How to apply inventory management in a PC company

A case study of Lenovo Company

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Summary

In recent years, Inventory management has become one of the most important parts in a company supply chain management. For a company, how to get effective and reasonable inventory management to reduce production costs becomes an important topic in today's enterprise management.

The development of inventory management in China is still at start-up stage. This thesis chose Lenovo as case study Company and analyzed the problem in Lenovo’s inventory management process. By comparing with Lenovo’s previous and current inventory management model, this thesis presents reasonable measurements of implementing vendor management inventory in Lenovo. Vendor managed inventory is an integrated approach for retailer–vendor coordination (Darwish & Odah, 2010).

In this case study, in order to get the basic information about Lenovo, interviews have been used. Other data were collected from literature review and Lenovo annual report. The VMI technology's impact on Lenovo was gradually revealed through long-term practice. It improved production flexibility, the core competitiveness of the entire supply chain and even corporate brand image. The VMI also helped Lenovo to reduce inventory and logistics operating costs and improve management capabilities and operational efficiency. Several features of Lenovo's VMI model have been presented in this thesis. They are information sharing, cost saving, sales forecasting, customer service level, quick response, and suppliers work all of which together to achieve a win-win situation and coordination of product supply and demand.

Key word: Inventory management, Lenovo, Vendor Management Inventory, Kanban System.
Content

1. Introduction .................................................................................................................................................. 1
   1.1 Background ........................................................................................................................................... 1
   1.2 Purpose .................................................................................................................................................. 2
   1.3 Information about Lenovo .................................................................................................................... 3
   1.4 The Structure of Thesis .......................................................................................................................... 3
2. Methodology ................................................................................................................................................. 4
   2.1 Overview of Research Process ................................................................................................................ 4
   2.2 Data Collection ....................................................................................................................................... 5
      2.2.1 Literature Review .............................................................................................................................. 5
      2.2.2 Case Study ........................................................................................................................................ 6
      2.2.3 Interview .......................................................................................................................................... 8
   2.3 Validity and Reliability ............................................................................................................................ 9
   2.4 Limitation ............................................................................................................................................... 10
3. Literature Review ......................................................................................................................................... 11
   3.1 Supply Chain Management .................................................................................................................... 11
   3.2 Warehouse Management ....................................................................................................................... 12
      3.2.1 Warehouse Management System .................................................................................................. 13
      3.2.2 Identify Activities of Warehouse Management ............................................................................. 13
      3.2.3 Warehouse Process ......................................................................................................................... 14
   3.3 Inventory Management .......................................................................................................................... 15
      3.3.1 Kanban System ............................................................................................................................... 16
      3.3.2 Bullwhip Effect .............................................................................................................................. 18
   3.4 Vendor Managed Inventory .................................................................................................................... 19
      3.4.1 Basic Knowledge of VMI ................................................................................................................ 20
      3.4.2 VMI’s Model Features .................................................................................................................... 20
      3.4.3 VMI Operating Modes .................................................................................................................... 23
      3.4.4 Suppliers -Manufacturer VMI Mode of Operation ....................................................................... 24
      3.4.5 Supplier - Retailer VMI Mode of Operation ................................................................................... 24
3.4.6 The Mode of the Third-party Logistics Enterprises’ Participation

3.5 Summary of Theory

4. Case Study

4.1 The Case Company Lenovo

4.2 Lenovo’s Supply Chain Status

4.3 Lenovo’s Previous Inventory Management Mode: Kanban System

4.4 Lenovo’s Present Inventory Mode: Vendor Management Inventory

4.5 Lenovo’s Cash Flow Management Model in VMI

4.6 Lenovo’s Information Management Model in VMI

4.7 Lenovo’s VMI Logistics Management under the Overall Pattern

5. Discussion

5.1 The Deficiencies in Lenovo's Previous Inventory Management Model

5.2 The Benefit of Implementation of the VMI System in Lenovo

5.3 Lenovo’s VMI Implementation Mode

5.4 Lenovo’s VMI Model Features

5.5 The New Lenovo VMI Features

5.6 The Significant Changes in Integration VMI in Lenovo

6. Conclusion

6.1 Important Factors in Implementation of VMI in Lenovo

6.2 Future Study

References

Appendix
List of figures and tables

Figure 1, the structure of thesis

Figure 2 Use of Kanban card for transfer between stocks

Figure 3 Overview of the VMI scenario

Figure 4 the flow chart of Lenovo Supply Chain Management

Figure 5 The Lenovo VMI warehouse operations process

Table 1 Summary of the VMI’s Model Features

Abbreviation list

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>TPL</td>
<td>Third party logistics</td>
</tr>
<tr>
<td>VMI</td>
<td>Vendor Management Inventory</td>
</tr>
</tbody>
</table>
1. Introduction

1.1 Background

In recent years, with the rapid development of global economic integration and China's economy, Chinese manufacturing industry has experienced great changes. For a Chinese multinational technology firm, Lenovo Group Limited, how to get production cost controlled has become important. Cost control includes, warehouse management which is an important part of enterprise logistics activities, and should thus becomes, more and more prioritized by enterprise managers.

Lenovo Group Limited was incorporated in Hong Kong in 1988 and it has been grew to be the largest PC Company in China. Lenovo has more than 30,000 employees in more than 60 countries, and it serving customers in over 160 countries. Lenovo's product lines include legendary Think-branded commercial PCs and Idea-branded consumer PCs, as well as servers, workstations and a family of mobile internet devices, including tablets and smart phones.

In order to face the increasing fierce market competition, getting effective and reasonable inventory management occupies an important position in today's enterprise management. For one company, it is very difficult to achieve the optimization of inventory and not just simply to increase or decrease inventory. The effect of inventory management directly affects the amount of inventory procurement, material intangible loss, the fund's turnover rate, and warehouse services levels (Forslund, 2007). According to these situations, more and more companies start to use VMI to reduce their production costs, and to improve the efficiency of enterprise logistics, to keep their competitiveness in market (Luo, 2007).

Vendor managed inventory, it abbreviate as VMI, is an integrated approach for retailer–vendor coordination (Darwish & Odah, 2010). It allows both users and
suppliers to get the lowest cost. VMI integrated supply chain management model, and to adapt to change the market requirements (Achabal et al., 2000).

1.2 Purpose

Since to adopt VMI could increase the competitiveness for companies, it is necessary to help the companies to implement VMI. Lenovo is the first one adopted the VMI in China. The conclusions from Lenovo adopted VMI process may be very useful for helping other PC companies to prepare implement VMI. This thesis carries on this as the starting point to view that how the inventory management applies VMI in Lenovo companies. In this thesis, the authors will choose Lenovo as a case company and the research is focus on Lenovo’s PC production department in Beijing. The purpose of this thesis is to analyze a part of the inventory management model: VMI, throughout a case study to discover how the VMI is implemented in the company. This thesis combines a theoretical literature review and results from interviews in order to draw a conclusion.

The research questions are:

- Before introducing VMI system to Lenovo, what was the Lenovo’s previous inventory management mode?

- Were there any deficiencies of Lenovo’s previous system that drove Lenovo to implement a new one?

- How is the Lenovo manage inventory, and the VMI process?

- What are the Lenovo’s VMI features?

- What benefits dose VMI bring to Lenovo?

- What are the significant changes in the process of integration VMI in Lenovo?
As the first company to introduce VMI in China, are there any implications that Lenovo can give to other PC companies?

1.3 Information about Lenovo

Lenovo is a highly innovative, international technology company. As a leader in the global PC market, Lenovo is engaged in the development, manufacture and sales of the most reliable, safety and easy-to-use technology products. Lenovo professional services helped global customers and partners to succeed. Lenovo Company mainly produces desktop computers, servers, laptops, printers, handheld computers, motherboards, mobile phones and other goods. At the beginning of 1996, Lenovo PC sales were among the first in the Chinese domestic market (Lenovo, 2013).

