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Inventory Optimization

Based on Purchasing Activities Analysis

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Abstract
Inventory optimization is a popular topic among companies, especially in SMEs. Based on the traditional inventory management methods, some other operations management concepts were considered to improve the inventory performance more comprehensively. On the basis of a case analysis for Company X, some attempts were made to achieve the goal of optimizing inventory from purchasing activities, purchasing strategy and supply chain points of view.

Regarding the imbalanced inventory structure and imperfect inventory management system of Company X, some new improvement solutions including inventory replenishment method, overall purchasing strategy and JIT-QM Joint strategy were proposed in order to solve the current existing problems and promote the long-term development of the company.

The recommended solutions described in the thesis were presented based on relevant literatures and theoretical calculations, thus the practicality of them needs to be tested empirically to demonstrate a broader support. Nevertheless, the new ideas and methods suggested in the thesis will enhance the vision of purchasing executives during the decision-making process, aiming at minimizing the inventory costs and maximizing the services.

Keywords
Inventory Management, Purchasing, Just-in-Time Management, Quality Management

Miscellaneous

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1. Introduction

According to the Economic situation and outlook 4/2014, offered by The Federation of Finnish Technology Industries, the growth of the world economy has failed to achieve the level predicted for this year. One of the crucial factors is the slowdown in economic growth in the large developed countries, such as the European countries and Japan. For example, the Finnish technology and mechanical industry, which sets a warning example of the poor cost competitiveness in terms of the labor costs and productivity, also experienced a significant decrease. (Economic situation and outlook, 2014.)

When it comes to the Finnish manufacturing market, the Small and Medium Scale Industrial Enterprises (SMEs) play an important role. To improve competitiveness and achieve cost efficiency, a company should not only try to meet its customers' needs and learn the competitors' actions, but also improve the internal performance by improving its operational processes, such as inventory control, purchasing and manufacturing, etc. Especially since inventory constitutes a vital portion of the current assets of SMEs, inventory management is closely related to the utilization of capacity and the realization of profit. Therefore, efficient inventory management is meaningful for Small and Medium Scale manufacturing organizations as well as for a country's economic growth.

1.1 Objectives of the Thesis

The thesis was implemented based on a case company X. The research and analysis were focused especially on assessing the current inventory and purchasing performance. Based on a comparison between the optimum (theoretically) results and the current one, an attempt was made to find corresponding solutions to deal with the company's existing problems and improve the future performance.

More specifically, the primary goal was to assess the performance of non-active stocks and to discover the factors causing them. The thesis mainly focused on the field of waste reduction by applying the JIT Management and Quality Management principles. Secondly, to achieve cost efficiency, the company itself implemented some strategy modifications regarding the purchasing process. In this case, further comparison between the modified purchasing strategy and theoretical recommendation was implemented, in order to assist the future decision-making process of the purchasing team and ensure the company's long-term competitiveness.

From a scholar point of view, despite a good combination of theoretical study and practical knowledge during the research and analysis process, the practicality of certain theories was verified as well. For instance, assessment was made whether the JIT principle was applicable for finished products in a non-manufacturing environment. Moreover, this work also reflected on whether the Economic Order Quantity (EOQ) calculating method was the most efficient way to find out the optimum order quantity.

1.2 Research Methods

The research was based on the case company X. All the data were collected from the company's database, interviews of the personnel from the related departments and the company's website.

By implementing an ABC analysis and an XYZ analysis, detailed information about product sales and transactions could be found. In addition, according to the expectations of the company, appropriate approaches needed to be found in order to eliminate the stocks with 0 turnovers and prevent the related problems from happening in the future. In terms of the inventory system, the overall structure could be thus optimized by adjusting the percentage distribution of active and non-active products. Meanwhile, the most suitable purchasing strategies were expected to be designed as well regarding different groups of items, in order to reduce inventory cost and improve

efficiency. The main academic approaches include inventory management, JIT Management and Quality Management.

Concerning the research and analysis methods, a combination of qualitative and quantitative methods was applied. For example, to determine the optimal ordering level, some calculations were performed with a series of numerical data. However, only supported by quantitative data, the study results might be unconvincing enough. Since the acquisition and analysis of different types of data took place in a separate phase, and since each type of information was used to measure different but complementary aspects of the same object, both of them were important for the interpretation of the results. (Joan Miquel & Marti 2011.) As a result, a qualitative approach was applied at the same time so as to be able to explain the dynamics between the actors and other relevant factors (Fenson & Edin 2008, 22).

1.3 Case Company

For decades, Company X has been a remarkable manufacturer and importer of oil and water hydraulics components and systems. Over decades, global OEM customers as well as the industrial customers of Company X have experienced high quality, cleanliness and delivery reliability provided by the case company.

According to the purchasing manager of Company X, “Although the domestic sales situation is not that optimistic at the moment, the current financial status is still doing good. The good result is attributable to the global exporting sales to a large extent.” (Purchasing Manager of Company X, 2014.) However, according to the Managing Director of Company X, “in terms of current stock situation, a large amount of non-active stock has been stored in the warehouse for so many years.” Especially from a long-term point view, if the amount of non-active stock continues to increase, the business profit will finally be affected negatively. In order to spare more development space for crucial products, which need to be handled with more care, the stock with no sales should be reduced or eliminated to as great an extent as possible.

