.


**Hisense Electric Co.**

Background: Hisense Electric Co. (HEC) is the largest subsidiary of Hisense Group, and as the predecessor of Hisense Group, HEC is also the oldest subsidiary of Hisense Group. HEC is headquartered in Qingdao, Shandong province. It mainly produces large-screen rear-projection TV, LCD TV, PDP TV and set-top boxes.


### 2.5 Data collection

There are two different types in the data collection, including primary and secondary data. It is important to collect data for writing thesis (Myers, 2013).

**Primary Data**

Primary data concentrates on the data from specific purpose of research (Saunders et al., 2009). There are interviews and observations in collection of primary data (Bryman & Bell, 2011).

Interview contains three different methods which are structured, semi-structured and unstructured (Bell, 2010). Structured interviews based on using a quantitative approach to research problem. Then, structured interviews have a fixed questions and pre-set questions (Bryman & Bell, 2011). Semi-structured interviews, although there are some pre-set questions, it is expected to further interpret (Saunders et al., 2009). Yin (2014) pointed out that unstructured interviews involve wider range of topics, but it only refers to few special issues. Moreover, Semi-structured and unstructured interviews both are
basis on using a quantitative approach (Bryman & Bell, 2011). In addition, the advantage of interview is that the problem can be adjusted during the interview process and can be understood deeply about the research object (Bell, 2010), the disadvantage is that it requires a lot of time in this interview process (Bryman & Bell, 2011).

Secondary Data

Secondary data is based on collection for previous studies through different sources to investigate the issue by researchers (Saunders et al., 2009). Furthermore, the advantage of secondary data can be finished with the limited resources during a limited timeframe (O’Leary, 2009). The disadvantage of secondary data involves a broad topics or inappropriate assumptions and results which are affected by the original researcher (Vartanian, 2010).

Data collection of this thesis

Primary data and secondary data could be used for this thesis. Primary data would be obtained through interview. In order to understand the research object deeper, Semi-structured interview as the main way of interview could be used to give a different questioning. The interview guideline could be found in Appendix 1.

Secondary data could be collected from books, articles and internet such as the company's website. Search engine was gathered through database access of Linnaeus University Library. The other engines used from Google Scholar or One Search. Primary search keywords included VMI system, risk management in supply chain, household appliance company and so on.

2.6 Analysis method

There are two different analysis methods, including pattern-matching and correlational analysis (Yin, 2012). It is important to use analysis method to write this thesis.

Pattern-matching

The pattern-matching contains linking two patterns or models, one is theoretical framework, and the other is empirical data (Saunders et al., 2009). Finger 5 describes the model of pattern-matching in this process.
According to Yin (2014) that the pattern-matching uses the combination of theoretical framework and empirical data to match the research questions and analyze the results. This method mainly focuses on qualitative studies, mostly deals with the research question ‘why’, but not excluding qualitative research (Saunders et al. 2009). Yin (2014) pointed out that time series analysis can be utilized.

**Correlational analysis**

Graziano and Raulin (2010) fingered out that this method is suitable for multiple cases, because it covers a variety of subjects and their relationships with potential cause. The correlational analysis provides accreditation trend or development (Graziano & Raulin, 2010). Saunders et al. (2009) pointed out that correlational analysis need samples with numerical value to display the characteristics of interpretation.

**Analysis methods of this thesis**

The pattern-matching and correlational analysis could be used for this thesis, because this thesis contained four samples to carry out a multiple case study during the limited
time frame. Moreover, using VMI system and supply chain risk management as theoretical frames, while the empirical data from Electrolux in Sweden, Midea, Haier and Hisense in China relied on the four dimensions in theoretical study to gather. By the empirical data and theoretical study to match in order to build analysis model and answer two research questions.

2.7 Scientific quality

For qualitative research method, it is easily to mix researchers own thought and values (Holme et al, 1997). As a credible research it should study and cover two aspects: validity and reliability (Yin, 2014).

2.7.1 Validity

The concept of validity is not simplex, stable or general concept (Golafshani, N., 2003), but “rather a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects” (Winter, 2000, p.1). Some researchers argued that validity may inadequately apply in qualitative research, however, they also realized some kind of measure are needed for their research (Golafshani, N., 2003). Thus, many research developed the concept of validity to be more appropriate terms, such as, quality, rigor and trustworthiness, for adopted (Davies & Dodd, 2002; Lincoln & Guba, 1985; Creswell & Mishler, 2000; Seale, 1999; Stenbacka, 2001). Mason and Bramble (1989) indicated the three basic approaches of the validity of tests:

A. content validity. This approach tests the degree of items which represent the domain or universe of the trait or property;
B. construct validity. The approach concerns the degree of the test to measure the construct;
C. criterion-related validity, this approach is referred to measuring whether the criteria of traits or constructs exist or not.

Validity of this thesis

This thesis was ensured to collect enough and reliable empirical data for analyzing, and data from multiple case study companies helped authors to improve validity of research. The content validity approach was used for measuring the theoretical data. Authors had responsibility to insure our theoretical data related to the topic and to work well in the research. Then the high construct validity had been shown on the sources are from the reliable theoretical background and multiple case studies.

2.7.2 Reliability

Reliability means a research is consistent over time and base on the studies, which are reliable and reproduced in the same methodology, and then the research is regarded as
reliable. The citation of research is repeatable idea or result and observations (Joppe, 2000). According to Kirk and Miller (1986), there are three types of reliabilities in quantitative research: (1) keep the same degree to measurement; (2) the measurement is consistent over time; (3) the similarity of measurements within a given time period. However, it is possible to lead to errors of measurement, for example, when a respondent only answers the questions we ask, it limits the sample of behavior (Crocker and Algina, 1986). And external change can be a factor to influence the degree of reliability. Hence, the responsibility of research is to assure high reliability (Joppe, 2000).

Reliability of this thesis

In order to get a high reliability in this thesis, authors would like to obtain data and information not only via interview, but also by literature and journal, etc. Considering business environment was changing rapidly (Schmidt et al., 2013), and companies’ strategy was developing, author only used the recently empirical data as reference. Then the repeatability of research was carried out, for the different perspective and the changing environment, this thesis did not necessarily to show similar result.

2.8 Ethical considerations

Ethical considerations contain four principles of conduct, including merit and integrity, justice, beneficence and respect. Merit and integrity are based on rationality of the potential benefits, skills and expertise to research. This means it improves the learning skill of participants by using current literature sound approaches and the appropriate amenities and resources to oversee the design and development. Justice is involved in an equitable choice, which provides an opportunity for equitable selection of participants. Beneficence means the benefits of research outweigh any risks or damages that might be directed against researchers, participants or society. Otherwise, research should be suspended, if risks here are no longer reasonable. Respect mainly focus on confidentiality, faith and protection of privacy for study. They are information as important parts of ethical research (Wallace and Sheldon, 2014).

Ethical considerations of this thesis

Integrity and beneficence could be used for this thesis. One reason was that this thesis was written to provide the information about empirical data through interview data from one company and secondary data from reports and journals that related to our purpose and topic. So integrity could improve analytical skills based on current literature and appropriate resources. The other reason was that in this thesis, it would study how to manage the risk in using VMI in our case companies. So it means beneficence in the process of research.
2.9 Summary

The figure below shows a summary overview of the methodological approaches for this thesis:

*Figure 4. Summary of the methodological approach [Source: Own creation]*
3. Theoretical study

This chapter gives background of theoretical in this thesis. First of all, the chapter provides an outset to explain how authors try to integrate theoretical studies used in empirical research. Then, dimensions, activities, benefits and risks of VMI system and supply chain risk management will be introduced. And theoretical study provides relevant theories in this thesis to guide our research. Authors choose to illustrate VMI system as the main topic of this chapter. Moreover, the theory of VMI system and supply chain risk management as a basis to analysis in next chapter for Swedish and Chinese household appliance companies and answer the research questions “what risk factors” and “how to manage risk” in using VMI system.

3.1 VMI system

3.1.1 Overview

Razmi et al. (2010, p1) defined VMI system as “a mechanism where the supplier creates the purchase orders based on the demand information exchanged by the retailer/customer”. It also can be called continuous replenishment, automatic replenishment, or supplier-managed inventory. In VMI system, suppliers substitute retailers for managing inventories and decide how many to replenishment per item and when (Savasaneril and Erkip, 2010). Kannan et al. (2013) also mentioned the upstream supply chain of VMI system (the vendor) controls the inventory upon safety stock level, instead of upon customer ordering. Hence, the vendor can concentrate on optimizing production efficiency and capacity planning, and improve forecast accuracy.

In supply chain, VMI system provides essential information sharing between actors from upstream supply chain to downstream supply chain. It supervises the process of operation to adjust the decisions promptly and avoid emergency situations. The characteristics of VMI supply chain shows VMI system should coordinate the partnering stages, continuous information sharing and regular meetings about critical issues and follow-up actions (Kannan et al., 2013). Therefore, the success of VMI relies on the communication of the partners, the willingness of data sharing, collaboration and coordination, and an information technology system (Duchessi and Chengalur-Smith 2008).

Reducing the costs and improving customer service level are recognized as two main advantages of VMI (Waller et al., 1999). Cetinkaya and Lee (2000) added that VMI enhances the ability of synchronization of inventory and transportation decisions, while it also reduces inventory-carrying costs and shortage problem. Then, for retailers, VMI provides the higher product availability, service level and lower inventory monitoring and ordering cost to improve competitiveness (Waller et al., 1999). The other hand, for
vendors, it decreases the bullwhip effect (Lee et al., 1997), better manufacturing capacity utility, and better synchronization of replenishment planning (Waller et al., 1999).

### 3.1.2 Dimensions of VMI system

There are different categories and operation way in VMI system (Hemilä, J. et al., 2007). Then Elvander et al. (2007) developed a framework for dimensions of VMI system which are allocated to four perspectives: inventory-related dimensions, information-related dimensions, decision-making dimensions, and system integration level dimensions. Through these four dimensions of VMI, it can be a tool to evaluate the design of VMI system and to facilitate the comparison and analysis of different VMI system configurations. For this thesis, four dimensions of VMI system would be a tool to help authors identify case companies’ actual categories and types of VMI system, and understand more in depth about the operation of VMI system from four perspectives.

#### Inventory-related dimensions

These dimensions include inventory location, sourcing policy and inventory ownership. Inventory location dimension means the physical location of the inventory which is owned by supplier. Sourcing policy considers how to arrange the sourcing of a customer’s inventory, which implies that supplier should delivery to customer from its production or from its own stock. Inventory ownership, the evident is the ownership of inventory, while as well as when the invoice is issued to the customer (Elvander et al, 2007). In order to understand inventory-related dimensions clearly, the sheet is showed on below:

<table>
<thead>
<tr>
<th>Inventory-related dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Inventory location" /></td>
</tr>
<tr>
<td><strong>Option 1</strong></td>
</tr>
<tr>
<td><strong>Option 2</strong></td>
</tr>
</tbody>
</table>
Sheet 3. The possible alternatives of inventory-related dimensions [Source: Own
creation inspired by Elvander et al, 2007]

For example, the inventory location dimension has three options. The first one can be
defined as VMI at “Virtual” Hubs. It means creating a “virtual” VMI hub in suppliers’
sides, so that suppliers can hold inventory at their own locations. Then, suppliers deliver
products to buying enterprise according to pull signals directly from their own unallocated
inventory (E2open, 2011).

Figure 5. VMI at Third-Party Hubs [Source: E2open, 2011, p3]

The second option can be considered as a third-party logistics provider (3PL). It controls
the inventory as a VMI hub. 3PL delivers products to buying enterprise, when pull
signal is sent to 3PL. Then 3PL send receipts to suppliers to replenish inventory in safety
level at the 3PL hub (E2open, 2011).
Then the last option can be regarded as VMI at Buyer Locations. In this case, VMI hub is near to the buying enterprise’s location and holds the inventory. It can quickly response customer order. Moreover, inventory is pulled according to order and is replenished by the supplier on the basis of actual demand (E2open, 2011).