1.4 The Structure of Thesis

This thesis contains six sections (See figure 1). The first section is introduction. The introduction part contains background, purpose, and information about the case company Lenovo. The second section is methodology, which shows what kinds of methods have been used for this thesis. The section three is literature review, introducing what theories have been used in this paper. Case study, which shows in the section four, contains case company Lenovo’s information, and their previous and current situation of their inventory management system. Finally, the section five shows the result of what we got during the case study. The last section contains the conclusion of this theory.
2. Methodology

2.1 Overview of Research Process

In order to make a clear overview of the method that has been used in this thesis, here we present the sequence of the method. The acquired theoretical framework in this thesis was to collect by literature review. Possible approach such as the case study also was considered. It was the empirical study for this thesis. The case study of Lenovo Company had four stages, during the case study, the research questions and data have been analyzed. The results from the case study have been shown by graphic illustrations with written explanations.

Skype interview was used to collect primary data in this thesis. By interviewing with the sales manager of Lenovo, the authors had an overview of Lenovo’s previous and current inventory management characteristics. The detail information can be found in appendix.
2.2 Data Collection

Triangulation was the underlying principle of this theses data collection. It used the different methods to study the same phenomenon. Data collection may include interviews, questionnaires, direct observations, survey, content analysis of documents and archival research (Christer, 2009). If the multiple sources of data on the same phenomenon were used, the reliability would be increased.

“Primary data is the data observed, experienced or recorded closest to the event. It was the nearest one can get the truth, while distortions inevitably occur as the proximity to the event decreases” (Walliman, 2005). The method to collect primary data in this thesis was email interview. The purpose of this interview was to make an overview of the Lenovo's inventory management as well as study the previous and current characteristic. The data was directly collected through e-mail by authors with high veracity and accuracy.

Secondary data was collected through Lenovo's annual report (Walliman, 2005). The annual report could be found on Lenovo’s official website.

2.2.1 Literature Review

Literature review is a valid and essential part of all kinds of researches. It mentioned both textbooks on research methodologies and methodological papers in high quality journals (Seuring & Muller, 2005). The literature review could be the driving forces and preliminary step for the thesis (Ridley, 2010). It could help to identify the generate ideas for research, conceptual content of the field, and summarize existing research by identifying patterns, themes and issues and contribute to theory development (Seuring & Muller, 2005).

"A Literature Review is a systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of recorded documents" (Seuring & Muller, 2005). It could provide an insight of the research area regarding
with both theoretical and practical implications (Ridley, 2010).

In order to get fundamental and theoretical background in inventory management, the literatures used in this thesis included scientific articles, books, and journals. This thesis used the scientific databases “Science Direct” and “Google Scholar” for searching for academic journal articles in Lenovo. Moreover, the thesis was also used the keywords “Lenovo”, “Inventory Management” and “VMI”. By reading the titles and the abstract of the found articles, the authors choose the most relevant ones to include with this thesis. When reviewing the literature, research questions provided the reviewing direction, which led the review focusing on the factors of inventory management.

2.2.2 Case Study

Case study is a concentration of a single unit (for example, a person, group, or event) with emphasis between the context of the relationship and development of factor analysis (Thomas, 2011).

They may be potential factors (decorate in the establishment of the standard and the standard case, as they become available), or reviews (established in the standard from the history of into research, select cases) in the case study (Robert, 2009).

Thomas (2011) defined the case study analysis of people, events, decisions, during the project, policy, institution, or other system of one or more methods study from overall situation. Case study is an instance of a class of phenomena that provides a framework among them is studied under the condition of light and detailed instructions.

Case study should be defined as a research strategy of empirical investigation and study of phenomena in the real life background. Case study is likely to mean that single and multiple case studies, including quantititative evidence, relies on multiple sources of evidence, from theory argues that the benefits of priority to the
Qualitative research has been used in the case study; they could be any combination of quantitative and qualitative evidence. Based on single discipline research provides a quantitative case study of the data to make inferences from statistical framework (Thomas, 2011). The case study for this thesis is mainly focused on Lenovo PC production department in Beijing.

**Stage 1 Research Question**

The first step of case study was to create research questions; authors could refer to a complex phenomenon or object of the research process. A case study of the object study usually was a program about an entity, a person or a group of people (Seuring & Muller, 2005). During this stage, the research question was the importance of inventory management for Lenovo PC production department in Beijing.

**Stage 2 Data Gathering**

A major advantage of the case study method was to use multiple data sources in the data collection process. Authors decided what evidence should be collected and which data analysis technique was used in advance. In addition, which research questions have been answered to be collected data is usually mainly qualitative, but it also could be quantitative (Seuring & Muller, 2005). The data collection tool are included interviews, document review in this thesis.

**Stage 3 Data Analysis**

During the data analysis part, the authors examined the raw data, used many explanations, in order to find the object of study, with reference to the link between the results of the original research questions. Through the whole process of assessment and analysis, the authors remained to open to new opportunities and insights. In findings and conclusions parts, it used multiple data collection methods
and analysis techniques, in order to strengthen the research results and conclusions (Seuring & Muller, 2005)

As a case study, the data would deliberately sort, deliberately look for conflicting data in many different ways to expose or create new insights, and disconfirm analysis. The authors classified lists and restructuring data for research purposes. The Authors also crosschecked the facts and variance accounts. Focused, short and repeat visits may be necessary to collect more data to verify key observations or check facts (Yin, 2009).

Specific information has made into the array, or created a matrix class, and the authors created a flow chart and tabulation activities frequency. The authors have been collected to prove and support to understand the intrinsic relationship of reason. Another approach was using multiple surveys as a variety of perspectives and insights, checking the data and results (Seuring & Muller, 2005). The multiple observations increase confidence in the responsibility

Stage 4 Dissemination

A typical case study report helped us to understand a complex issue easily. The goal of report was to convey to the reader with a vicarious experience, depicting a complex problem. The case studies presented data in some very publicly accessible ways and may cause the reader to experience his or her own situation. Authors paid particular attention to get enough evidence and reader's confidence. All avenues have been explored, clearly communicated boundaries and payed special attention to conflict proposition (Seuring & Muller, 2005).

2.2.3 Interview

Interview is a common and efficient method by using primary data to question or discuss issues with people (Blaxter, et al., 2006). It is one of survey methods of data collection.
This paper had interviews with Mr. Zhang, who is assistant governor and sales manager of Lenovo. Even though he was not the production manager, but he was the only one we can connected with. Fortunately, He knows company’s project operation and inventory management process.

Interview may be made face-to-face, by using the Skype and e-mail (Blaxter et al., 2006). The problem of interview may be in gaining the require responses from the complete sample, and difficult judge response’s quality of the subjects. Interview was flexible and wide range approach for application, and particularly useful qualitative research (Walliman, 2005). Due to the distance between China and Sweden, The interview has been decided through e-mail and Skype. E-mail interview was a fast and workable way, and it’s easy to contact the interviewee who can have enough time to consider answer questions, comparing to the face-to-face interview and it is not restricted by time and place (Biggam, 2008).

The interview has two types: the structured interviews and unstructured interviews (Biggam, 2008). A structured interview was prepared and repeated questions to acquire consistent and thus easily getting comparable responses. An unstructured interview was semi-prepared questions involved with the subject (Biggam, 2008). Our interview contained structured interview and unstructured interview. In order to guarantee asking right question, the theoretical knowledge has been worked with reference, and aimed at creating the interview guides. We have prepared some questions before the interview, however, during the interview process; it came up with some new questions. Other information about Lenovo was found at the Lenovo official website. The detail information of three times interviews can be found in the Appendix.

2.3 Validity and Reliability

In order to obtain high-level credibility, this thesis follows the principle of reliability and validity. “Validity is dependent on the degree to which a study actually
measures what it purports to measure whether the truth is accurately identified and described” (Yin, 2009).