2. Operations Management

Operations management is the area relating to the efficiency and effectiveness of the operations supporting the development of a company's strategic goals. The four primary functional areas of a firm are marketing, finance, operations and human resources. Operations are the technical core of an organization. They interact with the other areas and suppliers in order to produce products and provide services for customers. They are focused on the planning, scheduling, and control of manufacturing, or services. (Russell & Taylor 2009, 4.)

Operations management mainly includes two critical aspects – competitiveness and performance. In order to improve competitiveness in the market, a company should try to meet the needs of the customers to the maximum extent, while learning good actions from its competitors. In terms of the overall performance improvement, companies normally focus on certain operational processes such as purchasing, inventory management or production. While maintaining or improving the quality of a process, cost efficiency is also expected to be achieved. When analyzing the relations between competitiveness and performance, an outstanding performance will obviously contribute to a firm's competitiveness, and, in turn, strong competitiveness will motivate the company to achieve better performance in the future. In this thesis, the current performance of two important logistics operations processes - purchasing and inventory management processes - were deeply analyzed in order to make possible strategy adjustments regarding the improvement of the future performance and hence the overall business competitiveness.

2.1 Inventory Management

2.1.1 Target of Inventory Management

As part of the most significant assets of a company, stock gives a buffer between supply and demand. It allows for variation and uncertainty in both

supply and demand, and makes operations continue smoothly (Waters 2003, 8). Organizations usually hold different types of stock, such as raw materials, purchased parts, work in progress, finished goods and so on. There is a variation of stock holding strategies between different types of company. However, the importance of keeping the right stocks at the right time is indubitable. On the one hand, stocks allow the company's internal operations to be more effective. Externally, stocks affect lead times and the availability of materials, thereby affecting customer' satisfaction and the perceived value of the products (ibid., 10). In the end, they also play a strategic role affecting the operating costs and hence the financial performance of the whole business in the long term. On the other hand, keeping stocks can be either encouraging or risky, depending on the inventory management method, or in other words how to manage the stocks that must be held in the most effective way.

Inventory Management manages the product flow along a supply chain, and it also helps to determine how much products to order and when to replenish. Meanwhile, Inventory Management plays an important role in cost reduction. Especially in the current global business environment with more rapid product updating, the cost of inventory has increased partly as a result of quicker product obsolescence. (Russell & Taylor 2009, 527.) So, the question of how to lower the inventory cost while maintaining the required service level of products has become a popular topic among different types of organizations.

In order to achieve the target that materials or items are available when they are required while the holding costs are minimized, efficient cooperation in the decision-making between different levels of an organization is highly recommended. In general, there are three types of objectives for inventory management. They are classified as follows.

- *Strategic decisions* are the most important, because they have long-term effects, use many resources and are the most risky. They set the overall directions for the operations.
- *Tactical decisions* are concerned with implementing the strategies over the medium term. They look at more detail, involve fewer resources and some risk.

- *Operational decisions* are concerned with implementing the tactics over the short term. They are the most detailed, and involve few resources and little risk.
  (Waters 2003, 37.)

After setting the higher strategies regarding the overall direction, the tactical and operational decisions show how the detailed inventory management strategy is implemented. Decisions for inventory management come from all levels, forming part of the overall logistics strategy and the lower tactical and operational decisions. (ibid., 37.) Nowadays in a modern organization, most of the decisions are discussed between different departments instead of simply passing them down through a strict hierarchy. Furthermore, usually the most suitable person who makes a decision is the one most closely involved with the issue.

2.1.2 Inventory Key Concepts

Demand Analysis

Demand can be regarded as the initial point of the whole supply chain, so the analysis of demand is crucial. The purchasing decisions regarding “when to order” and “how much to order” rely on an effective demand analysis to a large extent. Therefore it would be necessary to understand some basic terminologies relating to the analysis of demand.

Demand: the number of units to be supplied from stock in a given period. (Waters 2003, 69)

Independent demand: refers to random demand, which is independent of all other products. It does not have a consistent pattern and may have high or low volumes. (Emmett & Granville 2007, 36.)

Lead time: the full time period from when the decision is made to order until the product is available for issue. (ibid., 94.)

Cycle time: the time between two consecutive replenishments. It depends on the order quantity, with larger orders leading to longer cycle times. (Waters 2003, 69.)

Order quantity: the fixed order size that has been always used. (ibid., 69.)

Reorder point (ROP): the level of inventory that triggers an action to replenish certain inventory stock. In other words, when it is time to place an order, the stock on hand must just cover the demand until this order arrives. The level is normally calculated as the forecast usage during the replenishment lead time plus the safety stock. (ibid., 69.)

Service level: a target for the proportion of demand that is met directly from stock. It can be measured by the percentage values such as the percentage of orders completely satisfied from stock, the percentage of demands that are delivered from stock, and the percentage of demands that are delivered on time, etc. (ibid., 171.)

Back-orders: they occur when a customer orders an item that is out of stock, and then wait to receive the item from the latter delivery from suppliers. (ibid., 121.)