In these three options of VMI inventory dimension, it implies VMI system improve inventory management levels via higher cost-effectively which response to actual
demand directly, instead of forecasting are made several tiers away from the final customer (E2open, 2011).

**Information-related dimensions**

There are three dimensions involved in information-related dimensions. A demand visibility dimension is one of the information-related dimensions. It refers to the demand information that is provided to supplier so that supplier can control the customer’s inventory and also how far the information stretches in time. Then access to information dimension means the way that the supplier obtains the customer’s demand data and inventory levels. The last is IT configuration, which concerns the type of IT configuration used in VMI system (Elvander et al, 2007). The content of these dimensions shows on sheet 4.

<table>
<thead>
<tr>
<th>Information-related dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand visibility</strong></td>
</tr>
<tr>
<td>Option 1</td>
</tr>
<tr>
<td>Option 2</td>
</tr>
<tr>
<td>Option 3</td>
</tr>
<tr>
<td>Option 4</td>
</tr>
</tbody>
</table>

*Sheet 4. The alternatives of information-related dimensions [Source: Own creation inspired by Elvander et al, 2007]*

**Decision-making dimensions**

Decision-making dimensions contain four dimensions. (1) Replenishment monitoring and ordering, this dimension concerns to how often the supplier monitors the customer’s inventory and demand in support of a replenishment order or a production order in their own ERP system. (2) Control limits dimension means what extent the supplier controls the inventory at a customer’s premises. (3) Replenishment decision refers to the extent
Decision-making dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Replenishment monitoring and ordering</th>
<th>Control limits</th>
<th>Replenishment decision</th>
<th>Shipment decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>continuous review and ordering</td>
<td>no minimum/maximum windows</td>
<td>supplier makes replenishment order decisions</td>
<td>supplier: supplier makes shipment decision</td>
</tr>
<tr>
<td>Option 2</td>
<td>periodic review and ordering</td>
<td>only minimum limit</td>
<td>supplier decides only quantity or time, not both</td>
<td>customer: customer makes shipment decision</td>
</tr>
<tr>
<td>Option 3</td>
<td>periodic ordering (including scheduled visits)</td>
<td>only maximum limit</td>
<td>customer confirms replenishment orders made by supplier</td>
<td></td>
</tr>
<tr>
<td>Option 4</td>
<td>maximum and minimum limits</td>
<td></td>
<td>customer gives order proposals</td>
<td></td>
</tr>
</tbody>
</table>

Sheet 5. The alternatives of decision-making dimensions [Source: Own creation inspired by Elvander et al, 2007]

System integration level dimensions

According to Elvander et al. (2007), system integration level dimensions include level of horizontal integration of customers, level of horizontal integration of items and level of vertical integration. Firstly, level of horizontal integration of customers implies that supplier should consider combining several customers’ needs in inventory control and production planning processes. Then level of horizontal integration of items means the extent of different items is taken into consideration when a supplier carries out his inventory control and production planning processes. The extent that supplier take different resources in the value chain is referred by level of vertical integration, in order to plan new replenishment orders to the VMI customers’ inventories. Sheet 6 shows below to reveal their alternatives.
### System integration level dimensions

<table>
<thead>
<tr>
<th>Options</th>
<th>Level of horizontal integration of customers</th>
<th>Level of horizontal integration of items</th>
<th>Level of vertical integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>focus on one VMI customer at a time</td>
<td>focus on single VMI item at a time</td>
<td>customers’ inventory</td>
</tr>
<tr>
<td>Option 2</td>
<td>focus on all VMI customers simultaneously</td>
<td>focus on all VMI items simultaneously</td>
<td>customers’ inventory and suppliers’ own inventory</td>
</tr>
<tr>
<td>Option 3</td>
<td>focus on all customers simultaneously</td>
<td></td>
<td>customers’ and suppliers’ inventory and suppliers manufacturing capacity</td>
</tr>
</tbody>
</table>

*Sheet 6. The alternatives of system integration level dimensions [Source: Own creation inspired by Elvander et al, 2007]*

### 3.1.3 Supporting activities

In this part, that introduces several major activities which support and assist VMI system operation more effectively in supply chain. VMI is usually applied by them but is not mandatory.

#### The forecasting scheme

*Scan-based trading (SBT)*

SBT is a relatively complex VMI arrangement that the vendor has unrestricted store access, is responsible for inventory maintaining, and is paid based on scanned sales. It can provide a high level of data visibility between the retailer and the vendor, because it stipulates both parties to share information to each stock keeping unit (SKU) exchanged. Relative information from both sides are collected and protected in a single repository, typically assisted by a third-party information intermediary. The collected information becomes the data of record, in order to generate invoices between the vendor and the retailer. It helps to reduce the financial burden of both the retailer and the vendor (Rungtusanatham, M. et al., 2007).

*Point-of-sales (POS) data*
“Generally the POS data would provide information about the store, product, sales volume, price, sales value, types of promotion involved during sales of the product and also duration of such promotions” (Balaji, M.; Rao, G.S.V.R.K., 2013, p1). POS data is regarded as very raw and often stored in disparate data sources, such as text, spreadsheets and so on. Since it refers to information about the pricing of the product, POS data becomes a confidential data. It is also important to provide information for prediction of base line sales (Balaji, M.; Rao, G.S.V.R.K., 2013).

**Continuous replenishment program (CRP)**

The concept of continuous replenishment program (CRP) could support efficient consumer response (ECR) strategy. CRP concentrates on improving product flow in the supply chain, that forwards to the customer and ultimately to the end consumer, and return to the supplier. The goals of CRP are to increase inventory turns, reduce inventory levels and stock outs, improve customer service level, boost warehouse efficiency and enhance trading partners’ perception of value (Zenjiro Imaoka, 2012).

**Technology support**

**Enterprise resource planning (ERP)**

ERP is one kind of business management software, which could be used within companies to collect, store, manage and interpret data from business activities, such as product planning, cost, manufacturing or service delivery, marketing and sales, inventory management and shipping and payment (Shaul & Tauber, 2012), through tracking business resources, such as cash, raw materials, production capacity, and statuses of business commitments: orders, purchase orders, and payroll (Adam, Kotzé & Van der Merwe, 2011).

**Radio-frequency identification (RFID)**

Radio-frequency identification (RFID) is a wireless technology that helps track the various projects in the supply chain (Finkenzeller, 2003). There are three main components in the RFDI system, including RFID tags, RFID readers and information processing systems (Barchetti, et al., 2010). RFID technology can be applied in the procurement, production, transportation, receiving and storage, particularly in the logistics and retail (Maloni & DeWolf, 2006). RFID is believed to provide many benefits for companies, such as enhance inventory management, reduce costs, and improve safety and efficiency (Yue, et al., 2011).

**Shared information quality**
Electronic data interchange (EDI)

Electronic data interchange (EDI) can provide data of electronic communication method through any electronic device. EDI file must be processed by a computer instead of people, a standard format must be able to read and understand the document used in computer. There are three main components in the EDI system, including (1) business documents, the common documents are exchanged purchase orders, invoices and advance shipping notice through EDI, (2) standard format, there is a uniform standard of file by using EDI, (3) business partners, EDI file exchanges between two companies known as business partner or trading partner (Rochelle P. Cohen, 2013).

Extensive markup language (XML)

XML is one of the most popular data formats for data representation and transmission on the internet in recent years (Bray T, 1997). XML is a popular and standardized markup language for semi-structured data. Because of its simplicity and versatility, XML is widely used in many applications (Bray et al., 2008). Many data have been typed in XML result in the volume of a single XML document is enormous and also grows very quickly (Choi, H., Lee, K. H., & Lee, Y. J., 2014).

Oracle database system (ORACLE)

Oracle Database (ORACLE) is designed for enterprise grid computing and it is the first database with the most flexible and cost effective way to manage information and applications. Then enterprise grid computing creates large industry-standard, modular storage and servers pools. Under ORACLE system, the pool of components can rapidly provide every new system. It is not necessary to worry peak workloads, because capacity can be easily added or reallocated from the resource pools as needed (Oracle Corporation, 2010).

Collaboration strategy partner

Efficient consumer response (ECR)

“ECR is a comprehensive management concept based on vertical collaboration in manufacturing and retailing with the objective of an efficient satisfaction of consumer needs” (Seifert, D, 2003, p3). Seifert (2003) also indicates that the ECR implies two essential parts which are consumer and efficient response. It can be explained that the retail and manufacturing work together to make supply chain more efficient and rational to consumer’s need. ECR efficiently reduce and avoid no-added activities, and maximize value and productivity (Seifert, D, 2003).

Quick response (QR)
QR is an operational strategy which uses a range of technologies (such as enhanced information systems and expedited logistics operations) to reduce lead time and improve supply flexibility (G.P. Cachon, 2009). It can be defined as a partnership from suppliers to retailers working together to respond rapidly to customers’ needs by sharing the point-of-sale scan data, and replenishing customer requirements (Gu Haiou, 2009). QR helps companies to avoid overproduction, reduce inventory, and implement strategy for customer behavior. For retailers, QR rapidly adjusts their ordering quantity through the market demand information (Z.J.M. Shen, 2007).

Collaborative Planning, Forecasting and Replenishment (CPFR)

Collaborative Planning, Forecasting and Replenishment (CPFR) system is a business mode that under the supply chain management (John Berry, 2013). It is basic that provides framework of information for liquidity products and services, and deepens relationships with information sharing and process management (Seifert, 2003). According to John Berry (2013), the CPFR mode includes four main components: strategy & Planning, demand & supply management, execution, analysis.

3.1.4 General risk in using VMI system

Actually, because of its properties, the vendor-managed inventory is not imperfect. There are six risks within the system (Keith Carruthers, 2015).

Confidence crisis

In fact, for the effective functioning of VMI system there needs to build trust between the manufacture (supplier) and retailer (distributor). The trust is significant issue in the Vendor Managed Inventory because retailer will no longer order stock items and supplier should track retailer’s consumption of stocks automatically to replace the necessary inventory that ensure retailer to run out even rarer. However, retailers concern about suppliers cannot honor their commitments, which means suppliers are not approaching 100% level of service or suppliers do not have a perfect record in VMI implementation. In this process, there are results in a crisis of confidence (David Burch, 2008).

Lack of resource

Currently, the development of vendor-managed inventory depends on big business or mid-sized company. VMI system is running efficiently and successfully under preconditions of the client (retailer / distributor) that must keep frequent and large orders. If the customers (retailer/distributor) from small business do not actually order too much, then the VMI system might not be runs successfully between the manufacture
(supplier) and retailer (distributor). According to the above, there is a limitation for the size of company in VMI system (Robert Malone, 2011).

**Information technology system and cooperation**

In fact, a powerful information system would be supported in VMI system which should have at least one information sharing platform to conduct, especially, companies (retailer/distributor) use enterprise resource planning (ERP) system to connect with manufacture (supplier). It is very important for VMI system to be successful. However, there is a big issue in the information technology system in VMI system in which information sharing is not enough between the manufacture (supplier) and retailer (distributor). It means that if the cooperation of one or both parties is not willing to share their market sales, inventory levels, sales estimates and other information with each other, so that the other party cannot optimize inventory, reduce costs and lead to the failure of implementation of VMI (Xiaohui Liu & Youwang Sun, 2011).

**Electronic data interchange (EDI) issue**

According Rochelle P. Cohen (2013) who pointed out that Electronic data interchange (EDI) provides a data of electronic communication method through any electronic device. Using EDI systems is a very important link to the implementation of VMI. Figure 10 illustrates a typical manual process without EDI in VMI system. Then figure 11 show an EDI process under VMI system.