Internal validity was the extent based on certain conditions, which can establish a causal relationship (Christer, 2009). Internal validity is shown to lead to other conditions, as distinguished from spurious relationships and it cannot be observed directly and infer an explanation based on interview (Yin, 2009). It could divide into construct validity and content validity. The construct validity was the extent, which established correct operational measures for the concepts being studied (Christer, 2009).

Christer (2009) states reliability was the extent that whether a study's operations can be repeated with the same results or not. There were two keys to reliability in case study: used of a case study protocol and the development of a case study database (Ellram, 1996).

At the beginning of the research designing stage, case study has been planned to do. For the purpose of developing the database of case study, we did interview with assistant governor and sales manager from Lenovo Company three times. In order to obtain high-level credibility, the interview questions included objective and subjective question based on the theoretical review. Thus, the interviews were less influenced personally and had overall effect on the interview results which were good enough for the interview. What is more, these questions had been sorted out to the document and then sent to case company (See Appendix I).

2.4 Limitation

There were vast numbers of previous researches about inventory management, while there were a few works in China inventory management and data was lacking. This thesis integrated western author’s results combined with Lenovo’s thoughts.

However, this thesis also had limitation about the interview. First, the interview
with Mr. Zhang was not the production manager; he was the sales manager of Lenovo. But he was the only one we can connect with. Even though he knows how the inventory management process in Lenovo production line, the interview result may has its limitation.

3. Literature Review

The literature review focus on reviewing of the documents about the supply chain management, warehouse management and inventory management.

3.1 Supply Chain Management

The trend towards global organization of both manufacturing and marketing was highlighting the critical importance of logistics and supply chain management as the keys to profitability.

The difference between logistics and supply chain management are: logistics is prefer to have a single flow in process but, supply chain management is more focus on operation, relationship and properly managed to get more profitable outcome (Lumsden, 2007). What’s more, Compared to the original logistics, Supply Chain Management (SCM) will increase the range of products, marketing the product life cycles shorter and having more marketplaces (Fawcett, 2008). Economic globalization provided new opportunities for companies. Due to this development, the supply chain design becomes more importance.

Christopher (2011) presented that the management of upstream and downstream relationship with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole. SCM connect the suppliers, manufacturers, distributors, retailers and the user by information, logistics and capital flow. It is the process of co-ordination of production processes and materials in the most effective way among the partners within the value chain (Lumsden, 2007). It focuses on operation, relationship and properly managed to get more profitable outcome.
It has emerged to become one of competitive advantages for enterprise.

In order to get fluency and effective information flow of time, cost and performance, it is necessary to get collaborate in each department (Lee, H. et al, 1997). However, due to the complexity network of interrelated systems and their component, an enterprise practically cannot perform all of the activities alone. It will be much better if an enterprise focuses on a particular area of competence and other parts depends on partners to help them achieving the process (Thomas and Griffin, 1996).

Supply Chain management also consists to collaborating with the firms that have similar strategic positioning to improve operating efficiency (Bowersox et al., 2010). For PC industry, there will be many customer value is added outside, enterprise can pay more attention on core competence due to outsourcing. Moreover, enterprise can often no longer develop products on their own (Fisher, 1997). This kind of activities in supply chain can enhances the proactiveness and responsiveness to customers’ needs and reduced new products delivery time and services to the market (Bowersox et. al., 2010). What's more, it can ensure the enterprise meet the continuous change in the taste of customers.

In the SCM process, it includes inventory management, procurement, supplier management and efficient flow of information in the organization (Christopher, 2011). Supply Chain is a complex process that involved so many activities that is difficult to touch within the little scope of this thesis. Due to the thesis was a case study, and the case company Lenovo was the first one to implement VMI in China. This thesis mainly focuses on warehouse management, inventory management and VMI.

3.2 Warehouse Management

Warehouse management, it is stand for WM. It refers to the effective control of the goods received for storage transceiver, balances and other activities (Bowersox &
The warehouse management’s purpose is to ensure that warehouse’s goods intact and to ensure normal production and business activities (Koster et al., 2006). At the same time, to chart a clear manner to express the status of the storage of goods in quantity, quality, and their present geographical location, department, orders attribution and warehousing degree of dispersion of the integrated management form (Berg, 1999).

3.2.1 Warehouse Management System

A warehousing system refers to the combination of equipment and operating policies used in an item picking or storage/retrieval environment (Berg, 1999). With respect to the level of automation, there are three types of warehousing systems: Manual warehousing systems (picker-to-product systems), automated warehousing systems (product-to picker systems) and automatic warehousing systems.

3.2.2 Identify Activities of Warehouse Management

Businesses can choose self-storage, leasing public warehouse or contract warehousing inventory of materials, commodities ready warehousing space (Koster, et.al., 2006)

The combination of products in the warehouse, proper stowage and liquid packaging activities is to improve handling efficiency, make full use of transport and reducing the cost of transportation expenditures (Koster et al., 2006). The storage conditions are specific tangible or intangible spaces with modern technology. It called "specific". Each enterprise supply chain is specific (Kim et al., 2003). Tangible place refers to the warehouses, garages or storage tanks. In the modern economic context, storage in a virtual space also requires a lot of modern technology support.

Reasonable and accurate warehousing activities will reduce the commodity flow,
reduce the number of operations to take the mechanization and automation of warehousing operations, they have contributed to reduce the cost of warehousing operations (Autry et al., 2005). Implementing warehousing management can ensure the company an effective custody, conservation of the commodity, and accurately control the quantity, thus greatly reducing the risk of warehousing (Koster et al., 2006).

3.2.3 Warehouse Process

According to the principles of supply chain management, modern companies attempt to achieve high-volume production and distribution using minimal inventories throughout the logistic chain that are to be delivered within short response times. The changes outlined above have had a dramatic impact on warehouse management. Low volumes have to be delivered more frequently with shorter response times from a significantly wider variety of stock keeping units. The warehouse processes is “Inventory management and storage location assignment policies determine which products arrive and where these should be stored” (Berg, 1999).

Warehousing management and storage location allocation is a typical problem. Intelligent inventory management may result in reduced storage costs (Berg, 1999). For example, through the application of advanced production planning and ordering policy, it may reduce the total inventory, while ensuring a satisfactory level of service. (Koster et al., 2006). Service levels specified in the order are the percentage of stock. Reduce inventory levels, not only reduces inventory costs, but also improve the efficiency of the order picking operations in the warehouse (Vassiliadis, et al., 2001).

In addition, the effective storage location policy may reduce the average travel time for storage / retrieval and order picking. In addition, through the distribution activities evenly distributed in the storage subsystem, may reduce congestion and things may be a better balance between the subsystems, thereby increasing throughput capacity (Bouzeghoub & Matulovic, 1999).
3.3 Inventory Management

"Inventory management is the process of storing of goods that contains raw materials, spare parts, products and other material inputs in continuous production process in a safe and cost effective way till the time of its usage"(Frankel, 2006). Inventory management is an important aspect of supply chain management. The common components of an inventory management system involves a system to keep track of inventory, a reliable forecast of demand, knowledge of lead times, a classification system and reasonable estimates of holding costs, ordering costs and shortage costs (Stevenson & Hojati, 2007). By overseeing the constant flow of units into and out of an existing inventory, inventory management can prevent the operation of the company into risk situation. In addition, Effective inventory management seeks to control the costs through the inventory in total value of the goods and the tax burden in cumulative inventory value (Silver, et al., 1998).

Paying attention to these key aspects of inventory can balancing the various task of inventory management. First, understanding how long it takes a supplier to process an order and execute a delivery. Secondly, understanding how long it will take those materials to transfer out of the inventory established. After knowing the two important lead times, it is possible to know when to place an order and how many units must be ordered to keep production running smoothly (Andersson et, al., 2010)

Inventory management is not merely to know where the raw materials go in the operational process. Knowing the movement of those materials in various stages of the operation is also important. Materials in process inventory used to create finished goods and help to identify the need to adjust ordering amounts, before the raw materials inventory gets dangerously (Frankel, 2006).