Stock Analysis

Safety stock: the stock kept beyond expected needs, adding a margin of safety. It is served as an insurance against stockout when there is uncertainty in demand and supply. The level of safety stock can be defined by using either the demand of the period or mathematical formula.

Active stock: an assortment of assets that will be used or sold within a certain period (normally a year).

Non-active stock: some non-moving stocks on hand, and when these have no foreseeable future use, they are declared as obsolete stock (Emmett & Granville 2007, 162). The non-active stock may be caused by the backlog of obsolete stocks for many years, and there is no market demand for the product.

Overstock: the result of poor management of stock demand or of materials flow in process management.

Understock: the items whose quantity is under safety stock. The lesser quantity means the weaker service level.

Demand Forecasting

When dealing with independent demand, forecasting is an important step for the best estimation and prediction of possible changes in the future replenishment. Forecasting also aims to minimize the inaccuracy based on the previous forecasts. Demand forecasting can be either easy or hard, depending on the type of products, stability of demand and the length of the time period.

Time Series Methods: These methods involve looking at the pattern of the past demand and extending this into the future, in other words, predicting the future based on the past data. (Emmett & Granville 2007, 51.)

Accuracy of forecast: refers to the actual demand versus demand forecasted in a period. (ibid., 186.)

ABC Analysis

Background of ABC Analysis

Since there are many individual items needing to be managed in a complicated inventory system, it is highly important to make a reasonable time distribution for items with different values. In order to count the accuracy of the inventory in a cost-effective manner, one of the useful methods is ABC Classification / Analysis, which is based on the product consumption during a particular time period (normally one year). The analysis is based on Pareto's 80 – 20 rule, which presents that 20% of the population owns 80% of the wealth. This observation was first made by the Italian economist Vilfredo Pareto, and more widely speaking, the rule illustrates a high incidence in one set of variables and equates to a smaller incidence in a corresponding set of variables. (Emmett & Granville 2007, 41.) As applied to the inventory field, a typical relation between the percentage of items and the percentage of the sales or usage values can be in the following pattern:

A Product – about 20% of the items account for about 80% of profit, sales or usage.

B Product – about 30% of the items account for about 15% of profit, sales or usage.

C Product – about 50% of the items account for about 5% of profit, sales or usage.

However, the percentage values can be varied depending on different industries. The above distribution is not the absolute pattern.

Handling different classes of product

According to some suggested guidelines for handling A, B and C classes of items, there are different management procedures based on different levels of consumption values.

Class A items

Theoretically, Class A items represent a group of products with high consumption values. This group requires very strict control, no or very low safety stock, frequent ordering (weekly), weekly control statements, as many sources as possible for each item, accurate forecasts, minimization of waste obsolete and surplus and maximum efforts to reduce lead time. (Rama 2009.)

Class B items

Comparing to Class A products, “B” items require moderate control, lower safety stock, delivery once in three months, monthly control reports, two or more reliable sources for each item, estimation based on past data and quarterly control over surplus and obsolete items. (ibid.)

Class C items

C items have the lowest consumption values comparing to the first two groups. When dealing with this class of products, loose control, high safety stock, bulk ordering once in 6 months, quarterly control reports, two reliable sources for each item, and a rough estimation for planning are needed. In addition, an annual review over surplus and obsolete materials is sufficient, and minimal clerical efforts should be made on. (ibid.)

Advantages and disadvantages of an ABC inventory analysis

Even though the ABC Analysis can help to ensure considerable reduction of storage expenses and at the same time preserve costly items if applied with

care, it is still significant to understand the advantages and disadvantages of the analysis method.

Better Control of High-Priority Inventory

ABC inventory analysis places tighter and more frequent controls on high-priority inventory. Class A inventory includes critical items with the highest value to the company, so it is crucial to constantly monitor the demand for it and ensure that stock levels match the corresponding demand. (Advantages and Disadvantages of ABC Analysis Inventory N.d.) On the contrary, Class C products can be managed with basic and simple records. In addition, inventory quantities can be larger with very few periodic reviews. In short, ABC Analysis assists a company to understand which items need to be focused on, and which are not so important and require less care.

More Efficient Cycle Counts

When applying the ABC inventory analysis method, the resources can be allocated more efficiently during cycle counts, meaning the process of counting only certain items on scheduled dates. The frequency of the cycle counts and the items selected to include depend on how often the inventory fluctuates. If the inventory is classified by class, Class A inventory could be handled with regular cycle counts. If necessary, Class B products could be counted as infrequently as twice per year and Class C products only once per year. (ibid.) In this way, both time and labor costs can be considerably reduced.

Nevertheless, the ABC Analysis suffers from the following drawbacks at the same time.

Risk of Undersupply and Oversupply

Since an ABC analysis is performed based on dollar values rather than on the number of items, some companies may only concentrate on high-value products, this means that there is a risk of running out of low-value items which are, nevertheless, essential in terms of the overall business. The

opposite situation exits too – an excess Class B and C items may pile up in the inventory if they are regularly reordered without a review. Sometimes those stocks can even be in danger of obsolescence or damage, causing a great deal of extra costs.