*Figure 8. A typical manual process without EDI [source: Rochelle P. Cohen, 2013, p5]*
Using EDI does not involve paper and people different from the manual process in the VMI system. However, there is a crisis in this process. Due to EDI file must be processed by a computer instead of people, a standard format must be able to read and understand the document used in computer. Actually, the format in many companies from developing countries has not a uniform standard by using EDI. If this format has low standard, then each company would send files by exploiting specific format their company, such as a Swedish-speaking person probably does not understand Chinese. That means the receiver’s computer system does not understand the format of sender's company-specific format (Rochelle P. Cohen, 2013).

**Forecasting level of manufacture/supplier**

Forecasting level for manufacture/supplier is also a crucial issue for the successful implementation of VMI. VMI system need suppliers to provide more effective forecasting for inventory levels and cooperate with retailer/distributor’s strategies in different periods, such as seasonal capacity adjustments and the introduction of new products, etc. That requires suppliers to put forward higher level of predict (David Burch, 2008).

### 3.2 Supply chain risk management

For this thesis, supply chain risk management would be a good tool to identify the supply chain risk when a company uses VMI system, and to divide risks into the different kinds of VMI risk, then to control or manage the risk.

#### 3.2.1 Overview

Jüttner et al. (2013) pointed out that due to internal and external influences target of the logistic network, the supply chain risk management is necessary to existence. And it is the significant factor of successful business, because by using risk management tools improves the market competitiveness and the development of the supply chain (Ellis, Simon, 2009). Moreover, its purpose is to reduce supply chain risk, which includes all of the technology, information, systems, measures and strategies (Kersten et al, 2006).
The Supply chain risk management are classified into four steps to handle risks. This model is illustrated in the figure 12, including identifying internal and external environment risks, assessing and mitigating risks for the supply chain, monitoring and review of risk as well as treating risks. In the risk assessment, it is using a list of common risks, including internal risks such as facility unavailability and external risks such as labor uncertainty. There are three parts in this process, which is risk identification, risk analysis and risk evaluation. Then in order to strengthen the speed of risk treatment, companies must communication, monitoring and review in risk treatment (Neiger et al., 2009).

![Figure 10. Risk Management Process](Source: Neiger et al., 2009, p203)

### 3.2.2 Basic supply chain risk model

There is a basic model to mitigate the effects of supply chain risk, which has mainly four areas: (1) product management, (2) supply management, (3) information management (4) demand management. This model is illustrated in the figure 13. First, product management involves products design and modification processes, which make it easier to ensure the supply could satisfy demand. Secondly, supply management covers cooperation with downstream partners and coordination with upstream partners to ensure timely delivery the materials throughout the supply chain. Thirdly, in order to obtain individual supply chain partners in the information management, supply chain partners can approach other kinds of information. Lastly, in demand management, it is responsible for working with downstream partners, which means it affects demand in the profitable way (Tang, 2006).
3.3 Theoretical model

3.3.1 Overview

Figure 14 shows a model, which explains characteristics of the theoretical research. Authors describe five aspects of VMI system, which are overview of VMI system, dimensions of VMI system, supporting activities, risk, in order to formulate the empirical data to be a basis for analysis. Then, supply chain risk management is presented by overview and basically supply chain risk analysis model. Supply chain risk management basic model helps authors identify the risk in supply chain when company uses VMI system. Thus, authors integrate the VMI system with supply chain risk management aiming to contribute to analyze easier and more easily and effectively.
Figure 12. Theoretical model [Source: Own creation]

### 3.3.2 Theoretical Concepts Summary

<table>
<thead>
<tr>
<th>Concept</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions of VMI</td>
<td>Inventory-related dimensions</td>
</tr>
<tr>
<td></td>
<td>Information-related dimensions</td>
</tr>
<tr>
<td></td>
<td>Decision-making dimensions</td>
</tr>
<tr>
<td></td>
<td>System integration level dimensions</td>
</tr>
<tr>
<td>Supporting activities</td>
<td>The forecasting scheme</td>
</tr>
<tr>
<td></td>
<td>Technology support</td>
</tr>
<tr>
<td></td>
<td>Shared information quality</td>
</tr>
<tr>
<td>Risk</td>
<td>Collaboration strategy partner</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Confidence crisis,</td>
<td></td>
</tr>
<tr>
<td>Lack of resources,</td>
<td></td>
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<tr>
<td>Information technology system and cooperation,</td>
<td></td>
</tr>
<tr>
<td>Electronic data interchange (EDI) issue,</td>
<td></td>
</tr>
<tr>
<td>Forecasting level of manufacturer/supplier,</td>
<td></td>
</tr>
</tbody>
</table>

**Supply chain risk management** | **Basic supply chain risk model**

*Sheet 7. Theoretical Concepts [Source: Own creation]*

These concepts are basis of theoretical study. The four dimensions of VMI help us to know the operation process of VMI system in case companies from four perspectives. Then supporting activities concentrate to be described in an independent part, in order to show with more details and more clearly. When a company applies VMI system, some activities should be used to support VMI system to operate, such as ERP system, company uses them as a platform to share information and Point-of-sales (POS) data, it is referred to control demand information. Supporting activities also can integrate with four dimensions of VMI system. Benefits and risks of VMI system provide a general driving forces and issue when a company uses VMI system. Basic supply chain risk model guides the way to analyses risk in supply chain when a company uses VMI system.
4. Empirical Data

This chapter provides some views about the current VMI system operating in those household appliance companies from Sweden and China. This chapter also gives the empirical data of this thesis. The data is mainly through primary data, i.e. interview in Electrolux Laundry Systems Sweden AB, and second data, i.e. collecting information from journals or some books within Haier Logistics Co., Ltd, Hisense Eletric Co. and Midea Air-conditioning. While gathering information about VMI risk managing divide four dimensions for discussion and kept in mind to contribute to this thesis’ research questions.

4.1 Chinese perspective

4.1.1 Chinese household appliance company

The Chinese household appliances include refrigeration appliances (fridges, freezers and fridge freezers); cooking appliances (cookers, microwaves, ovens, cooker hoods, food processors and toasters); washing appliances (washing machines, clothes dryers and washer-dryers); room comfort and water heater appliances (which include air conditioning, circulating and ventilation fans, space heaters and water heaters); vacuum cleaners; and dishwashers (Household Appliances Industry Profile: China, 2014).

During 2009-2013 periods, the Chinese household appliance market show a rapid growth, which grew by 17.1% in 2013 to reach a value of $93,538.6 million (Household Appliances Industry Profile: China, 2014). However, Household Appliances Industry Profile: China (2014) reported a forecast from Marketline, which predicted Chinese household appliances market value is likely to increase since 2013. The information show on figure 15 and 16 below.

<table>
<thead>
<tr>
<th>Year</th>
<th>$ million</th>
<th>CNY million</th>
<th>€ million</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>61,193.9</td>
<td>379,084.0</td>
<td>46,084.2</td>
<td>8.3%</td>
</tr>
<tr>
<td>2010</td>
<td>66,295.4</td>
<td>410,666.5</td>
<td>49,926.0</td>
<td>8.3%</td>
</tr>
<tr>
<td>2011</td>
<td>73,422.9</td>
<td>454,840.0</td>
<td>55,293.7</td>
<td>10.8%</td>
</tr>
<tr>
<td>2012</td>
<td>79,868.0</td>
<td>494,766.2</td>
<td>60,147.4</td>
<td>8.8%</td>
</tr>
<tr>
<td>2013</td>
<td>93,538.5</td>
<td>579,452.8</td>
<td>70,442.5</td>
<td>17.1%</td>
</tr>
</tbody>
</table>

CAGR: 2009–13 11.2%

Figure 13. Chinese household appliances market value: $ million, 2009–13 [Source: Household Appliances Industry Profile: China, 2014, p.8]
According market analysis and comparing compound annual growth rate (CAGR) between 2009 and 2013, the Chinese household appliances market has a strong growing trend on the sales aspects, because in recent years, Chinese household appliances industry is increasing penetration and Chinese consumers are lifting consuming capability. Also, many household appliance companies in China selling products through internet retailing, the convenient internet retailing channels more or less increased consumer desire to purchase (Household Appliances Industry Profile: China, 2014). However, the product development and innovation capacity have serious shortage in Chinese household appliance company (Xiao Hong, 2007).

4.1.2 VMI in China

Currently, there is not more Chinese enterprises attempting management of VMI system. And most implement VMI system enterprises are multinational companies, which set up manufacturing plants in China. They are managed distributor in China by VMI system, such as L’Oreal in China established a special VMI management team to manage distributor and distribution systems. For Chinese enterprises, most of those rapid developments of large enterprises are implementing VMI system, like Lenovo began to use VMI management for raw material suppliers from upstream supply chain in 2004. Then it has achieved good efficiency and reduced the company's raw material inventory and improved competitiveness of enterprises for the implementation of more than ten years. Meanwhile, Chinese household appliance companies such as Haier, Midea and Huawei are both adopting VMI system. And other large and medium enterprises in China are preparing attempt to introduce the VMI system (Xiao Hong, 2007).

The development of VMI in China has a good opportunity. It is mainly manifested in: Firstly, the government in China encourages the development of enterprises. With the expansion of business scale, information management requirements will be higher, corresponding this macro environment provides a broad space for development of VMI system. Secondly, many companies realize that it is an important role in logistics cost control. The state encourages the development of logistics centers and reconstruction.
the existing logistics network in China. Modern multi-purpose logistics companies are emerging. It creates a hardware environment for VMI system. Finally, the Chinese software companies are flourishing, especially in software management such as ERP, CRM and other software is written for a particular company. Making some modifications in the software can be a good convergence with VMI system (Xiao Hong, 2007).

However, there are some problems in the process of VMI development in China:

**Unsound credit system and Lack of cooperation concept**

It is significant for information sharing and strengthens cooperation between the various businesses. Therefore, an improved credit system is necessary for the successful implementation of VMI system. But the proportion of credit transactions in China accounted for only 20% and they have a weak awareness of cooperation (Xiao Hong, 2007).

**Low level of management and information technology**

VMI support of technology is based on improved information systems and a high managerial level. But in China, the most companies have many problems about low level of management and information technology. For example, China's businesses mobile asset turnover is only 1.62 times / year, while the US and German companies’ mobile asset turnover is 8 times / year, Japanese companies’ mobile asset turnover is more than 7 times / year. Currently, utilizing VMI to optimize inventory management processes are not many success stories in China (Xiao Hong, 2007).

**Summary**

According to Wu Chanjuan (2014) pointed that there is still some issue in the process of VMI development in China, including weak sense of the supply chain, unsound credit system and lack of cooperation concept, low level of management and information technology, ect. So risk managing in using VMI system is quite serious issue in Chinese companies (Wu Chanjuan, 2014).

**4.1.3 VMI at Haier Logistics Co., Ltd**

**Overview**

Haier Group was founded in 1984, it was a small factory which on the verge of bankruptcy before 30 years ago. In order to survive and develop, Haier implemented brand strategy, diversification strategy and internationalization strategy, meanwhile reorganizing the logistic system three times during these 30 years. Nowadays, Haier has
grown into the number one brand in Chinese home appliance industry and the 4th largest home appliance manufacturer in the world, it has more than 70,000 employees around the international group and recorded revenues of RMB 135.7 billion in 2015. There are six units in Haier's businesses, including white and brown appliance (Air-conditioners, Washing Machines, digital and personal product), retailing (own home appliance sales channels), equipment components manufacturing group (home appliances, electronic and automobile manufacturing products), customer solutions business (medical freezers and integrated kitchens) and financial (finance and real estate businesses). Moreover, Haier group maintains 58800 sales outlets in more than 160 countries (He et al, 2014).