Calculating the buffer stock is also a key factor to ensure effective inventory management. Buffer stock is additional units exceed the minimum number required in order to maintain production levels (Carroll et, al., 1992). It can help to minimize the
chance for production interrupted due to lack of essential parts in the operation supply inventory. In addition to maintaining volume and movement of various inventories level, inventory management, also make accurate records for taxes on each inventory type (Andersson et, al., 2010). With the help of precise data in overall operation, enterprise can calculate the tax amounts accurately.

In big manufacturing companies, it is difficult with inventory management due to a lot of inventory has to be kept for continuous running of the system (Bowersox et.al, 2010). Non-predictable of the usage of material will raise the difficulties of procurement and collaborate.

3.3.1 Kanban System

The Kanban system is an element of just-in-time system, which viewed as an information system. It contains information as the Kanban type, component name and number, the station location and the destination station (Gupta et al., 1999).

There are two main type of Kanban method: one is the traditional Kanban based on some form of physical and visual initiation of new orders. Another one carried out through a computerized planning system, which based on some form of administrative initiation (Jonsson, 2008). Both of them are single card systems, in which the Kanban card initiates both manufacturing and transportation.

The Kanban principle for initiation of transfer of materials from stocks to an assembly unit was illustrated in figure 2. The figure shows how pallets with transport Kanban card affixed; they transferred from central stores to local stores where assembly takes place.
When a new package of material from the local store is withdrawn, the transport Kanban card attached to the package from the package (1) they are removed and sent to the central store (2). For central store, the empty card is a signal to replenish the local store with a full package according to the instructions on the card. The card is attached to a full package at the central store and the package is moved to the local store (3) where the package with the attached card is stored until moved to the assembly station(4) (Jonsson, 2008).

The number of cards needs additional considerations to take current delivery time and any required safety stock to prevent changes in demand and other
Advantages of using Kanban system are: Kanban system have the ability to control production and it can simplicity in production scheduling, reduced burden on operators, easy to identification of parts by the Kanban attached to the containers (Gupta et al., 1999).

3.3.2 Bullwhip Effect

Bullwhip effect is the amplification of demand variability from a downstream site to an upstream site (Lee et al., 1997). Bullwhip effect also used to describe the distortion of information from one stage to another stage in supply chain (Lee et al., 2006). Bullwhip effect has impact on lead time, exponential smoothing forecast factor (Kelepouris et al., 2008). However, the magnitudes of the bullwhip effect will affected by smoothing the order rate, which will result in poor customer service (Ciancimino et al., 2012).

In the supply chain, each firm will order from upstream suppliers. Under normal circumstances, the supplier will not just give orders and then make an order. Seller will consider based on the inventory and transportation costs in a single cycle, consider the follow-up of a certain number of manufacturers to their suppliers for order (Chen, et al., 2000).

In order to reduce costs, frequency of orders and avoid the risk of the stock market, suppliers are often the best economies of scale in order to increase the order quantity (Fransoo & Wouters, 2000).

Frequent order will increase the workload and cost of the supplier, the suppliers often demand distributors to order a certain amount or a certain period. Sales in order to get the goods as soon as possible, they will tend to increase the order quantity, due to the ordering policy has led to the "bullwhip effect" (Disney & Towill, 2003).
3.4 Vendor Managed Inventory

VMI is abbreviation of Vendor Managed Inventory. Vendor managed inventory is an integrated approach for retailer–vendor coordination (Darwish & Odah, 2010). It allows both users and suppliers to get the lowest cost. Sarmah et al. (2006) presented that vendor decides the appropriate inventory levels within contractual agreement between vendor and retailers. A common agreement by the VMI is continue to oversee the implementation of the agreement and amendments to the content of the agreement (Waller et.al., 1999). The VMI is contrary to the traditional inventory management mode. VMI integrates the supply chain management model, and adapts to changing market requirements (Achabal et al., 2000). VMI’s role in the distribution chain is very important, so more and more people pay attention to it (Cetinkaya and Lee, 2000). VMI has been continuously improved.

Figure 3 Overview of the VMI scenario (Disney and Towill, 2003)
3.4.1 Basic Knowledge of VMI

VMI has a minimum and maximum inventory point. The on-time delivery can be measured by relative inventory levels (Waller et.al., 1999). In figure 3, it describes the overview of the VMI scenario. For example, the inventory is zero, the risk is very high; inventory is lower than the lowest point, the risk is quite high; stock is higher than the highest point, the stock risk is low but it increased risk of obsolete stockpiles (Disney & Towill, 2003)

In this way, the statistics of the various situations can measure supplier delivery performance. Delivery program based on the future demand for materials and suppliers can also predict the inventory points in the future (Cetinkaya and Lee, 2000).

VMI management mode from the quick response and efficient customer response developed on the basis VMI's core idea, it used enterprises inventory and actual consumption data as practical basis for supplier’s replenishment. VMI management mode is accordance with the actual consumption model, consumption trends and replenishment strategies (Achabal et al, 2000).

According to an independent predictor of the traditional mode, the maximum extent possible to reduce the uncertainty caused due to an independent predictor of business flow, logistics and information flow waste, this model is reducing the total cost of the whole supply chain (Waller et.al., 1999).

3.4.2 VMI’s Model Features

● Information sharing

The implementation of VMI has many advantages with information sharing. Palmer and Markus (2000) clearly recognize that inventory reduction can be reached by implementing supply chain coordination initiatives, such as IS, CRP, or VMI.
Research has shown that IOSs, as links between suppliers and buyers, can improve a firm’s performance and bring it competitive advantages. Chen et al., (2000) has found that the consequences of the bullwhip effect can be minimized through information sharing. Retailers to plan more effectively help suppliers, suppliers for point-of-sale data from retailers and use this data to coordinate their production, inventory activities and retailers sales activities (Cetinkaya & Lee, 2000). What's more, VMI can decrease the bullwhip effect, thereby improving supply chain efficiency, such as by lowering inventory levels and reducing cycle time (Kulp et al., 2004).

Ragunathanan (2001), however, points out that the value of information sharing can be insignificant if the manufacturer uses the order history to forecast the retailer order quantity. By using simulation, Yang et al. (2003) examine a VMI distribution system and conclude that VMI is very effective at mitigating the bullwhip effect. Waller et al. (1999) also using simulations and find the operational benefits of VMI are very compelling, especially in reducing inventory without compromising customer service levels.

Suppliers for point-of-sale data to predict demand became more accurately after using information sharing (Yao & Dresner, 2008). Information sharing helps to reduce the uncertainty of predictions and the amount of safety stock and determine the passenger and cargo volume became easier. At the same time, supplier’s faster response to user needs, also improve service levels, and reduced the user's inventory levels (Ragunathanan, 2001).

- **Cost savings**

VMI is effective in reducing the inventory-related costs. It has been well documented that cost savings and inventory reductions can be reached by implementing collaborative initiatives vendor managed inventory, that allow for information sharing and integration among firms in the supply chain(Yao, et.al.,
Hughes (1996) presented that the costing saving can through optimizing shipment quantities as observed in typical VMI practice. Both the buyer of a product and the vendor (supply chain) supplier of that product and the supplier used to manage their respective inventory independently. However, after implementing VMI, the buyer occupied most of short-term cost savings of the product and the profit under VMI had significantly higher than before (Dong & Xu, 2002). In addition, Inventory reductions can also be achieved by implementing initiatives through VMI. The uses of VMI tend to result in inventory reductions for both the manufacturer and the retailer (Yao & Dresner, 2008). It also can decrease the frequency of replenishment in VMI.