Requires Substantial Resources

The ABC analysis method requires more resources for maintenance than traditional costing systems. When cycle counts are performed, Class A must be routinely analyzed to determine if the inventory still consists of high-priority items. If an inventory piece is no longer used or demanded as frequently, it is moved to another inventory classification. (ibid.) In this case, a good system of codification should be adopted for the success of the analysis, and it would be even better if the company's inventory system allowed for accurate and timely information updating.

XYZ Analysis

The XYZ classification is a modification of ABC analysis, based on the structure of selling in pieces. Both ABC and XYZ analysis are following 80/20 rule, which means that about 20% of things produce about 80% of results. Apart from the assumed criterion according to the sales in value (ABC analysis), to achieve better segmentation of products, one should divide them also according to the sales quantity (Bulinski, Waszkiewicz, & Buraczewski 2013, 93). The XYZ classification divides products into three groups:

Group X – the products of high selling rate

Group Y – the products of average selling rate

Group Z – the products of low selling rate (sold occasionally)

Carrying out the ABC/XYZ analysis enables to arrange the products according to selected criterion. A combination of total sales value and demand size analysis gives more accurate evaluation of a company's inventory performance. Meanwhile, when implementing both ABC and XYZ analysis, a more comprehensive examination enables to identify the specific products that

fail to bring the expected financial profits and allow for making some corresponding corrections. (Bulinski et al. 2013, 95.)

2.1.3 Inventory Costs

Value of Stocks

The treatment of the inventory in a company's financial account is normally different than in some other areas. It is important to have an accurate value for stocks and understand how inventory costs affect the profit and loss account, cash flow and the return on capital employed. There are mainly four methods of setting the stock values.

- *Actual cost method* assumes that the actual cost of each item can be tracked.
- *First-In, First-Out (FIFO)* assumes that the first goods that are purchased will be the first ones to be dispatched irrespective of the timing of the sale.
- *Last-In, First-Out (LIFO)* assumes that the items that have been recently purchased will be the ones that are sold first, regardless of when the actual sales take place.
- *Average cost method* finds the average unit cost of all purchased over some time, and assigns this value to all remaining stock.

(Emmett & Granville 2007, 105; Waters 2003, 49.)

Types of Cost

Keeping stocks produces costs. Simply reducing the amount of stocks is not the best way to minimize the inventory costs, since sometimes even low stocks can lead to shortage that affect operations and cause extra cost. In this case, a detailed analysis of specific type of inventory costs is needed. Generally, the inventory costs can be classified into four categories.

- *Unit cost* is the price charged by suppliers for one unit of the item, or the cost to the organization of purchasing one unit.
- *Carrying costs* are the costs of holding one unit of an item in stock for one period of time. The most obvious carrying cost is the money tied up –

which is either borrowed or could be put to other use. Some other types of carrying costs include storage cost, damage/loss cost, handling cost, administration cost, insurance and so on.

- *Ordering costs* are the ones associated with replenishing the stock of inventory being held. This type of cost may include allowance for drawing-up an order, correspondence and telephone costs, supervision, use of equipment and follow-up, etc. Sometimes costs such as quality control, transport, delivery, sorting and movement of received goods are also included.
- *Shortage costs* usually occur when customer demand cannot be met because of inefficient inventory. This kind of shortage can result in customer dissatisfaction and even permanent loss of sales.

(Waters 2003, 52-53; Russell & Taylor 2009, 530-531.)

Financial Impact of Inventory

Obviously the inventory has a direct impact on the financial performance of a firm. Firstly, as current asset, the inventory directly influences the revenue, cost and profit. Both the revenue and cost will occur in the profit and loss statement when the sales and purchasing costs of the items occur in the same period. But when item is purchased in one time period and then is used in a later period, the adjustment has to be made to the profit in order to allow for the increase of stock levels. (Emmett & Granville 2007, 107.) Moreover, the inventory, as one type of capital employed, can affect the performance of cash flow and even the operation of the supply chain. And, in turn, the inventory management also has a direct impact on capital employed and therefore capital/asset turnover. Last but not least, there are some further impacts that are not as obvious. For example, the warehouse operating costs, extra transport costs, extra salaries or allowances and the disposal costs caused by damaged and obsolete items, etc. may also become obstacles to inventory level optimization and costs reduction.

2.1.4 Inventory Performance Assessment

When company's replenishment process is based on forecasts, the forecast accuracy and the purchasing frequency determine the stock levels. To reduce the stock levels while achieving customer service targets, an accurate inventory performance evaluation is expected to be made regularly.

Inventory Turnover

In order to monitor the inventory performance over a certain period (normally one year), one effective measure to decide whether existing inventory levels are reasonable or not is to calculate the Stock turnover. The ratio can be calculated as $\frac{number\ of\ units\ sold\ in\ a\ period}{average\ stock}$, and it demonstrates the number of times the company sells its inventory during a certain period. Alternatively, when organizations often find their stock turnover indirectly from accounts, the Stock turnover is usually defined according to the following formula:

$$Stock\ turnover\ = \frac{Cost\ of\ units\ sold}{Average\ value\ of\ stock}$$

(Waters 2003, 53 – 54.)