Haier Logistics Co., Ltd., belonging to Haier group, is establishment in 1999. Relying on advanced management concepts of the Haier Group and logistics technology applications, it develops in socialized business and satisfied internal logistics services, which means Haier Logistics Co., Ltd is a successful model in transformation from the enterprise logistics to logistics enterprise (Greg, 2014).

Haier Logistics Co., Ltd focuses on optimizing the entire supply chain and synchronized the whole process. In order to support customers achieve their goals of quickly obtain orders and order fulfillment, eliminating duplication of work and invalid in the internal and external aspects of Haier Logistics Co. (Greg, 2014).

Haier Logistics was rewarded “China Logistics Hundred Enterprises” “Top 100 Enterprises of Logistics Comprehensive strength in China” and “Best Home Appliance Logistics Enterprises” through advanced management concepts of the Haier Group and logistics technology applications. Currently, the three-year goal of Haier Logistics Company from 2016 to 2018 is to create a platform of globally competitive third-party logistics (Greg, 2014).

Haier Logistics Co., Ltd initiated VMI-Hub in 2000, because VMI system can accelerate reaction speed of supply chain in Haier Logistics and enhance the market competitiveness of Haier products. Since Haier Logistics using VMI system, it can save more than tens of millions RMB cost and help Haier Logistics Co., Ltd maintain high profit in the fierce market competition (Greg, 2014).

Inventory-related dimensions

The category of VMI system in Haier Logistics Co., Ltd (HLCL) can be seen in the following figure 17.
In the supply chain, HLCL is regarded as a vendor and the inventory is located in its side. Then the inventory is owned by manufacturer, but HLCL as a third-party logistics provider (3PL) manage the inventory as a VMI hub. In addition, HLCL has 300 manufacturers in China. Some manufacturers are belonging to Haier Group, while others are belong to other companies. But in this thesis, authors only study for some manufacturers are belonging to Haier Group. In China, HLCL has six VMI-Hubs by using VMI system. Generally, several of manufacturers are located near one VMI-Hub of HLCL less 2-3 km. The manufacturers produce products when they received the order, and directly deliver to HLCL’s stock from their production processes. The important variable is manufacturer’s production lead time (He et al, 2014).

**Information-related dimensions**

The forecasts information and delivery schedules are used for the inventory control process. By forecasting demand and actual customer order, HLCL purchasing manager makes order by customer ERP system. Manufacturers can receive the order in ERP system and start to produce. In other words, manufacturers and HLCL have online access to customer ERP system to perform the inventory control directly and to pick up the necessary information to be able to place a replenishment order or a production order. For HLCL and its manufacturers, the level of visibility and information sharing is very high because they are in the same Group and can share everything about inventory and customer demand. However, in VMI system, the level of forecasts information is not very high (He et al, 2014).

**Decision-making dimensions**
In order to improve inventory turns and reduce inventory costs, HLCL can cooperate with Haier Group and its manufacturers through ERP system with each other. That means in this process, Haier Group as HLCL’s customer, it makes replenishment order decision because they are in the same Group and Haier Group is responsible for the review the inventory information periodically and places orders if needed. Although the warehouse is in HLCL’s location, the inventories are held by manufacturer. So the replenishment order decision and shipment decision are made by HLCL. Moreover, HLCL depended on the customer demand to make replenishment in stock but it is lack to keep safety stock in warehouse (He et al, 2014).

**System integration level dimensions**

In this supply chain, the HLCL’s main manufacturer focuses on HLCL at a time and do not make products consolidation to deliver to more than one vendors. In the VMI replenishment planning process, there is only HLCL’s inventory which in HLCL’s site (He et al, 2014).

**Summary**

The following figure 18 summarizes four dimensions of VMI system in HLCL.

<table>
<thead>
<tr>
<th>Inventory-related dimensions</th>
<th>Information-related dimensions</th>
<th>Decision-making dimensions</th>
<th>System integration level dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory location is near HLCL’s site</td>
<td>Demand visibility bases on forecasts and allocations</td>
<td>Replenishment monitoring and ordering by continuing review and ordering</td>
<td>Focus on one VMI vendor at a time</td>
</tr>
<tr>
<td>Deliveries are from manufacturers production</td>
<td>On-line access to HLCL’s ERP system</td>
<td>Only a minimum limit for the inventory that the manufacturer has to stay above</td>
<td>Focus on single VMI item at a time</td>
</tr>
<tr>
<td>Manufacturers invoice when items are issued and own inventory</td>
<td>IT configuration is on-line in HLCL’s ERP system</td>
<td>HLCL gives an order proposal</td>
<td>the only resource that is considered is HLCL’s site inventory.</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>HLCL makes shipment decision</td>
<td>-</td>
</tr>
</tbody>
</table>

*Sheet 8. Summary of four dimensions of VMI system in HLCL. [Source: Own creation]*
4.1.4 VMI at Hisense Electric Co.

Overview

Hisense Electric Co. (HEC) is the largest subsidiary of Hisense Group, and as the predecessor of Hisense Group, HEC is also the oldest subsidiary of Hisense Group. HEC is headquartered in Qingdao, Shandong province. It mainly produces large-screen rear-projection TV, LCD TV, PDP TV and set-top boxes (Si Yan, 2012).

HEC has a long product line, in recent years, the annual output has reached 800 million units. In addition, HEC needs to purchase large quantities of production materials for HEC’s Huangdao information industrial Park, purchase the vast majority of materials for Linyi Hisense and Zibo Hisense, purchase key materials (picture tubes, integrated circuits etc.) for Liaoning and Guiyang Hisense and also purchase parts and components for South Africa and Hungary Hisense. There is thousands of procurement of material, which require huge material turnover monthly. In the process of turnover, a tiny mistake is most likely to cause the large backlog of reserve funds and materials (Si Yan, 2012).

In 2004, HEC learn from other companies’ example to utilize VMI system. The implementation of VMI system brings a new dawn to reserves management for HEC (Si Yan, 2012).

According to Si Yan (2012), one thing needs to mention before authors research VMI in HEC. HEC divides all materials into three categories (Consignment materials, Owned material and Materials by the customer directly sent to the production line), VMI system is only used by the first categories (Consignment materials).

Inventory-related dimensions

The category of VMI system in HEC can be seen in the following figure 18.
Figure 16. The category of VMI system in Hisense Electric Co. [Source: Own creation inspired by Si Yan, 2012]

Consignment materials stored in a warehouse which located in the side of manufacturer, and all these materials owned by the manufacturer. The manufacturer delivers to HEC from its stock, and these materials must pass inspection, otherwise are not allowed to enter into warehouse. Although the manufacturer owns and managed VMI warehouse, the employees, who work in the VMI warehouse, must be trained and evaluated by HEC before taking a post. The manufacturer delivers consignment materials to appointed place according to the requirement of HEC, and gets receipt. After that, the materials ownership is transferred from manufacturer to HEC (Si Yan, 2012).

Information-related dimensions

The forecasts and allocations are used for the inventory control process. By forecasting demand and actual customer order, HEC purchasing manager makes order in internal ERP system and sends customer demand information for manufacturer through EDI. Due to all these materials owned by the manufacturer, so that manufacturer control material demand information to get more accurate prediction, and guarantee JIT delivery. In VMI relationship between HEC and its manufacturer, the information sharing is very convenient. But the level of visibility is not considerably high because they are not in the same Group and lacking trust each other to share everything about inventory and customer demand (Si Yan, 2012).

Decision-making dimensions

Although the warehouse is in manufacturer’s location, the replenishment order decisions by HEC and the employee in inventory must be trained by HEC. In this process, HEC gives order proposals for its manufacturer (Si Yan, 2012). In addition, according to HEC 2012 annual report, 9.19% of consignment materials are imported material. Because of the longer international shipping and ordering cycle, HEC still need to own and control some of these inventories (Hisense Group, 2013).

System integration level dimensions

HEC’s manufacturer have many different customers, but most of them focus on HEC’s order at a time in each planning cycle. Because VMI of HEC only refers to consignment materials, the supplier focuses on all consignment materials of HEC simultaneously. Moreover, HEC’s manufacturer only focus on their own inventories and according to the forecasting to replenishment their own inventories (Si Yan, 2012).

Summary

The summary of VMI four dimensions in HEC shows on the following figure 20.
<table>
<thead>
<tr>
<th>dimensions</th>
<th>related dimensions</th>
<th>dimensions</th>
<th>level dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory located in manufacturer's site</td>
<td>Demand visibility bases on forecasts and allocations</td>
<td>Replenishment monitoring and ordering by continuing review and ordering</td>
<td>Focus on one VMI vendor at a time</td>
</tr>
<tr>
<td>Deliveries are from manufacturer’s stock</td>
<td>On-line access to HEC’s ERP system</td>
<td>There is only a maximum window in control limits due to physical space restrictions.</td>
<td>Focus on all consignment materials of HEC simultaneously</td>
</tr>
<tr>
<td>Manufacturers invoice when goods are delivered and own inventory</td>
<td>IT configuration is on-line in HEC’s ERP system</td>
<td>HEC makes replenishment order decision and gives order proposal</td>
<td>Focus on manufacturer’s inventory</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>Manufacturers make shipment decision</td>
<td>-</td>
</tr>
</tbody>
</table>

*Sheet 9. Summary of four dimensions of VMI system in HEC. [Source: Own creation]*

### 4.1.5 VMI at Midea Air-conditioning

#### Overview

Midea Group is founded in 1980 and now it is one of the biggest appliances manufacturers in China. It is headquartered in Shunde, Guangdong province. As of 2012, the firm employs approximately 135,000 people in the world. Its main business refers to household appliances and commercial air conditioners and also to integrate product develop, produce and service (Midea Group, 2012).

Midea Air-conditioning, belonging to Midea Group, is in the air-conditioning company ‘top three’ list in China. However, in the fiercely competitive market, it is not easy to keep competitiveness. In recent years, Midea Air-conditioning changed its strategy to reduce cost and increase efficiency frequently, such as reducing the market cost, downsizing, lowering the purchase price and so on. Moreover, for Air-conditioning companies, the level of inventory management is directly related to the overall cost, and is also related to the competitiveness of product price (Beijing Logistics, 2014).

Midea Air-conditioning initiated VMI system in 2002. Its inventory turnover of spare parts reached about 70-80 times and the inventory cycle decrease from 5-7 days before to 3 days in 2002. Just by improving one inventory turn, Midea Air-conditioning can save more than tens of millions RMB cost. Comparing with 2001, the sales volume of Midea Air-conditioning increased by 50%-60% in 2002, however, the finished goods inventory decreased 90,000 units. It helps Midea Air-conditioning maintain high profit in the fierce market competition (Beijing Logistics, 2014).
Inventory-related dimensions

It can be seen as Midea Air-conditioning (MAc) VMI system in figure 19. MAc as a leader in supply chain has 300 manufacturers (suppliers) and there are more than 30,000 kinds of spare parts products (combining exports and domestic sale). 60% of MAc’s manufacturers are near their headquarter, the other manufacturers are located within 3-5 driving days. Then MAc built many warehouses near its headquartered and rent to manufacturers. Manufacturers deliver spare parts into the warehouse for storage and the inventories are also managed by themselves. The manufacturers own the inventory in MAc’s side and invoice the customers when items are issued from stock. Then the property of items is transferred from manufacturers to MAc, before that manufacturers assume all inventory costs (Beijing Logistics, 2014).

Information-related dimensions

MAc establishes an information sharing platform with its manufacturers in the ERP system on the basis of ORACLE. Manufacturers can see the order information (including Varieties, type, quantity and delivery time, etc) through visiting MAc’s ERP system. Actually, manufacturers are not required to install ERP system, but they log on MAc’s page by web to obtain order information. At the beginning of each year, MAc selects manufacturers, sign the agreement and decide the price. MAc publishes the order information online, then, manufacturers confirm the order information, and a purchase order has been legalized. It reduces the number of agreements than before using this system (Beijing Logistics, 2014).