- **Sales Forecasting**

Implementing VMI help to determine the passenger and cargo volume, to reduce the uncertainty of predictions, thereby reducing the amount of safety stock, named smaller storage and supply costs (Cetinkaya & Lee, 2000). At the same time, supply providers can more quickly respond to user needs, improve service levels, making the user's inventory levels also reduced (Disney & Towill, 2002).

- **Customer Service Level**

Services to improve their performance in the replenishment for multi-user delivery coordination, improve supply chain flexibility, and the demand market information. Not only replenishment can be achieved in a timely manner in order to avoid out of stock, but also simplifying the distribution forecasting. Combined with the demand information for effective the forecast allows manufacturers to better production planning. For the demand side, the VMI implementation also increased delivery speeds and reduces the shortage (Achabal, et.al, 2000). What’s more, after implementing VMI system, customer service levels improved dramatically, and a significant improvement in inventory turnover was achieved (Choi and Sethi, 2010).
The amount of replenishment, at the right time and enhance the overall logistics performance. Their only concern is for the customer, the supply chain is at the right time, the right product (or service) in the right quantities to the hands of customers. Implementing VMI can help the entire supply chain of the shortest possible lead-time and the highest possible level of service at the lowest possible cost, quick response to market changes and customer needs (Yao & Dresner, 2008).

- **Quick Response**

  Quick response system is the system, which has been implemented by number of vendors (Achabal, et.al, 2000). It reduces the need for safety stock and improves inventory turnover.

  Implementing quick response system is beneficial to the supply chain and the retailer by alleviating the bullwhip effect, improving inventory management by better matching supply and demand in a timely manner, enhancing customer service in avoiding stock outs, and improving the speed of delivery (Lee et.al, 2000).

  What's more, Palmer and Markus (2000) presented that the supplier–buyer relationship, the quality of information are shared, and the forecasting scheme, the supply chain in alignment measures and the level of technological supports are key ingredients for successful quick response system development.

3.4.3 VMI Operating Modes

Morphology is different due to the different location of the core enterprises in the supply chain. According to the position of the core enterprise, it generally divided into two categories: Downstream supply chain as the core enterprise and upstream supply chain for the core business (Dong & Xu, 2002).

The advantages of using VMI to the downstream member are as follows: Waller et al. (1999) noted that VMI reduced costs and increased customer service levels to
one or both of the participating members. For downstream members, implementing VMI can improved customer service, reduced demand uncertainty, and reduced inventory requirements (Fox, 1996)

Upstream members also benefited from the VMI. Latamore (1999) believed that: By reducing stock outs, suppliers not only saved customer goodwill but also increased sales. Along with receiving more information on the customer's demand patterns that aided the supplier in better planning their own inventories. In addition, the ability to a better plan inventories and deliveries often cited as a major advantage to the upstream member of implementing VMI (Challener, 2000).

As mentioned earlier, in the VMI system, the core business either upstream in the supply chain can also downstream in the supply chain, while in the downstream turn that can be the middle part of the supply chain, can also be in the supply chain terminus. Obviously, different, the VMI's mode of operation is not the same; the main three cases are suppliers to manufacturers, suppliers to retailers and the core business to distributors (Jain, 1994).

3.4.4 Suppliers - Manufacturer VMI Mode of Operation

Dong & Xu (2002) pointed out that the manufacturer's production in this mode of operation is generally stable. The relatively large scale of production, daily changes in the demand for spare parts or raw materials is not good. It required small number of suppliers' delivery. Second, frequency of delivery is higher. It require twice a day to three times the supply frequency (Waller, et.al., 1999).

3.4.5 Supplier - Retailer VMI Mode of Operation

Mishra and Raghunathan (2004) provided a perspective justifying the interest of retailers in VMI. It showed that VMI increases the competition among manufacturers. After retailers sharing the information to the suppliers via a replenishment cycle; supplier did a demand forecast and put the predicted information input material
requirements planning (Darwish & Odah (2010).

Cachon, G. P. (2003) presented that produce the finished product warehousing, sorting, packaging, shipping to retailers can getting accordance with existing enterprise inventory and retailers, warehouse inventory, the production replenishment orders, production planning, production.

Cheung and Lee (2002) studied the problem of a supplier serving multiple retailers under different efforts. It manufacturers the difference of the mode of operation as follows: After the receipt of the goods, in the face of large retailers, the accounts payable. Usually large retailers only require the supplier of the goods sales payments to suppliers, or do not produce "accounts payable".

This mode generally does not require the construction of the central aspects of VMI HUB. For retailers, the two suppliers of the products are independent of each other, in the same period within the same time they are not required, unlike the manufacturers need parts or raw materials must generate a product the (Dong & Xu, 2002).

3.4.6 The Mode of the Third-party Logistics Enterprises’ Participation

In the actual implementation process, and sometimes requires the participation of third-party logistics service providers. In the suppliers - producers’ mode, regardless of the manufacturer or supplier, its core competitiveness reflected in its manufacturing, logistics and distribution. Obviously, the supplier or manufacturer to manage VMI HUB is not economical (Disney & Towill, 2002).

Supplier - Retailer mode have multiple kinds of contracts that achieve coordination and arbitrarily divide profit and coordination failure is common (Waller, et.al., 1999). The retailers a wide range of retail products, suppliers and retailers location far away, directly from the supplier to the retailer replenishment lead time is longer will also cause unexpected situations. (Cheung and Lee, 2002)
3.5 Summary of Theory

The literature review focus on reviewing of the documents based on the topic of inventory management and vendor management inventory. In order to get the knowledge of vendor management inventory, it is also necessary to acquaint with supply chain management and warehouse management.

Inventory management and warehouse management appear to refer to the same type of materials management in the supply chain; however, they are different in spite of their connection. Warehouse management refers to the control of the goods received for storage transceiver, balances and other activities; Inventory management is the process of storing of goods that contains raw materials, spare parts, products and other material inputs in continuous production process. However, both warehouse management and inventory management belong to vital activities in supply chain management. The type of materials management system which Lenovo use to catalog inventory depends on various factors that can affect the efficiency of Lenovo.

4. Case Study

4.1 The Case Company Lenovo

Lenovo Group Limited is a Chinese multinational technology firm with principal operations in Beijing, Morrisville in North Carolina and Singapore. Lenovo used integrated operational model to combine the procurement, production, distribution and logistics integrated into a unified system. The system contains a unified sort of coordinated approach with the investment and strategy making, policymaking, executing and operating layer. This case study focuses on Lenovo PC production department in Beijing.

The Lenovo brand came into existence only in 2004, While Legend Holdings formed with 25,000 RMB in a guardhouse in China in 1984. The company was incorporate in Hong Kong in 1988 and grows to be the largest PC Company in China.
According to Lenovo’s annual report, Today, Lenovo is a US $30 billion personal technology company and the world second-largest PC vendor. Lenovo has more than 30,000 employees in more than 60 countries serving customers in more than 160 countries. Lenovo is a global fortune 500 company (Lenovo annual report, 2012).

According to manager Zhang, Lenovo’s business built on product innovation, a highly efficient global supply chain and H3 strategic execution. The company develops manufactures and markets reliable in high quality, secure and easy-to-use technology products and services for customers. Lenovo's product lines include legendary think-branded commercial PCs and idea-branded consumer PCs, as well as servers, workstations and family mobile internet devices. Lenovo considered their culture as important as an effective business model, It called “Lenovo Way”, and principal among them which are serving customers, trust and integrity, teamwork across cultures and innovation and entrepreneurial spirit (Lenovo’s annual report, 2012). What's more, Personal computers, convergence and culture are Lenovo's three key areas. These three values not only leaded the industry with an ecosystem of devices and service for customers, but also helped Lenovo to become as the most trusted and most well respected companies.