Whether a current ratio is good or bad depends on the type of business. Generally, a higher inventory turnover is considered a positive indicator of operating efficiency, since inventory that remains in place produces no revenue but increases inventory carrying costs. However, a higher inventory turnover ratio does not always indicate better performance. A more specific and deep analysis should be implemented with some other trends within the financial statements. (Bierley, Jr., 2008)

Models for Implementing Inventory Controls

The basic steps for implementing inventory controls could be done as follows:

a) List all the items sold in the last 12 months at cost.
b) List the current stock value of each item at cost.

c) Arrange the information in descending order of value. Make the ABC analysis.

d) Review the stock level of A, B and C class items respectively.

e) Evaluate the stock turnover regarding each class of item.

f) Identify the items with no usage.

g) Review the inventory parameters such as reorder point, safety stock and EOQ, etc.

h) Compare current situation with the stockholding targets.

i) Strategy adjustment in order to make improvements.

In order to make a realistic assessment, it is important to have the ability to measure and understand the variances between targets and achievements. And according to Waters (2007, 183), it is good to remember that there is little point in planning if you do not intend to measure, and there is little point in measuring if there is not a target with which to compare results.

2.2 Purchasing Function

As a buying process, the purchasing function is directly link to the inventory level control and cost management. The purchasing function plays a significant role in the whole supply chain, starting from the supplier selection to follow-up and evaluation. Even though the purchasing seems separated from some operations such as materials requirements planning, inventory management, incoming inspection and quality control, etc., in order to maximize the company's efficiency, purchasing operations are implemented interrelated with those activities. Especially in terms of the current global business environment, in which there are more competitions as well as cooperation, the purchasing function of an organization becomes increasingly critical towards the excellent performance of the organization and the whole supply chain.

2.2.1 Strategic Process

Acting as the initial part of overall purchasing operations, the strategic purchasing sets a strong foundation for the following processes. An example strategic management process is demonstrated as follows:

FIGURE 1. Strategic Purchasing Process (adapted from Weele 2010, 191)

During the procedures for achieving the purchasing target, the initial step is to decide what activities to be performed inside or outside the company. And then the company should have a clear picture of its purchasing spend, specific information of suppliers, and so on, depending on the expected benefits. During the same stage, a specific plan about who will be responsible for each activity and how progress will be monitored has to be made as well. The next important task is to optimize the relationship with the suppliers, who are one of the key bodies along the supply chain. And based on worldwide supplier selection, there are more opportunities to increase business. To simplify the supplier selection process, a classification of suppliers could be helpful. Nevertheless, developing stable and reliable partnerships is not easy and takes long time. Nowadays more and more organizations tend to involve suppliers into the product innovation and the order fulfillment process to satisfy the final customers as best as they can. In additional, both parties cooperate with each other and work on issues such as how to increase the customer service, how to improve the asset utilization, and how to improve the

communication flexibility by applying modern ICT, etc. In the final stage, the buying company shares the benefits gained from all supplier improvement activities that are generated from its suppliers, rather than taking it all itself (Weele 2010, 192). This process also encourages both parties to work jointly with end customer to realize cost savings. However, the implementation of the strategic purchasing process still depends on the types of business, the products and the suppliers. (ibid., 190 – 192.)

2.2.2 Operational Process

On the basis of the strategic planning process, how to conduct the operation process is also significant for a company's sustainable performance. An example of operational process is demonstrated as follows:

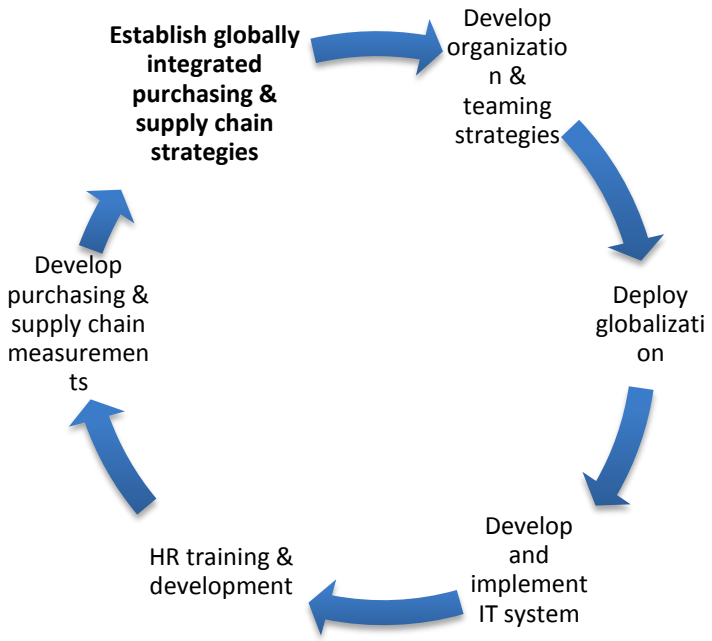

FIGURE 2. Operational Purchasing Process (adapted from Weele 2010, 193)

In terms of a multinational company, or a company dealing with international import and export, it is important to have standard rules and guidelines about how to develop every business unit, in order to avoid some possible misunderstandings or even conflicts when doing business with international partners. In addition, the information sharing and effective communication can also promote the collaboration between different stakeholders concerned. When it comes to the global sourcing process, sources of supply in low-cost

countries become increasingly attractive especially for the small and medium-sized companies. In this case, a basic understanding for the culture of the countries the company does business with is highly recommended, so as to avoid misunderstandings or some other possible risks. And to be able to produce effective purchasing management information and communicate timely, the investments in advanced IT systems and related facilities are necessary as well. Those systems should include specific procurement solutions aimed at simplifying order to pay transactions through electronic ordering and payment (Weele 2010, 194). From the view of human resource management, proper recruitment, training and remuneration policy also contribute to the purchasing efficiency and effectiveness. (ibid., 193 – 194.)