Decision-making dimensions
The replenishment order decisions and shipment decision are made by manufacturers. They review the inventory periodically and replenishment if needed. Although the warehouse is in MAc’s location, the inventories are held and are controlled by manufacturers. In addition, 10% of spare parts are imported material. Because of the longer international shipping and ordering cycle, MAc still needs to own and control some of these inventories (Beijing Logistics, 2014).

**System integration level dimensions**

MAc as the leader of supply chain, the manufacturers focus on MAc at a time and do not make products consolidation to deliver to more than one customers. Here, only the manufacturer’s inventory, which in MAc’s site, is considered in the VMI replenishment planning process (Beijing Logistics, 2014).

**Summary**

Following figure 22 is build to summarize the four deminsion of VMI system in MAc.

<table>
<thead>
<tr>
<th>Inventory-related dimensions</th>
<th>Information-related dimensions</th>
<th>Decision-making dimensions</th>
<th>System integration level dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory located in MAc’s site</td>
<td>Demand visibility through forecasts and/or delivery plans.</td>
<td>Replenishment monitoring and ordering by continuing review and ordering</td>
<td>Focus on one VMI vendor at a time</td>
</tr>
<tr>
<td>Deliveries are from manufacturer’ stock</td>
<td>On-line access to MAc’s ERP system</td>
<td>Only a minimum limit for the inventory that the manufacturer has to stay above</td>
<td>Focus on single VMI item at a time</td>
</tr>
<tr>
<td>Manufacturers invoice when items are issued and own inventory</td>
<td>IT configuration is on-line in MAc’s ERP system</td>
<td>Manufacturer makes order decision</td>
<td>Focus on manufacturer’s inventory</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>Manufacturer makes shipment decision</td>
<td>-</td>
</tr>
</tbody>
</table>

*Sheet 10. Summary of four dimensions of VMI system in MAc. [Source: Own creation]*

**4.2 Swedish perspective**
4.2.1 Swedish household appliance company

During 2008-2012 periods, the Swedish household appliances market had a big upward surge in overall performance (Household Appliances Industry Profile: Sweden, 2013). However, Household Appliances Industry Profile: Sweden (2013) reported a forecast from Marketline, which predicted Sweden household appliances market value is likely to decelerate during 2012-2017. The information show on figure 23 and 24 below.

![Figure 18. Sweden household appliances market value: $ million, 2008–12 [Source: Household Appliances Industry Profile: Sweden, 2013, p.8]](image1)

![Figure 19. Sweden household appliances market value forecast: $ million, 2012–17 [Source: Household Appliances Industry Profile: Sweden, 2013, p.12]](image2)

On the sales and product development aspects, a positive future has emerged in Sweden household appliance company. Its retail volume sales increased more positive than the slightly negative compound average growth rate (CAGR) in 2015. Because of more active real estate market and the development of employment marketplaces, these reasons stimulate consumers to invest new appliances. Also, the convenient internet retailing channels more or less increased consumer desire to purchase. On the product development aspects, in 2015 the subject of health and wellbeing influence household appliances industry in Sweden. The cooking appliances was the most popular product, it leads to taking a high level of cooking standard by offering consumers greater
possibilities in the kitchen. Then the interactive and smarter products will bring greater
growth in retail volume over the next five years (Country Report, 2016).

4.2.2 VMI in Sweden

According to Hemilä, J. et al. (2007), the definition of VMI is not clear in practice and
researches in Sweden. For VMI system, there are many articles and academic researches
to refer to different replenishment models, and is not clear to define a term for all
warehouse replenishment processes. In some cases, suppliers make decision to
replenishment for customers. One argument was that customer decides the items that it
uses and the rest is left as the concern of the supplier. Then in a VMI operation, it is hard
to define a certain kind operation is VMI and which is not. Hence Elvander et al. (2007)
developed a framework for characterizing the design of VMI systems based on a review
of prior research and an empirical investigation of Swedish industries. The new
framework summarizes the four main dimensions of VMI system and could be a tool for
profiling VMI system designs and for facilitating the comparison and analysis of different
VMI system configurations. In addition, by studying VMI system in three different kinds
of Swedish companies, Hemilä, J. et al. (2007, p.25) got the common idea “is that VMI
should somehow rationalize operations and the supply chain process, and then both the
supplier and the customer benefits (win-win situation)”

4.2.3 VMI at Electrolux Laundry Systems Sweden AB

Overview

Electrolux AB (Electrolux Group) was founded in 1919. Now it is one of the top ten
biggest household appliances producers, which emphasizes innovation and thoughtful
design, in the world. It is headquartered in Stockholm, Sweden and by the December 31,
2014, it employed approximately 60,038 people. In the financial year ended December
2014, Electrolux Group recorded revenues of SEK112, 143 million which increase 2.7%
than the revenues in financial year ended December 2013 (AB Electrolux, 2015).

There are three main divisions in Electrolux, which are Electrolux major appliances
(EMA), small appliances and Electrolux professional (EPR). The share of Group sales
revenue in 2015 revealed that EMA is the biggest part which occupied 80%, then small
appliances was 15%, EPR only occupied 5% share of Group sales (among the share of
EPR sales, 62% was professional kitchen, the remaining 38% was professional laundry)
(Marcus Larsson, personal communication, April 29, 2016).

Electrolux Professional AB had 2, 8960 employees and net got SEK6.5 billion net sales
in 2015. It owns 8 manufacturing plants in Europe and Asia, 6 R&D labs, 20 centers of
excellence worldwide, 8 strategic brands (such as, Thermaline, Alpeninox, Dito sama
etc.) and more than 140 markets worldwide (Marcus Larsson, personal communication,
April 29, 2016). Electrolux Professional AB brings the Foodservice and Laundry business closer together, in order to strengthen its sales and marketing functions. The implement of this view make more streamlined operations and an improved service to customers, particularly for those which span different divisions of Electrolux Professional (One Electrolux, n.d.).

Electrolux Laundry Systems Sweden AB, part of Electrolux Professional AB, engaged in the production, research and development of professional solutions for washing (Marcus Larsson, personal communication, April 29, 2016). According Marcus Larsson (April 29, 2016) who is purchasing manager spare parts laundry, VMI system as a solution applied to link from their factory to their spare parts warehouse. When he joined Electrolux Laundry Systems Sweden AB in 2010, VMI solution had been used for few years ago. He also mentioned before the established of VMI-solution people make order and communicate by e-mail, VMI system strengthens information flowrate and reduces time waste and inventory cost for Electrolux Laundry Systems Sweden AB.

**Inventory-related dimensions**

The category of VMI system in Electrolux Laundry Systems Sweden AB (ELSS) can be seen in the following figure 25.

![Figure 20. The category of VMI system in Electrolux Laundry Systems Sweden AB](Source: Own creation inspired by Marcus Larsson, personal communication, April 29, 2016)

In the supply chain, ELSS is regarded as a vendor and the inventory is located in its side. Then the inventory is owned and managed by itself. ELSS has 300 manufacturers and most of manufacturers are as well belonging to Electrolux Group. Its main manufacturer is located near ELSS less 1-2 km. The manufacturer produces products when he
received the order, and directly delivers to ELSS’s stock from his production processes. The important variable is manufacturer’s production lead time (Marcus Larsson, personal communication, April 29, 2016).

**Information-related dimensions**

The historical information and point-of-sale data is used for the inventory control process. By forecasting historical demand and actual customer order, ELSS purchasing manager makes order in internal Procurement and Roster Management System (PRMS) system. Manufacturers can receive the order in PRMS system and start to produce. In other words, manufacturers and ELSS have online access to PRMS system to perform the inventory control directly and to pick up the necessary information to be able to place a replenishment order or a production order. In VMI relationship between ELSS and its manufacturers, the level of visibility and information sharing is considerably high. Because they are in the same Group and can share everything about inventory and customer demand (Marcus Larsson, personal communication, April 29, 2016).

**Decision-making dimensions**

There are 30,300 kinds of spare part products in ELSS’s warehouse. One third of products need to keep safety stock in warehouse, and other products are depended on the customer demand to keep in stock. Every product has exclusive serial numbers, the inventory levels are continuously reviewed by ELSS and its manufacturers. Moreover, the replenishment order decision and shipment decision are made by ELSS (Marcus Larsson, personal communication, April 29, 2016).

**System integration level dimensions**

ELSS’s main manufacturer produces one VMI item at a time and deliver items only focus on one vendor (ELSS) at a time. And ELSS’s stock and manufacturers’ manufacturing capacity are included in the VMI replenishment planning process. In other words, when the planner in ELSS makes order, he also need consider the stock of spare parts warehouse as well as the production and delivery lead time of manufacturers (Marcus Larsson, personal communication, April 29, 2016).

**Summary**

The summary figure about four dimensions of VMI system in ELSS shows on the following.

<table>
<thead>
<tr>
<th>Inventory-related dimensions</th>
<th>Information-related dimensions</th>
<th>Decision-making dimensions</th>
<th>System integration level dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory location is near ELSS’s site</td>
<td>Historical demand/ point-of-sale data is</td>
<td>Replenishment monitoring and</td>
<td>Focus on one VMI vendor at a time</td>
</tr>
<tr>
<td></td>
<td>used for inventory control</td>
<td>ordering by continuing review and ordering</td>
<td>Deliveries are from manufacturers production</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------</td>
<td>-------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Manufacturers invoice when goods are delivered and own inventory</td>
<td>IT configuration is on-line in ELSS’s PRMS system</td>
<td>ELSS makes order decision</td>
<td>Focus on ELSS’ inventory and manufacturer’s manufacturing capacity</td>
</tr>
</tbody>
</table>

*Sheet 11. Summary of four dimensions of VMI system in ELSS. [Source: Own creation]*
This chapter relies on the empirical data and theoretical data to analyses and answer two research questions in this thesis: which the risk factors (RQ1) and how does to manage the risk in using VMI (RQ2) in Swedish and Chinese household appliance companies. The beginning of this chapter is to build the new analysis model and provides a comprehensive overview of VMI operating in the investigated companies. It helps author analyses easily and clearly.

5.1 Analysis model creation

5.1.1 Creating analysis model

According to Elvander et al. (2007) developed a framework of four VMI dimensions, here authors combine four dimensions of VMI system with the basic model of managing supply chain risk which created by Tang (2006). And then a new model is developed to assist the research of this thesis. In addition, in order to create an appropriate risk analysis model for VMI system, author would like to bring four dimensions of VMI system in the basic supply chain risk management model, instead of information management, demand management, product management and supply management. This new model showed in figure 27 will be used to analysis empirical data which in following chapter and help authors to find out the answer of research questions.
Four dimensions of VMI system provides a structure for company setup VMI system. Due to a number of different ways or options to configure VMI system, four dimensions of VMI system can effective identify factors that work in a VMI system (Elvander et al., 2007). Tang (2006) classified supply chain risk into four areas in a basic model to mitigate the effects of supply chain risk. Based on the basic supply chain risk management model, authors also divided risk of using VMI into four areas by four dimensions of VMI, in order to provide an efficient analysis model for this thesis.

Furthermore, there are five general risk factors in using VMI system, which authors have mentioned in chapter 3. These five general risk factors are Confidence crisis, Lack of resource, Information technology system and cooperation, Electronic data interchange (EDI) issue, and Forecasting level of manufacturer/supplier. Here, authors would like to describe them into four VMI dimensions, in order to analyzed how do the risk factors effect VMI system in case companies. Meanwhile, others risk factors might also exist in case companies, when they use VMI system. The following part, authors will figure out the risk factors in case companies of two countries.