4.2 Lenovo’s Supply Chain Status

As managers Zhang presented, Lenovo's materials are mainly divided into international procurement and domestic procurement. The manufacturing centers are located in Beijing, Huiyang, Shenzhen, and Shanghai in China, also in USA, India and Mexico. These manufacturing centers are produce laptops, net books, desktops, workstations and servers. It is a very intricate supply chain. The international procurement is shipment from Hong Kong to Beijing or Huiyang. In addition, the domestic procurement will be sent directly to the manufacturing centers to make into products and then send to the resellers and end-users. Well corresponding supply chain can help Lenovo meet the customer’s requirements. Lenovo executes material planning for the production needs combined safety stock and lead-time. What’s more,
Lenovo can quickly response corresponding to customers and market demand according to the customer's orders.

In addition, Lenovo’s information flows also drive the logistics system. With the help of the Lenovo's ERP system and high efficient SCM system, Lenovo achieves seamlessly and real-time interactions logistics and information flows with in procurement, production, distribution. It uses the automated storage facilities, flexible automation production lines. According to manager Zhang, Suppliers stock up on products according to Lenovo’s integrate planning system, and then deliver the products to the Lenovo's automatic solid warehouse. The automatic warehousing perception system will carry and sort automatically. The information flows go through the whole raw material purchasing, products manufacturing and distribution of the entire supply chain process. Information flows and supply chain combine closely are the biggest characteristic of Lenovo logistics system.
4.3 Lenovo’s Previous Inventory Management Mode: Kanban System

According to manager Zhang, before 2004, Lenovo's previous inventory management mode was the Kanban system. Lenovo Hong Kong made international procurement, then the inventory stock in Hong Kong warehouse. When there was an...
order made from the domestic production process, these inventories delivered from Hong Kong to manufacturing centers in China according to the production plan.

Although the previous Kanban system could minimize the domestic material inventory, but this system through 11 logistics links, involving as many as 18 internal and external units. The operation process was complex and it raised many uncontrollable factors. What’s more, most of the international suppliers’ delivery their materials in Hong Kong warehouse; However, Lenovo's production information system only used in mainland China. Therefore, the statistics from the factory mainland China could not reflect the real supplier delivery rate while others might cause information distortion.

4.4 Lenovo’s Present Inventory Mode: Vendor Management Inventory

The VMI project requirement was in accordance with Lenovo. Lenovo’s warehouse was set up in Beijing, Shanghai, which near the factory of the vendor-managed inventory. Lenovo shipping instructions were sent to the inventory management on a regular basis according to the production requirements. The third-party logistics company completes distribution of the production line. As manager Zhang said, from their receipt of the notification, confirmation, sorting, customs declaration and distribution to the production line, time requirements are max 2.5 hours. This project will achieve information sharing and timely delivery of goods between the third-party logistics and Lenovo, which ensures the timely delivery of production materials required.

What’s more, Lenovo takes these measures into VMI implementing process: First, Lenovo’s inventory management is managed by the vendor company. The vendor company is responsible for sorting, customs declaration and distribution to the production line. Secondly, Lenovo and the third-party logistics company work together in the operating system of customs clearance and bonded warehouse management system. Thirdly, Lenovo achieved the information sharing in logistics.
The Beijing customs office has changed the traditional regulatory mode of operation, clearance, and security clearance become more convenient.

4.5 Lenovo’s Cash Flow Management Model in VMI

Combined with Lenovo’s annual report and empirical data from manager Zhang, Purchase orders issued to the VMI warehouse and accept the distribution of materials in Lenovo. Therefore, the unit price of raw materials and parts was the actual purchase price. VMI warehouse actual purchase orders and shipments were according to the unit price recorded, and then sent shipments are reported to the supplier. In this process, the VMI warehouse is intermediate linked with third-party logistics operators. Third-party logistics operators will be charged by the supplier logistics.

4.6 Lenovo’s Information Management Model in VMI

According to the Lenovo sales forecast scheduled, warehouse inventory situation will inform VMI warehouse delivery information. After the goods stock in warehouse, the income warehouse management information system will mark the stock as the available inventory.

The demand of using material and actual purchasing information are sent to the Lenovo warehouse, then the warehouse delivered it to production line and sign for goods confirms information to the VMI warehouse. According to the VMI warehouse delivery, sales confirmation was recorded for check. VMI warehouse send the inventory report regularly, and takes into consideration of the shipment statistics report for supplier’s inventory control. What’s more, VMI warehouse technology has used the ID code, EDI, and Bar code; they are important electronic tool of inventory management and improve the efficiency of inventory management (Lenovo’s annual report, 2012)
4.7 Lenovo’s VMI Logistics Management under the Overall Pattern

The Lenovo’s warehouse has been set up in Lenovo's production plan, as storage of materials and production lines and distribution center. Storage means the goods from overseas (bonded goods) or domestic (Manager Zhang; Lenovo annual report). When the suppliers taken the responsible for storing, Lenovo could get benefit from warehouses allocate to other places.

Lenovo’s warehouse was taken control by the third-party logistics enterprises. It ensured a safety stock and maximum inventory levels based on production requirements. Lenovo based on the decentralization of production planning to make orders from VMI warehouse. It requires the production line feeding the VMI warehouse information in the database. If the return goods phenomenon occurs, there are two modes of operation to overcome this problem:

One is the VMI warehouses returned the goods to the manufacturer. The manufacturer was required to take responsibility for the VMI warehouse transferring return information. However, the property rights cannot be reversed all suppliers.

The other one is VMI warehouse returned the goods to the supplier. This kinds of behavior occurred in the receiving phase. When the warehouses found damage product or unqualified storage product, the manufacturer refunds the requests to the VMI warehouse.

Since the third party logistics enterprise managed the warehouse, the production in Lenovo needs to set up the safety stock and the highest inventory levels. According to the production plan, manufacturing enterprises made orders to VMI warehouse first, then the VMI warehouse picked up the goods follow the order requirement and sent to the manufacturer-receiving platform. The property rights were substantial transferred when the material outbound door was on arrival at the receiving platform (Lenovo’s annual report, 2012)
Figure 5: The Lenovo operations process
5. Discussion

5.1 The Deficiencies in Lenovo's Previous Inventory Management Model

Before introducing VMI system to Lenovo, Lenovo previous inventory management mode was the Kanban system. In addition, Lenovo's previous warehouse management was the traditional mode of warehouse, which faced up lots of problems, such as low-level information technology, not highly automated inventory management and lack of information sharing in related operation.

In the Lenovo previous inventory management process, the information level on the outsourcing warehouse was low and many irrelative systems were generating in the Lenovo information process at the same time. The information island phenomenon was exposed. In addition, the lack of inventory management integration led to a high degree of manual information dealing activity, causing data duplication and manual reconciliation. Manual inventory statistics often took more than one-week time and the internal price list update twice a year.

What's more, In Lenovo previous inventory management model, the various suppliers respective their own stocks, seeking to maximize their own benefit. However, Lenovo internal inventory information systems were not integrated well with these suppliers. When the suppliers needed to know about Lenovo’s demand information, they often got the time-delay information or inaccurate information. Other deficiencies in Lenovo’s previous inventory management model were lack of suppliers’ appraisal and management system. Because the traditional procurement was not built on long-term cooperation, so there was no need to set up the various standard of for supply of materials.

The traditional warehouse management concepts was backward, and warehouse management methods was obsolete. These deficiencies would cause damage on Lenovo. First, the previous manual inventory dealing with activities leading Lenovo
was slow to market. Lenovo could not avoid data corruption problems if Lenovo did keep fully up to date and know exactly what the inventories situation on the external market was. Second, since there was no uniform inventory information platform, the various links in the Lenovo supply chain management only considered their respective inventory. By keeping a record of their own, inventory level to forecast upstream customer demands without commutation with Lenovo. It caused seriously inventory facilities repetitive construction problem and affected the precision of the inventory level.

Then, Due to lack of the suppliers’ appraisal and management system, which not only caused confusion on Lenovo procurement process but also affected the quality of Lenovo’s products itself. Traditional procurement was mainly built on a temporary or short-term cooperation mechanism so it caused the competition rather than cooperation, leading to the uncertainty of procurement process. In order to cope with sudden demand changes and protect their own benefit, suppliers often expand their inventory levels. That would raise the total inventory costs and supply chain-operating costs, which corresponded to reduce Lenovo's competitive edge.