2.2.3 Purchasing Performance Assessment

After implementing both strategic and operational processes, another major concern for many companies is to measure and evaluate the purchasing performance in a certain period. The factors which may affect the strategic purchasing performance include “should cost” analysis, number of new suppliers contracted, and cost savings. For the operational purchasing function, which is handled by relatively lower positions of an organization, some parameters such as number of orders, order backlog, lead time, inventory reduction, and so on, may influence the measurement. (Weele 2010, 302-303.)

The key areas will be considered when making the evaluation consists of four main dimensions – purchasing cost, purchasing product/quality, purchasing logistics (handling process, supplier performance, and inventory level control) and purchasing organizations. All the aspects reflect the purchasing effectiveness related to the objectives and purchasing efficiency connected to the resources that are required to meet the purchasing goals. (ibid., 307-308.)

A regular reporting of actual versus planned results enables a company to verify whether its expectations have been realized. Based on the purchasing performance during the previous periods, the purchasing team may improve decision-making performance and prevent the previous variances happening

in the future. The performance assessment may also lead to better communication and mutual understandings between purchasing department and other departments. From a buyer's point of view, a proper performance evaluation system can meet his or her personal and motivational needs as well as constructive goal setting. (ibid., 304.)

2.3 Quality Management

According to the definition of quality given by IBM Company, "Quality is the degree in which customer requirements are met." Nowadays, in terms of a certain type of industry that is involved into a complete supply chain, the quality management represents the involvement and commitment of everyone, in continuously improving work processes, to satisfy the requirements and expectations of all internal and external customers (Emmett & Granville 2007, 198.)

In order to make sure that the customer's requirement will be met and at the same time minimize the inventory carrying costs, the quality management is playing a crucial role in optimizing inventory and improving quality of purchasing activities. Within an organization, the quality management is the responsibility of every employee. The organization structure and the level of training to the employees are closely linked to the quality improvement process.

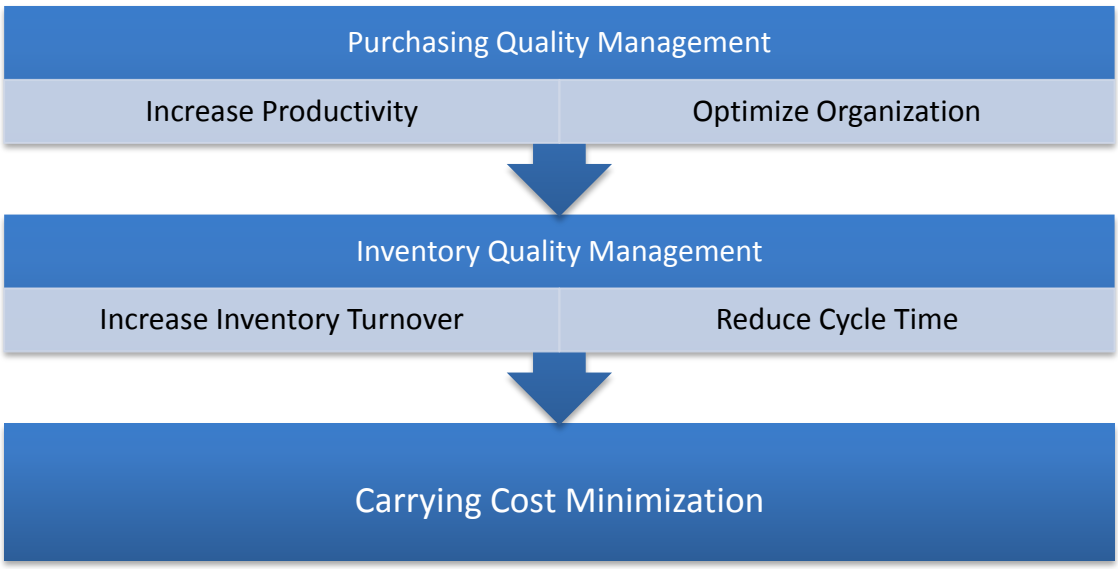

FIGURE 3. Competitive Advantage of Quality Management

2.3.1 Introduction to QM

Basic Concept of QM

Deming Cycle (PDCA Cycle)

To assure every transaction between customer and supplier can be made smoothly, the quality management requires intensive and effective cooperation between different departments inside the organization and with outside suppliers and customers. Generally, customer and supplier should make agreement regarding following aspects:

- the basic requirements of the transaction
- the way in which the requirements are to be realized
- how to check that the requirements are fulfilled
- the measures to be taken when the requirements are not met

(Weele 2010, 238.)