5.2 Research question 1

What are the risk factors between Chinese and Swedish household appliance companies when using VMI system?
5.2.1 Risk factors in inventory-related dimensions

Inventory-related dimensions of case companies

<table>
<thead>
<tr>
<th></th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inventory location</strong></td>
<td>HLCL’s site</td>
<td>Manufacturer’s site</td>
<td>MAc’s site</td>
<td>ELSS’s site</td>
</tr>
<tr>
<td><strong>Sourcing policy</strong></td>
<td>Deliveries from manufacturers production</td>
<td>Deliveries from manufacturer’s stock</td>
<td>Deliveries from manufacturers’ stock</td>
<td>Deliveries from manufacturers production</td>
</tr>
<tr>
<td><strong>Inventory ownership</strong></td>
<td>Manufacturers invoice when items are issued and own inventory</td>
<td>Manufacturers invoice when goods are delivered and own inventory</td>
<td>Manufacturers invoice when items are issued and own inventory</td>
<td>Manufacturer’s invoice when goods are delivered and ELSS own inventory</td>
</tr>
</tbody>
</table>

*Sheet 12. Inventory-related dimensions of case companies [source: Own creation]*

**Haier Logistics Co., Ltd (HLCL)**

Currently, the development of vendor-managed inventory depends on big business or mid-sized company. VMI system is running efficiently and successfully that must keep frequent and large orders (Robert Malone, 2011). In other words, companies should have enough resources to keep VMI efficiently running. HLCL was rewarded “China Logistics Hundred Enterprises” “Top 100 Enterprises of Logistics Comprehensive strength in China” and “Best Home Appliance Logistics Enterprises” (Greg, 2014), and HLCL has 300 manufacturers in China (He et al, 2014). So there is no risk about lack of resources in HLCL.

David Burch (2008) pointed out the effective functioning of VMI system there needs to build trust between the manufacture and vendor. The trust is significant issue in the VMI because sometime vendor will no longer order stock items and manufacturer should track vendor’s consumption of stocks automatically to replace the necessary inventory that ensure vendor to run out even rarer. Then HLCL’s manufacturers invoice when items are issued and own inventory, but HLCL manages the inventory (He et al, 2014). It might have a risk that manufacturers less control the inventory, when HLCL cannot build an trust mechanism to share information. But considering HLCL and its
manufacturers are belonging to the same group. They can share the information with each other. The confidence crisis is not existent.

The manufacturers produce products when he received the order, and directly deliver to HLCL’s stock from his production processes (He et al, 2014), and He et al (2014) also mentioned the important variable is manufacturer’s production lead time. Hence, the production lead time could be a risk to cause the replenishment is not timely. According to several of manufacturers are located near one VMI-Hub of HLCL less 2-3 km. The delivery lead time is not existent.

**Hisense Electric Co. (HEC)**

According to Si Yan (2012), in recent years, the annual output has reached 800 million units, HEC needs to purchase large quantities of production materials to produce its products. So, HEC have enough resources to keep VMI system operating efficiently.

Consignment materials stored in a warehouse which located in the side of manufacturer, and all these materials owned by the manufacturer. The manufacturer deliveries to HEC from its stock (Si Yan, 2012). The delivery lead time could be a potential risk.

Then, although the manufacturer owns and manages VMI warehouse, the employees, who work in the VMI warehouse, must be trained and evaluated by HEC before taking a post (Si Yan, 2012). It reduces the happening of confidence crisis.

**Midea Air-conditioning (MAc)**

MAc as a leader in supply chain has 300 manufacturers and there are more than 30,000 kinds of spare parts products (combining exports and domestic sale) (Beijing Logistics, 2014). Sufficient resources ensure VMI run efficient in MAc.

60% of MAc’s manufacturers are near them headquarter, the other manufacturers are located within 3-5 driving days (Beijing Logistics, 2014). It reduces the risk of delivery lead time.

Manufacturers deliver spare parts into the warehouse which is in MAc’s side, for storage, and the inventories are also managed by themselves. Manufacturers invoice when items are issued from stock. Then the property of items is transferred from manufacturers to MAc, before that manufacturers assume all inventory costs (Beijing Logistics, 2014). Manufacturers can totally control their inventories and decide the replenishment. So, the confidence crisis between manufacturers and MAc is not existent.

**Electrolux Laundry Systems Sweden AB (ELSS)**

Robert Malone (2011) mentioned VMI depends on big business or mid-sized company and requires the company must keep frequent and large orders. Electrolux Laundry Systems Sweden AB belong to Electrolux Group which is one of the top ten biggest household appliances companies (AB Electrolux, 2015). And ELSS has 300
manufacturers (Marcus Larsson, personal communication, April 29, 2016). This information can prove the lack of resources is not existent in ELSS.

Most of manufacturers are belonging to Electrolux Group (Marcus Larsson, personal communication, April 29, 2016). There is no risk of confidence crisis between manufacturers and ELSS. And ELSS’s main manufacturer is located near ELSS less 1-2 km. The manufacturer produces products when he received the order, and directly delivers to ELSS’s stock from its production processes. The important variable, production lead time could be a potential risk.

Summary and comparison

<table>
<thead>
<tr>
<th>companies</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haier Logistics Co., Ltd (HLCL)</td>
<td>Production lead time is variable</td>
</tr>
<tr>
<td>Hisense Electric Co. (HEC)</td>
<td>Delivery lead time is variable</td>
</tr>
<tr>
<td>Midea Air-conditioning (MAc)</td>
<td>Non</td>
</tr>
<tr>
<td>Electrolux Laundry Systems Sweden AB (ELSS)</td>
<td>Production lead time is variable</td>
</tr>
</tbody>
</table>

Sheet 13. Risk factors of case companies in inventory-related dimensions [source: Own creation]

Chinese household appliance companies

According to three Chinese household appliance case companies, they are big and mid-size companies and both of them are the leader of supply chain. Hence Chinese household appliance company does not exist the limitations of the business size. These three Chinese case companies have the common which give the ownership of inventory to their manufacturers. It helps company to reduce a huge cost for building or renting warehouse and managing inventory, except Haier Logistics Co. Ltd which is in charge of managing inventory for manufacturers. And one thing need to be paid more attention is the delivery lead time and production lead time.

Swedish household appliance company

Swedish household appliance case company (Electrolux Laundry System Sweden AB) is big size company, there is not the problem of business size. Considering the supplier (manufacturer) and case company are belonging to the same Group, then the downstream customer is also the same customer for manufacturer and case company. The manufacturer produces products when he received the order, and directly delivers to ELSS’s stock from its production processes. However, the manufacturer close to downstream customer less than case company. Some orders come from key downstream customers, the manufacturer cannot give more attention and priority like case company did. And Marcus Larsson (April 29, 2016) also pointed out this risk when VMI system operating in case company. Authors believe this risk also refer to the variable in production lead time.
5.2.2 Risk factors in information-related dimensions

### Information-related dimensions of case companies

<table>
<thead>
<tr>
<th></th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand visibility</strong></td>
<td>Forecasts and allocations</td>
<td>Forecasts and allocations</td>
<td>Forecasts/ delivery schedules</td>
<td>Historical demand/ point-of-sale data</td>
</tr>
<tr>
<td><strong>Access to information</strong></td>
<td>on-line access to HLCL’s ERP system</td>
<td>on-line access to HEC’s ERP system</td>
<td>on-line access to MAc’s ERP system</td>
<td>on-line access to ELSS’s PRMS system</td>
</tr>
<tr>
<td><strong>IT configuration</strong></td>
<td>on-line in HLCL’s ERP</td>
<td>on-line in HEC’s ERP</td>
<td>on-line in MAc’s ERP</td>
<td>on-line in ELSS’s PRMS</td>
</tr>
</tbody>
</table>

*Sheet 14. Information-related dimensions of case companies [source: Own creation]*

### Haier Logistics Co., Ltd (HLCL)

The demand visibility bases on forecasts and allocations (He et al, 2014). Due to Haier Logistics Co., Ltd.(HLCL), belonging to Haier group. Nowadays, it is a successful model to satisfied internal logistics services (Greg, 2014). In other word, because of HLCL and Haier company are same group, they can share information and allocate recourse each other, so demand information is transparent. In general, there is no risk about confidence in HLCL.

Forecasting level is a big issue for the successful implementation of VMI. Forecasts information is used for the inventory control process; vendors provide more effective forecasting for inventory levels for manufactures in different periods (David Burch, 2008). Moreover, HLCL belonging to Haier Company, it provides a complete all of the information such as seasonal capacity adjustments to the Haier Group. So there is no risk about level of forecasts and allocations in HLCL.

In the information technology system and cooperation, enterprise prefer to use enterprise resource planning (ERP) system to connect with their manufactures, but ERP system in VMI system need to share enough information between manufactures and
vendors (Xiaohui Liu & Youwang Sun, 2011). In this process, HLCL have online access to customer ERP system to perform the inventory control directly and to pick up the necessary information such as IT configuration to be able to place a replenishment order or a production order (He et al, 2014). And HLCL is controlled by Haier group, so HLCL willing to share their market sales, inventory levels, sales estimates and other information with Haier Group, so that there is no risk about information technology system and cooperation in HLCL.

**Hisense Electric Co. (HEC)**

Due to Electric Co. (HEC) and its manufacturer do not the same group in VMI relationship, and the manufacturer owned and managed VMI warehouse. Although the employees who work in the VMI warehouse must be trained and evaluated by HEC before taking a post (Si Yan, 2012), the level of visibility is not considerably high. One reason is that they are not in the same Group, the other reason is lacking trust each other to share everything such as inventory levels, sales estimates and customer demand. So that there is confidence crisis in HEC.

Enterprise prefer to use enterprise resource planning (ERP) system to connect with their manufactures (Xiaohui Liu & Youwang Sun, 2011), so HEC purchasing manager makes order in internal ERP system. However, in this process, the manufacturer owns all these materials so that it controls all material demand information to get more accurate prediction, and HEC and manufacturers want to get maximum profit each other, so that it not willing to sharing is not enough information such as market sales, inventory levels. Moreover, ERP belongs information technology. In general, there is a risk in information technology system and cooperation in HEC.

Electronic data interchange (EDI) provides a data of electronic communication method through any electronic device. And a standard format must be able to read and understand the document used quickly in computer (Rochelle P. Cohen, 2013). HEC purchasing manager sends customer demand information for manufacturer through EDI. In this process, HEC used same format in all of document with their manufactures, such as all of document word used Chinese Simplified and voice document used Mandarin. So there is no risk about EDI issue.

**Midea Air-conditioning (MAC)**

In the information technology system, Midea Air-conditioning (MAC) focus on enterprise resource planning (ERP) system to build an information sharing platform with its manufacturers. During this process, by visiting MAC’s ERP system, manufacturers could see all of the order information, such as quantity and delivery time. Moreover, manufacturers log on MAC’s page to obtain more order information through website. This process very convenient that MAC publishes the order information online and manufacturers confirm the order information. They can share enough order information each other. So there is no risk about information technology system and cooperation in MAC’s.

Due to the ERP system uses well between MAC’s and its manufacturer, through MAC’s control the inventory, it utilized ERP system to maintain a good working relationship
with manufactures and share information such as market sales, so there is no risk about confident crisis between MAc’s and its manufacturer.

Forecasting level is an important issue for the successful implementation of VMI. It is used for the inventory control process; vendors provide more effective forecasting for inventory levels for manufactures in different periods (David Burch, 2008). Moreover, MAc’s provides resource about order information and market sales to its manufacturer. It is help manufacturer improve the ability to predict accurately. So there is no risk about level of forecasts and allocations in MAc’s.

**Electrolux Laundry Systems Sweden AB (ELSS)**

Due to Electrolux Laundry Systems Sweden AB (ELSS), belonging to Electrolux Laundry group. And they can share everything about inventory and customer demand (Marcus Larsson, personal communication, April 29, 2016). In other word, because of ELSS and manufacturer are same group, they can allocate recourse each other, so the level of visibility and information sharing is considerably high. In general, there is no risk about confidence in ELSS.