The competition between the enterprises for the competition between supply chain managements was fiercer. There was no doubt that these deficiencies in previous inventory management will lead Lenovo to lose its predominant position. The traditional inventory management had become an obstacle, which could not afford Lenovo rapidly development. It was necessary to reform the system of traditional inventory management to reduce inventory costs. VMI offered a good solution for the information sharing and others problems.

5.2 The Benefit of Implementation of the VMI System in Lenovo

Waller et al. (1999) presented that the main advantages of VMI were reduced costs and increased customer service levels to one or both of the participating members. For downstream members, VMI improves customer service level, reduced
uncertainty demand and inventory requirements (Fox, 1996). In the supply chain, Lenovo downstream members also can get benefit from VMI. With the rapid development of the supply chain each link business, upstream to downstream of the supply chain inventory put forward higher request. After implementing VMI in Lenovo, Lenovo’s stock is managed by 3PL.

Implementing VMI in Lenovo meet the upstream and downstream enterprises to reduce costs and improve quality of service need. By reducing stock outs, suppliers not only save customer goodwill but also increase sales (Latamore, 1999). Meanwhile, Compare to Lenovo, suppliers have experience in the management of their own products and they are more professional. Lenovo's suppliers can provide the software, expertise, logistics, equipment, and personnel training services. It will improve Lenovo's supply chain service. In addition, Inventory management costs and inventory investment will reduce drastically. Thus, since the implementation of VMI in the supply chain upstream suppliers will also give benefits.

Lenovo’s VMI allows suppliers to obtain the necessary operating data, which is direct contact with the real demand information. After retailers sharing the information to the suppliers via a replenishment cycle, supplier made a demand forecast and put the predicted information input material requirements planning (Darwish & Odah, 2010). This information may help suppliers to eliminate unexpected short-term requirements, which are additional costs. At the same time, Lenovo safety stock is also greatly reduced. VMI suppliers consider sales data as market forecasting solution. Therefore, Lenovo can get accurate information consumer demand sales data.

In this way, suppliers become more effective and quicker to respond to market changes and consumer demand. Suppliers and supply chain upstream and downstream enterprises are share important information together. This improves the respective demand forecasting, replenishment plan, promotion management and transportation load plan. Over viewing the entire supply chain, Lenovo reduced the total inventory
and improved inventory turnover. Thus maintaining optimal inventory levels, inventory management level was significantly improved.

VMI suppliers to implement remote monitoring inventory provides an objective basis. VMI technology is the integration of the whole supply chain; Main chain is able to share the benefits with the risks. VMI technology takes care of the suppliers, the demand, and the tripartite interests of consumers as well as the three common interests.

Lenovo just needs to take control of the inventory transferred from the demand side to the supply side. Essentially the VMI meaning is the integration of the supply chain. VMI supply chain upstream and downstream enterprises are penetrating each other's production plan. The previous trading relations were developed to connect a close strategic win-win situation.

Accordingly, VMI's successful implementation of shared risks, benefits means that the supply chain node enterprises. The key of VMI is whether the parties to the transaction can establish the correct concept of cooperation and treated VMI as a long-term strategy.

5.3 Lenovo’s VMI Implementation Mode

Lenovo supply chain is greatly shortened, and cost reduction, enhance flexibility when implement the VMI model (Manager Zhang, 2013). The VMI mode involves Lenovo's international procurement of materials, the immediate needs of production and supplier inventory materials. It will face with many new requirements, for example, timeliness, frequency, etc.
5.4 Lenovo’s VMI Model Features

- Information Sharing

Information sharing promotes good communication between Lenovo and suppliers accelerated the speed of information transmission and processing and eliminate information islands. Yao & Dresner (2008) noted that using the information sharing, Suppliers for point-of-sale data to predict demand became more accurately. Compare to Lenovo have written internal price list once every two years, now it only takes 30 s to find out the latest price of any products. It greatly enhances the Lenovo's ability to response to market.

- Cost Savings

VMI is effective in reducing the inventory-related costs (Hughes, 1996). Procurement occupies a very important position in Lenovo. Lenovo spent nearly 40% to 60% value of sold product to buy components from suppliers which means a small step in material cost saving would cause huge effect than other field cost saving. Using VMI can increase the sales revenue, which can offset the additional cost of implementing VMI management. After implementing VMI in Lenovo, It cans easily mastery of the material quantities in warehouse and promptly adjusted purchase plan to control of procurement's cost. According to Lenovo's sales information in VMI, Suppliers can adjust their shipments. In addition, according to the materials and quantity of the demand of the market, Lenovo can also arrange the purchase plan to reduce material cost.

What's more, VMI can also reduce the transportation costs. In Lenovo’s warehouse, once Lenovo buy raw materials from suppliers, the storage location of the materials does not change. Only the material's ownership will be changed. Lenovo just need to use trucks to deliver the materials from suppliers to its manufactory's own warehouse. It decreases the warehouse and inventory cost but also improves the
efficiency of transport and production.

- **Sales Forecasting**

  Lenovo can use VMI to gathering the information about demand forecasting, inventory status, transport capacity and production capacity. After sorting the data, Lenovo can develop the master production plan. It avoids Lenovo to produce out-of-date products and cause excessive inventory. This information uses to collect from different vendor database and calculated by hand. After implementing the VMI, Not only shorten the time of sales forecast and production plans, but also increase the latest order response capability of the manufacturer. As Disney & Towill (2002) presented “supplier can more quickly respond to user needs, improve service levels, making the user's inventory levels also reduced.”

- **Customer Service Level**

  After implementing VMI system, customer service levels improve dramatically, and a significant improvement in inventory turnover is achieved (Choi and Sethi, 2010). The purpose of enterprises has changed from gain the maximal sales to pursuit of customer service level. Only to satisfy customer needs, enterprise will obtain long-term development. After implementing VMI, Lenovo sales system has turn to this guiding ideology.

  Currently, Lenovo has achieved a shift from the mass-producing a standardized product to flexible manufacturing customized product. In the flexible manufacturing lines, Lenovo customizes the product configurations according to customer demand. All of the CPU, hard drive, and memory and software systems can be custom fitted. A model is established in VMI, which can identify, filtrate, and translate the demand information for customization. By accumulation and analysis of customer information, Lenovo can understand the customer's overall needs. It achieves real-time customer information sharing, create value for customers and improve customer service level.
Quick Response

Quick response system is the system, which has been implemented by number of vendors (Achabal, et.al, 2000). After implementing VMI, all of the orders from vendor are passed over the network to Lenovo. Based on the conventional pull production system, a new quick response inventory mode is presented. By observation of the market and information from suppliers, Lenovo know each product’s shipments. Accordingly, Lenovo left best-selling products inventory for 12 days sales to shorten the delivery date. Lenovo's quick response system is based on inventory forecasting accuracy, which is also one of VMI model features.

5.5 The New Lenovo VMI Features

On the basis of further research, the authors concluded two new Lenovo VMI features. Compared to the VMI features like information sharing, sales forecasting and quick response, these new VMI features are likely to be applied to implementation of VMI in inventory management of other PC company.

Suppliers Work Together to Achieve a Win-win Situation

A competitive supply chain has a strong competitive edge. Based on this management thinking, Lenovo is committed to work together with suppliers to achieve a win-win situation. Generally, Lenovo weekly or biweekly provide suppliers with the next 12 to 16-week rolling to goods scheme (Lenovo annual report, 2013). In order to ensure suppliers on time delivery activities and get reasonable price, Lenovo have rigorous supplier evaluation method. In addition, Lenovo also evaluates the product quality, price, delivery and flexibility indicators. Mishra and Raghunathan (2004) noted that VMI increases the competition among suppliers. Lenovo evaluated the suppliers regularly, and use the supplier scoring system to determine the performance of its supplier.
Coordination of Product Supply and Demand

Lenovo's demand is seasonal, and eventually the demand of the market is closely related. However, Lenovo’s production is stable, so implementing VMI can minimize the cost of production and reserve enough stock to supply relatively hot season. If the price of raw materials are very volatile over time, such as chips, their price and closely related to the price of silicon, as a result, Lenovo will be low price purchasing in advance some chips.