Combining with Deming Cycle (PDCA Cycle), the basic elements of the quality management are demonstrated below:

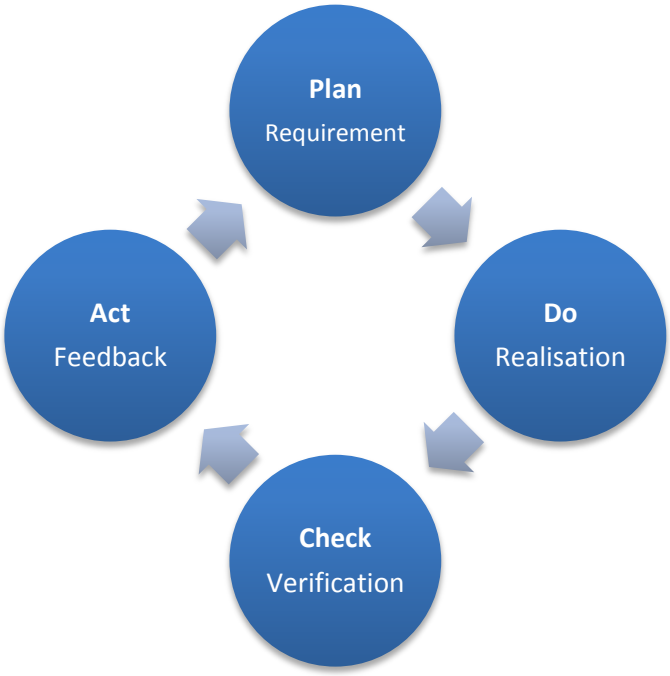

FIGURE 4. The Plan-Do-Check-Act Cycle (adapted from Weele 2010, 239)

The Seven Wastes

Mainly there are seven types of wastes needing to be minimized or eliminated through the quality management.

- *Overproduction* is the excess finished goods stocks resulting from production, especially found in make-to-stock scenarios.
- *Waiting* is the time spent on queuing for a machine to finish its cycle.
- *Transporting* is the moving of WIP (work-in-progress) around for finishing. The costs resulted from transport add no value to the finished product.
- *Inappropriate processing* is the waste resulted from over specifying/engineering.
- *Unnecessary inventory* is the stock over the required minimum.
- *Unnecessary motion* is the movement that does not contribute in getting products to customers.
- *Defects* are the faults that are required to be corrected.
  (Emmett & Granville 2007, 200.)

Quality Tools

The performance of quality in a company can be measured by using quality tools, especially through statistical process control. Currently there are seven well-known tools for identifying quality problems and improving the competition of the organization.

- ✧ *The process flowchart* is a diagram of the steps in a job, operation or process. The development of the flowchart can make the process more understandable and enable us to identify problems concerned.
- ✧ *A check sheet* is a list of causes of quality problems with the number of defects resulting from each cause used to develop a bar chart called a histogram.
- ✧ *The Pareto analysis* is a diagram for tallying the number of defects resulting from different causes to identify quality problems. Theoretically the identification of the Pareto chart is that 20% of problems produce 80% of defects.
- ✧ *Histogram* shows the frequency of data related to quality problems. A flat and wide curve means to stable, rather than vice versa.

- ✧ *Scatter Diagram* shows the relationship between two variables in a process, and it identifies a pattern that may cause a quality problem.
- ✧ *Statistical Process Control Chart* is the one with statistical upper and lower limits. If the process stays between these limits over time, it is in control and a problem does not exist.
- ✧ *Cause-and-Effect Diagram* also called a “fishbone” or Ishikawa diagram, which is used to identify the causes of a quality problem so as to correct it.

  (Russell & Taylor 2009, 60-63.)

Benefits of QM

The main goal of the quality management is to improve the quality level of products and optimize the overall function of an organization.

The major benefit of the quality management is to achieve productivity and process efficiency by identifying and eliminating problems occurred during the working process. Improving quality by reducing defects will increase good output and reduce input, and therefore will improve the overall productivity. From a long-term point of view, the quality management also helps with predicting and preventing unproductive activities.

One of the other biggest benefits of the quality management is the cost savings that will be achieved in the long run. The quality management aims at reducing or eliminating unnecessary and unproductive tasks such as non-confirmation and repetitive work. Moreover, the improved profit per product or service can be achieved through elimination of unnecessary steps and wasteful expenditure.

Better organization within a business is another benefit of the quality management. By analyzing available business data from different aspects, the optimized communication and the efficient information sharing between departments will be promoted. In addition, the employees will be more positive because of the more motivated and well-cooperated working environment.

An additional advantage of the quality management relates to customer satisfaction. For instance, the waiting time can be reduced by changing the

method of appointment scheduling or client handling, and the product reaches the customer faster due to the change of the delivery processes. In this case, customer loyalty can be maintained. (Idea: Nayab 2011.)