Focus on forecasting level, ELSS used historical information and point-of-sale data in the inventory control process, which means ELSS purchasing manager makes order in internal Procurement and Roster Management (PRMS) system. PRMS basis on historical demand to forecast demand in the future. In this process, manufacturers and ELSS have online to perform the inventory control directly and to pick up some information to be able to place a production order. However, PRMS is old system, and it is not obtaining all of information such as market sales, inventory levels or sales estimates like ERP system. PRMS is not improving the ability to predict accurately. So there is a risk about level of forecasts and allocations in ELSS.

### Summary and comparison

<table>
<thead>
<tr>
<th>companies</th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risks</strong></td>
<td>Non</td>
<td>1. Confidence crisis</td>
<td>Non</td>
<td>Forecasting level is not very high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Information technology system does not share enough information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Sheet 15. Risk factors of case companies in information dimensions [source: Own creation]*
According to three Chinese household appliance case companies, there is only Hisense Electric Co. (HEC) to exist crises. One risk is confidence crisis, the other is ERP system. The causes of these fundamental is not share enough information between vendor and manufacturer, especially they are not from the same group. So how to improve confidence between them become a big issue in Chinese household appliance companies.

**Swedish household appliance company**

Swedish household appliance case company (Electrolux Laundry System Sweden AB/ELSS) have very high confidence level with their manufacture. But in forecasting level, ELSS uses PRMS system which is old system basis on historical demand to predict and not obtain all of information such as market sales, inventory levels or sales estimates like ERP system. So Authors believe this risk could be solved, and suggest ELSS use ERP system to improve the ability to forecast level accurately.

### 5.2.3 Risk factors in decision-making dimensions

#### Decision-making dimensions of case companies

<table>
<thead>
<tr>
<th></th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replenishment monitoring and ordering</td>
<td>continuous review and ordering</td>
<td>continuous review and ordering</td>
<td>continuous review and ordering</td>
<td>continuous review and ordering</td>
</tr>
<tr>
<td>Control limits</td>
<td>Only a minimum limit for the inventory that the manufacturer has to stay above</td>
<td>Only a maximum window in control limits due to physical space restrictions.</td>
<td>Only a minimum limit for the inventory that the manufacturer has to stay above</td>
<td>No minimum and maximum windows for the manufacturer to control the inventory within.</td>
</tr>
<tr>
<td>Replenishment decision</td>
<td>HLCL gives an order proposal</td>
<td>HEC makes replenishment order decisions and gives order proposals</td>
<td>Manufacturers make replenishment order decisions</td>
<td>ELSS makes replenishment order decisions</td>
</tr>
</tbody>
</table>
Sheet 16. Decision-making dimensions of case companies [source: Own creation]

Haier Logistics Co., Ltd (HLCL)

The inventories are held by manufacturers, but the VMI-Hubs are managed by HLCL and located in HLCL’s site. And both the replenishment and shipment decisions are made by HLCL (He et al, 2014). For the decision-making dimensions, HLCL occupies the absolute initiative. So there is no risk in HLCL.

And there is only a minimum limit for the inventory that HLCL’s manufacturers have to stay above. However, He et al (2014) mentioned HLCL depended on the customer demand to make replenishment in stock but it is lack to keep safety stock in warehouse. Hence, the lack of safety stock come into being in HLCL.

Hisense Eletric Co. (HEC)

Although HEC is replenishment monitoring and ordering by continuing review and ordering, and also makes replenishment decision. The shipment decision is made by its’ manufacturers (Si Yan, 2012) and inventory is located in manufacturers’ site; and there is only a maximum window in control limits due to physical space restrictions; moreover according to HEC 2012 annual report, 9.19% of consignment materials are imported material. It leads to the longer international shipping and ordering cycle, HEC still need to own and control some of these inventories (Hisense Group, 2013). These issues are caused by the long delivery lead time.

Midea Air-conditioning (MAc)

The replenishment order decisions and shipment decision are made by manufacturers. They review the inventory periodically and replenishment if needed. And the warehouse is in MAC’s location, the inventories are held and are controlled by manufacturers. For MAc, by rights, should not have the risk about long delivery lead time. However, there are 10% of spare parts are imported material. Because of the longer international shipping and ordering cycle, MAc still needs to own and control some of these inventories (Beijing Logistics, 2014). Hence, VMI operated in MAc still exists the risk of long delivery lead time.

Electrolux Laundry Systems Sweden AB (ELSS)

In these dimensions, every product has exclusive serial numbers, the inventory levels are continuously reviewed by ELSS and its manufacturers. And the replenishment order decision and shipment decision are made by ELSS. There is one risk factor. Because one third of products need keep safety stock in warehouse, and other products are depended on the customer actual demand (Marcus Larsson, personal communication, April 29, 2016). It implies that part of the replenishment order and shipment decisions owned by downstream customer actual demand. The downstream customer make order
and confirm delivery lead time, case company needs make order from its manufacturer (supplier) through downstream customer’s requirement. Under this background, if planner in ELSS makes a little mistake in ordering process or downstream customer changes demand, it will cause the manufacturer get wrong information. Manufacturer produces products by the wrong information, if manufacturer is already in production process, it is not easy to fix the mistake (Marcus Larsson, personal communication, April 29, 2016). Hence, Swedish household appliance case company in these dimensions is less controlling the replenishment order and shipment decisions.

**Summary and comparison**

<table>
<thead>
<tr>
<th>companies</th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risks</td>
<td>lack of safety stock</td>
<td>Long delivery lead time</td>
<td>Long delivery lead time</td>
<td>less controlling the replenishment order and shipment decisions</td>
</tr>
</tbody>
</table>

*Sheet 17. Risk factors of case companies in decision-making dimensions [source: Own creation]*

**Chinese household appliance companies**

For Chinese household appliance case companies, the replenishment order decision or shipment decision are made by manufacturer, except HLCL. There are two risk factors in decision-making dimensions. According He et al (2014) pointed that one risk factor is lack to keep safety stock in warehouse, because some Chinese companies only depended on the customer demand to make replenishment in stock. It saves inventory cost, but it cannot quick response emergency situation. According Beijing Logistics (2014) pointed that another risk factor is that some Chinese companies still need to own and control some of these inventories because some spare parts are imported material and they need longer international shipping and ordering cycle.

**Swedish household appliance company**

Swedish household appliance case company (ELSS) keep safety stock for one third of products and its main manufacturer is located near ELSS less 1-2 km (Marcus Larsson, personal communication, April 29, 2016). So, ELSS does not have the problem about lack safety stock and long delivery lead time. However, part of replenishment demand depends on downstream customer actual demand that causes ELSS less control for the replenishment order decision and shipment decision.

**5.2.4 Risk factors in system integration level dimensions**
## System integration level dimensions of case companies

<table>
<thead>
<tr>
<th></th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of horizontal integration of customers</strong></td>
<td>focus on one VMI vendor at a time</td>
<td>focus on one VMI vendor at a time</td>
<td>focus on one VMI vendor at a time</td>
<td>focus on one VMI vendor at a time</td>
</tr>
<tr>
<td><strong>Level of horizontal integration of items</strong></td>
<td>focus on single VMI item at a time</td>
<td>focuses on all consignment materials of HEC simultaneously</td>
<td>focus on single VMI item at a time</td>
<td>focus on single VMI item at a time</td>
</tr>
<tr>
<td><strong>Level of vertical integration</strong></td>
<td>HLCL’s inventory</td>
<td>Manufacturers own inventory</td>
<td>Manufacturers own inventory</td>
<td>ELSS’s inventory and manufacturer’s manufacturing capacity</td>
</tr>
</tbody>
</table>

Sheet 18. System integration level dimensions of case companies [source: Own creation]

### Haier Logistics Co., Ltd (HLCL)

In this supply chain, the HLCL’s main manufacturer focuses on HLCL at a time and focuses on single VMI item at a time. In the VMI replenishment planning process, there is only HLCL’s inventory which in HLCL’s site (He et al, 2014). Authors believe that risk do not exist in HLCL.

### Hisense Electric Co. (HEC)

The manufacturers focus one VMI vendor at a time and can consider the total demand for all consignment materials in each planning cycle and try to optimize delivery (Si Yan, 2012). There is no risk. However, considering its manufacturers own inventory and 9.19% of consignment materials are imported material, HEC do not hold own inventory (Hisense Group, 2013). Hence, there is a risk of long delivery lead time in this VMI dimensions.

### Midea Air-conditioning (MAc)

According to Beijing Logistics (2014), MAc as the leader of supply chain, the manufacturers focus on MAc at a time and single VMI item at a time. There is no risk. However, 10% of spare parts are imported material, and MAc do not own the inventory.
for the imported material. Then the long delivery lead time also exist in this dimension of VMI for MAc.

**Electrolux Laundry Systems Sweden AB (ELSS)**

Manufacturer produces one VMI item at a time and deliver items only focus on ELSS at a time. And ELSS’s stock and manufacturers’ manufacturing capacity are included in the VMI replenishment planning process (Marcus Larsson, personal communication, April 29, 2016). And the manufacturer and ELSS are belonging to the same Group. Considering above reasons, author think the risk factors do not exist in these dimensions.

### Summary and comparison

<table>
<thead>
<tr>
<th>companies</th>
<th>Haier Logistics Co., Ltd (HLCL)</th>
<th>Hisense Electric Co. (HEC)</th>
<th>Midea Air-conditioning (MAc)</th>
<th>Electrolux Laundry Systems Sweden AB (ELSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risks</td>
<td>Non</td>
<td>Long delivery lead time</td>
<td>Long delivery lead time</td>
<td>Non</td>
</tr>
</tbody>
</table>

*Sheet 19. Risk factors of case companies in system integration level dimensions [source: Own creation]*

**Chinese household appliance companies**

In these dimensions, Chinese household appliance case companies are the leader of their supply chain, the behavior of manufacturer is almost based on case companies. Hence, manufacturer only focuses on case companies at a time. However, except HLCL, other two companies do not own inventories by themselves, and they cannot handle the imported material that need a long delivery time. In these dimensions, there is a risk of long delivery time in MAc and HEC.

**Swedish household appliance company**

For Swedish household appliance company (ELSS), the manufacturer only focuses on ELSS and single VMI item at a time. And the resources are considered ELSS’s inventory and manufacturer’s manufacturing capacity. There is no risk in ELSS.

**5.2.5 Summary: risk factors between Chinese and Swedish case companies**
According to the analysis of research question 1, there are seven risk factors between Chinese and Swedish household appliance companies when they use VMI system. These seven risk factors are showed on the bellowing sheet 20.

<table>
<thead>
<tr>
<th>Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Uncertain production lead time</td>
</tr>
<tr>
<td>2. Long delivery lead time</td>
</tr>
<tr>
<td>3. Confidence crisis</td>
</tr>
<tr>
<td>4. Forecasting level is not high</td>
</tr>
<tr>
<td>5. Less control the decision making</td>
</tr>
<tr>
<td>6. Low information technology system and cooperation</td>
</tr>
<tr>
<td>7. Lack of safety stock</td>
</tr>
</tbody>
</table>

Sheet 20. Risk factors of VMI system in Chinese and Swedish household appliance companies [source: Own creation]

5.3 Research question 2

How do Swedish and Chinese household appliance companies manage the risk in using VMI?
In this part, the author would like to analyze the way Chinese and Swedish household appliance companies manage and avoid these seven risk factors. Because these seven risk factors refer to four different dimensions of VMI system, authors think this paper should also find the method from four dimensions of VMI.

5.3.1 Managing risk factors in inventory-related dimensions

![Diagram showing risk factors in inventory-related dimensions in Chinese and Swedish household appliance companies.]