5.6 The Significant Changes in The Process of Integration VMI in Lenovo

After implementing VMI, Lenovo have improved the degree of coordination and response capability.

The most obvious change after implementing VMI is accelerating the pace of the entire operating system. Lenovo can receive sales orders in the morning, about one hour before the production plan. Then, the information flow passed to suppliers located around the factory. After that, the suppliers prepared the materials and sent directly to the production line. At that time, factory can put the morning orders into production immediately.

Warehouse is part of the production process in Lenovo. After implementing VMI, all of the raw materials were imported. It contributes Lenovo to defer tax time after sold products. The storage of raw materials was closer to the Lenovo factory. What’s more, the delivery time in warehouse has been shortened to speed up the delivery time of raw materials.

Implementing VMI have greatly improve overall operational efficiency. The entire batches of finish product storage of last 24 hours have increased from 40% to more than 90%. What's more, Lenovo's inventory turnover rate has improved. Lenovo's annual output have already reached 400 million units, the improved efficiency have very huge changes. Moreover, the real-time information sharing and
collaborative operation between upstream and downstream enterprises has been improved. The competitiveness of the entire supply chain has been greatly enhanced. After implementation of VMI, Lenovo inventory level has also reduced. Lenovo suppliers can keep abreast of the enterprise product inventory and demand, and customers’ orders can be scheduling immediately.

6. Conclusion

As one of the earliest Chinese to adopt VMI strategy, Lenovo is committed to implementing the strategy to increase the competitiveness of the company. It is the major objective of this dissertation to analyze the VMI inventory management model and discuss further implementation in Lenovo. The conclusion is believed to be applied to other PC companies as well.

Lenovo’s previous inventory mode was the Kanban system. The deficiency of the previous mode is that the information level on the outsourcing warehouse was low, where the so-called information island phenomenon might be triggered. Furthermore, Lenovo’s internal inventory information system was not integrated appropriately with the suppliers, in which both appraisal and management system of suppliers are absent. Comparatively, Lenovo’s present inventory mode is the vendor management inventory, Lenovo inventory is managed by vendor who is responsible for sorting, customs declaration and distribution to the production line.

This thesis concludes the Lenovo’s VMI features, for example, information sharing promoted good communications between Lenovo and suppliers, accelerated speed of information transmission and processing where information islands were eliminated. The cost saving features controls the material quantities in warehouse and promptly adjusted purchase plan to control of procurement's cost. The sales forecasting features help Lenovo gather information related to demand forecasting, inventory status, transport capacity and production capacity. In the flexible manufacturing lines, Lenovo has customized the product according to customer
demand. What’s more, it has uplifted the customer service level to a great extent. After implementing VMI, all of the orders from vendors are passed over the network to Lenovo. Based on the conventional pull system production, a new quick response inventory mode is presented.

In addition, the authors conclude two more Lenovo VMI features. One is that suppliers are working together to achieve a win-win situation. The other one is coordination of product supply and demand. It minimizes the cost of production and reserve enough stock to supply relatively hot season.

Lenovo supply chain was greatly shortened which leads to cost reduction and enhanced flexibility after implementing VMI mode. The VMI mode was involved Lenovo's international procurement of materials, the immediate needs of production and supplier inventory materials.

6.1 Important Factors in Implementation of VMI in Lenovo

- **Technical Problems**

  The use of advanced information technology is mainly to ensure the timeliness and accuracy of data transfer, however inevitably these techniques are expensive. Using the point-of-sale information, the distribution of information are transmitted to suppliers and retailers when the bar code technology and scanning technology are introduced to ensure the accuracy. Meantime, inventory control and planning systems must be guaranteed to be accurate and available online.

- **Inventory Ownership**

  Before deciding who is going to replenish stocks, retailers receive the goods, the ownership transfer; suppliers have stocks until the goods are sold. At the same time, the management responsibilities of suppliers increase and cost increases, the two sides have to negotiate the terms, so that retailers and suppliers can share overall
inventories system.

- **Funds to Pay.**

  In the past, retailers usually need one to three months to receive the goods before payment are made. With the development of VMI, the payment period will be shortened and the speed and frequency of money transfer between Lenovo and retailers are accelerating rapidly.

6.2 Future Study

After the completion of VMI study, the understanding of the mode is consolidated. However, the fact that the benefits of VMI are unable to act quickly was noticed. Therefore, if company wants to implement VMI, it should be based on a long-term consideration. In implementation of VMI, both the third-party logistics enterprises and company itself should adjust continuously. In order to accommodate the entire implementation of VMI, the product management should be to standardized, such as product packaging, specifications and so on. Meantime, quality system should be the same diameter as well. Not only has it mitigated the misunderstanding between both companies, but also has guaranteed the product after-sales service. What’s more, employee’s exchanges and training are required since VMI is an agreement of cooperation between enterprises. Both companies can periodically send employees to each other for the purpose of visiting and gaining more experience, which leads to better understanding between both parties. In addition, encouraging the employees to keep learning the new technology of VMI can maintain the company’s competitiveness.
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Publications.


Appendix

Appendix contains a brief description of interview with case company Lenovo. Since Lenovo is at abroad, the interviews were held through e-mails and Skype meetings during May 10th to 16th 2013. For the e-mail interview, first, a request was to sent interviewees to ask for participation in the interview. Then questions were sent to interviewee through e-mail and interviewee replied next day, while if necessary further questions were sent.

For the Skype interview, appointments are often made by phone calls by talking with interviewee directly talking to arrange the interview. Before the interview, two interviewers prepared several questions in a structure path to ensure that the topics in the interview could cover all aspects of case study. The whole process of interview could divide into three times and the process of each interview will be presented below with a question list.

The first interview was held via the Skype in 10th May 2013. The whole interview lasted about 30 minutes. In the first interview, Interviewers introduced aims of the interview, then interviewees introduced themselves and some basic information about Lenovo. Questions asked during the first interview are shown as follow:

- Could you describe your job in detail? What is your position in company? What are you responsible for?
- Could you introduce of Lenovo? The background and the market position.
- What is Lenovo’s key area? What is Lenovo’s mission? What is Lenovo’s value?
- What is supply chain status of Lenovo? Where are the Lenovo principal operations, research centers, sales headquarters and manufacturing centers?

The second interview was held through e-mails on 13th May 2013. The
interview questions mainly contain Lenovo’s previous inventory management and Kanban system. The interview questions as follows:

- How was Lenovo’s previous inventory management model implement?
- Why Lenovo used VMI instead of the Kanban system? Were there any deficiencies in Lenovo's previous Kanban system?
- Are there any deficiencies in Lenovo's original warehouse management model?
- Are there any deficiencies in Lenovo's previous inventory management model?
- What impact will these deficiencies have on Lenovo previous inventory management?

The third interview was held through e-mail on May 15th 2013. It mainly mentioned Lenovo’s VMI system. The interview questions were as follows:

- What is the Lenovo's current VMI inventory operating system?
- What significant change should be addressed during VMI consolidation process?
- VMI has the characteristics of information sharing, how does Lenovo use VMI to realize information sharing?
- How did Lenovo forecast deviations quickly adjust the procurement plan?
- If purchasing can't tracking, how dose Lenovo handle this problem?
- How does Lenovo use VMI to control the cash flow?
- Are there any experiences about the successful and creative uses of VMI?
- Are there any difference in inventory management between Lenovo and other western PC enterprise?