Considering MAc is no risk in this dimensions, authors would like to use MAc as an example to analyze the managing way in inventory-related dimensions.

**Uncertain production lead time (HLCL and ELSS)**

Previously, authors analyze the main reason, that cause uncertain production lead time, is manufacturers deliver from their production to case companies’ stock. For this risk, MAc’s manufacturers deliver products from their stock instead of production. Then in case avoid long delivery lead time, when deliver from manufacturers’ stock, MAc build closely warehouse and rent to manufacturers. So, the managing way are from manufacturers ‘stock delivery and closely warehouse.

**Long delivery lead time (HEC)**

Long delivery lead time in HEC, because its inventory is located in manufacturers’ site and the manufacturers deliver to HEC from its stock. Considering the managing way of MAc, the inventory location should be near company’s site or purchase from the closely manufacturers.
Summary

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Management of VMI risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertain production lead time (HLCL and ELSS)</td>
<td>Manufacturers’ stock delivery and closely warehouse (MAc)</td>
</tr>
<tr>
<td>Long delivery lead time (HEC)</td>
<td>The inventory location near company’s site or purchase from the closely manufacturers (MAc)</td>
</tr>
</tbody>
</table>

*Sheet 21. Managing risk factors in inventory-related dimensions [source: Own creation]*

5.3.2 Managing risk factors in information-related dimensions

**Figure 24. Risk factors of information-related dimensions in Chinese and Swedish household appliance companies [source: Own creation]**

**Confidence crisis (HEC)**

In the Hisense Electric Co. (HEC), there is a big issue when HEC using VMI system, which is confidence crisis with its manufacture, because HEC and manufacture are not same group and lacking trust each other to share everything. In this VMI system, the manufacturer owned and managed VMI warehouse. In order to solve the issue, Authors provide the other cases company, which are Haier Logistics Co., Ltd.(HLCL) and Electrolux Laundry Systems Sweden AB (ELSS) manage the confidence issue. They and their manufactures are from their own companies, which means HLCL from Haier.
group and ELSS from Electrolux Group. Due to they are from the same group, which is distinguished from different companies such as HEC. They are responsible for all logistics business from the same company and share information or resources each other.

So authors suggest HEC will be set up their own logistics company. Because owning logistics company such as HLCL and ELSS can improve confidence level for each other. It is benefit for HEC and reducing confidence crisis with its manufacture.

Invalid information system (HEC)

In the information technology system, HEC does not share enough information with its manufacture when using ERP system. Because of all these materials owned by the manufacturer, HEC and manufacturers want to get maximum profit each other, so that it not willing to sharing is not enough information such as market sales, inventory levels. In order to solve the issue, Authors provide the other cases company, which is Midea Air-conditioning (MAC). MAC does not only control all these materials, but also builds an information sharing platform with its manufacturers when using ERP system. It means that manufacturers log on MAC’s page to obtain more order information through website, then MAC publishes the order information online and manufacturers confirm the order information. They can share enough order information each other.

So authors suggest HEC set up an information sharing platform with its manufacturers when using ERP system, which means HEC publishes the order information online and manufacturers log on HEC page to obtain and confirm the order information. This process is improving management in ERP system.

Low forecasting level (ELSS)

In the forecasting level, Electrolux Laundry Systems Sweden AB (ELSS) purchasing manager makes order in internal Procurement and Roster Management (PRMS) system, which is old system and basis on historical information and point-of-sale data in the inventory. PRMS system is not obtaining all of information such as inventory levels. In order to solve the issue, Authors provide the other cases company, which is Midea Air-conditioning (MAC). MAC utilize ERP system and set up an information sharing platform with its manufacturers. MAC publishes the order information in website and manufacturers log on MAC page to obtain and confirm the order information. By this process, MAC could improve forecasting level with manufacture. It is better than PRMS system which is only basis on historical demand. ERP system indirectly help to improve the forecasting level.

So authors suggest ELSS uses ERP system to replace the PRMS system and utilized ERP system enhance ability to obtain all order information online between ELSS and manufacture. Along with getting more information such as quarterly sales, forecasting level will be higher in ELSS.

Summary

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<th>Management of VMI risks</th>
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5.3.3 Managing risk factors in decision-making dimensions

How do the others case companies manage the risk?

- **Lack of safety stock (HLCL)**
  
  In HLCL manufacturers need to stay above safety stock because of only a minimum limit. But the replenishment and shipment decision are made by HLCL, manufacturers less control the inventory. It is main reason to cause lack of safety stock. For this risk, Mac could be a good example, because both HLCL and Mac have only a minimum limit for the inventory that the manufacturer has to stay above, but Mac’s manufacturers make replenishment and shipment decision by themselves. It avoids to less control their stack and keep the safety stock.

- **Long delivery lead time (HEC and Mac)**
  
  There are 10% of spare parts are imported materials in Mac, and 9.19% of consignment materials are imported material in HEC. Because of the longer international shipping
and ordering cycle, these around 10% materials need long delivery lead time. According to Si Yan (2012) and Beijing Logistics (2014) suggest HEC and MAC should own and control some of inventory for the imported materials.

**Less control the decision making (ELSS)**

This risk in ELSS is caused by the fluctuating downstream customer order, and distant relationship between manufacturer and downstream customer. For this risk, authors believe HEC can be a good example. HEC makes replenishment order decisions and also give the order proposals to manufacturers. In this case, HEC can control a part of replenishment decision and also give part of decisions to manufacturers by HEC’s order proposal. Then manufacturer starts to focus on some actual customer orders and also have chance to close the downstream customer’s requirement.

**Summary**

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<th>Risk factors</th>
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<tr>
<td>Lack of safety stock (HLCL)</td>
<td>Manufacturers make replenishment and shipment decision by themselves (MAC)</td>
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<td>Long delivery lead time (HEC and MAC)</td>
<td>owning and controlling some of inventory for the imported materials</td>
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<tr>
<td>Less control the decision making (ELSS)</td>
<td>giving the order proposals to manufacturers (HEC)</td>
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</table>

*Sheet 23. Managing risk factors in decision-making dimensions [source: Own creation]*

**5.3.4 Managing risk factors in system integration level dimensions**

*Figure 26. Risk factors of decision-making dimensions in Chinese and Swedish household appliance companies [source: Own creation]*

**Long delivery lead time (HEC and MAC)**

**How do the others case companies manage the risk?**
In this dimensions, it is the same as in decision-making dimensions, HEC and MAc still exist the long delivery lead time because of the oversea purchasing. The managing way is to hold and control safety stock of imported materials by themselves.

Summary

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<th>Risk factors</th>
<th>Management of VMI risks</th>
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</thead>
<tbody>
<tr>
<td>Long delivery lead time (HEC and MAc)</td>
<td>holding and controlling the safety stock of imported materials by themselves</td>
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Sheet 24. Managing risk factors in system integration level dimensions [source: Own creation]
6. Conclusion and recommendation

6.1 Conclusion

In this thesis, authors do a research about risk in using VMI system in Chinese and Swedish household appliance companies. Three Chinese household appliance companies (Haier Logistics Co., Ltd, Hisense Electric Co. and Midea Air-conditioning) and one Swedish household appliance company (Electrolux Laundry System Sweden AB) are selected as sample for research. Based on theoretical and empirical data, author create an analysis model, which is the integration between four dimensions of VMI system and the basic supply chain risk management model, to assist the analysis of research questions. Through analysis, authors identify seven risk factors:

1. Uncertain production lead time
2. Long delivery lead time
3. Confidence crisis
4. Forecasting level is not high
5. Less control the decision making
6. Low information technology system and cooperation
7. Lack of safety stock

in using VMI system from four dimensions of VMI respectively between Chinese household appliance and Swedish household appliance case companies.

And then, authors also illustrate the method of managing risk in using VMI system from four dimensions in Chinese and Swedish household appliance case companies. It describes on the following part (implication for management).

6.2 Implication for management

Via the analysis and comparison, author found the methods of risk managing in using VMI system between Chinese and Swedish household appliance companies have some different and can learn from each other. For Chinese household appliance company, they should have more confidence with VMI partner and information sharing should more open. It is a good idea to learn from Swedish household appliance case company which the manufacturer is belonging in the same Group. It also can help Chinese household appliance company to improve their forecasting level. For Swedish household appliance company, to improve technology system learn from Chinese household appliance company using ERP system. It helps Swedish household appliance case company to improve the quality of information. And ERP system also can help the manufacturer of Swedish household appliance case company to be closer to downstream customer. Because, in ERP system, the information shares more intuitive and clearer for all partner in VMI system.

6.3 Further research

This study carries out a qualitative research for the four case household appliance companies from Sweden and China. The field of research is the VMI system risk managing as the theme deal with the related issue within Swedish and Chinese
household appliance companies as well as providing recommendation. Due to the limited
time to carry out this item, this thesis will be limited to the process from companies in
upstream supply chain are facing risk managing in using VMI system. Hence, for this
thesis, author only focus on the upstream of supply chain. The risk of using VMI system
in downstream supply chain or in the whole supply chain can be a new vision to future
study. And, the method, which help Chinese and Swedish household appliance companies
to avoid the risk in using VMI system and improve their risk managing way, can be
studied in further.

Moreover, this thesis only focus on explaining the risk factors and the way risk managing
in using VMI system. The further research can expand to expose the effect of these seven
risk factors in these four case companies and study deeply to explore the result of
management of VMI risk.
Reference list


Gu Haiou (2009), The Research of QR and ECR, *Chinese hi-tech enterprises*.


Zenjiro Imaoka, (2012), Understand Supply Chain Management through 100 words, KOUGYOUCHOUSAKAI.


Internet:


Interview:

Marcus Larsson (2016, April 29). Personal Interview.
Appendix A - Interview guide for Electrolux Laundry Systems Sweden AB

Interviewee: Marcus Larsson (purchasing manager)

Date: 2016-04-29

General questions about VMI

1. Why does Electrolux implement VMI system?
   a. When did you implement VMI?
   b. Who initiated on the VMI implementation?
   c. What was the reaction from the employees at your company when introducing VMI?
   d. How many VMI implementations does your company have?
   e. How long time did VMI take to implement/develop?

2. How work in VMI system?
   a. Is it inbound VMI or is outbound VMI?
   b. What are the product(s) characteristics?
   c. Who paid for it, you or your VMI partner?
   d. Where is your VMI-partner located?
   e. Who owns the inventory?
   f. Are you using ERP system? and what type of ERP system?

3. What information transferred between Electrolux’s supplier and Electrolux in VMI relationship or between Electrolux and Electrolux’s distribution centre?
   a. What information is shared? what is not shared?
   b. How is the information shared? And what are the information sharing activities?

4. What are the benefits of VMI system, when you implement it?
a. Have the VMI implementation resulted in changed service levels?
   Sals volume? Stock out costs?

b. Have the VMI implementation resulted in changed administration levels?
   Order process? Forecast process? Invoice process?

c. Have the VMI implementation resulted in changed inventory level?
   Row material? Finished goods? Work in process? Safety stock?

d. Have the VMI implementation changed the production?
   Productivity? Machine utilization? Through put time?

e. What are the benefits for you and your VMI partner?

5. What risks are there when Electrolux uses VMI system?
a. What are the major risks with the VMI implementation?

6. In VMI process, how to reduce risks in VMI system?

**Specific questions**

1. How many suppliers does your company have?

2. How large is the VMI-customer(s) in terms of demand?

3. Is any information sensitive to share with the supplier?

4. Has any information leaked to competitive companies during the VMI process?

5. Is the information shared accurate?

6. What are the causes of inaccurate information?

7. What are the effects of inaccurate information?

8. How could you profit more from the VMI relationship?

9. Will the VMI relationship be further developed in the future?