2.3.2 Inventory and QM

Effect on inventory turnover

The impact of the quality management on inventory turnover can be demonstrated by examining the functional elements of aggregate inventory. When there are some quality problems occur in the purchasing or manufacturing process, large amounts of safety stock inventory are required, in order to compensate the absence of constant work flow. In terms of the variance of lead-time, since lead-time varies more because of manufacturing or purchasing process problems, more safety stock is required to guarantee the meeting of customer needs. At the same time, the quality management also allows the use of smaller lots, which reduces cycle stock and safety stock buffers. Thus, the quality management leads to a relatively lower inventory level. (Flynn, Sakakibara, & Schroeder 1995, 1329.) In terms of the scrapped and obsolete items that are often the least costly component of poor quality, the quality management can also prevent recurrence of problems by improving buying or production process.

Effect on cycle time

Since the quality management practices reduce the amount of items requiring rework, cycle times are shortened accordingly, allowing improved schedule attainment and relatively faster response to market demands. In addition, based on the quality criteria, the cooperation with quality certified suppliers can reduce or eliminate preprocessing cycle time delays for incoming inspection. During the processing and the post-processing stages, the effective quality management practices also reduce or eliminate time delays for rework and process inspection of in-process and finished goods. In short, cycle times will be reduced if there is less time wastage resulting from rework of defective items. (ibid.,1328-1329.) As we say that “time is money”, some impressive cost savings can be achieved correspondingly.

2.3.3 Purchasing and QM

A better-controlled inventory situation could be realized through purchasing process optimization. In terms of the purchasing activities, one of the most important responsibilities is to maintain and improve the quality of purchased goods and services. Firstly this is based on selection of suppliers who can guarantee a sufficient level of quality (Weele 2010, 241). Therefore, it is essential to measure the performance of suppliers for the needs of setting up the reliable relationships. Normally, suppliers are evaluated on the basis of their quality, price, delivery time and materials, etc. Including some other specific aspects such as environmental awareness and sustainability, the elements involved in the quality measurement towards suppliers include:

- Preparation of the purchase order specification
- Preliminary qualification of potential suppliers
- Sample inspection procedure
- Inspection of first and following production series
- Conclude a quality agreement and certification
- Periodic verification

  (ibid., 249).

As a result, companies enter into long-term agreements with certified suppliers, while non-certified suppliers are classified into acceptable, trial and unacceptable groups (Antic & Novicevic 2012, 197). Within a specific period, companies could also track and analyze all the supplier's deliveries in order to prevent possible non-value-added activities such as waste examination and backorder backlogs.

Another important aspect is relating to customer satisfaction. According to some researches done by companies, there is a direct link between customer satisfaction and attrition rates, indicating that delighted customers are less likely to defeat than dissatisfied customers (Russell & Taylor 2009, 65). The primary means for gathering feedback from customers and measuring customer satisfaction is the customer survey, which could be implemented regularly. Since the total cycle time will be reduced to a large extent through the quality management, the customer services can be improved by increasing the flexibility in meeting customer demands. The most direct

advantage for customer is that the waiting times are reduced to a large degree.

Meanwhile, the roles of employees and purchasing organization are also significant when implementing the quality management practices. The quality management practices are designed to better assess both customer's needs and organization's effectiveness, in order to develop a match between them (Flynn, Sakakibara, & Schroeder 1995, 1327). In terms of the employee development, the job training is one of the major aspects. For example, the training in implementing quality tools such as statistical process control, enabling employees to diagnose and correct day-to-day problems related to their jobs. This provides employees with greater responsibility for improving product quality and greater satisfaction for doing their part to achieve quality. (Russell & Taylor 2009, 67.) When employees are directly involved into the quality management process, the participation in identifying and solving relevant problems will promote employees' morale, improve job skills and finally increase productivity. In terms of the overall business structure, *Process improvement teams,* also called quality improvement teams (QIT) are recommended to be built. The teams focus on business processes rather than separate company functions. (ibid., 69.) In other words, cross-functional or even cross-business processes will be constituted. Especially regarding the working process of the purchasing department, which plays a role as an information center or a transit point, the effective communication and cooperation with other functions or departments should be proceed with the goal of promoting the more efficient overall process and the better product or service. A key tool for helping the teams understand and analyze the process works is a process flowchart, which assists the personnel to focus on the quality problems might exist (ibid., 69).

2.4 Just-in-Time Management

According to Weele (2010, 260), the principle of the Just-in-Time management (JIT) means that all materials and products become available at the very moment when they are needed in the production process, not sooner and not

later, but exactly on time and in exactly the right quantity. Accordingly, the Just-in-Time inventory is intended to avoid situations where inventory exceeds demand and burdens the business to manage the extra inventory. Originally manufacturers use the JIT Management method aiming at using materials for production at levels that meet the demand of customer without excess, since excess inventory causes unnecessary storage and management costs. However, nowadays the JIT principles are also applicable in a non-manufacturing environment.

2.4.1 JIT Purchasing

Definition of JIT Purchasing

The JIT purchasing is an integral part of the entire JIT manufacturing concept (Chung & Bakar 2001, 1). On the basis of eliminating waste and the cooperative effort of everyone in the organization, the essence of the JIT purchasing is to purchase the right amount of materials at the right time for consumption, and at the same time to ensure the high quality of all the materials in order to enable the smooth operation of the system. Theoretically a successful JIT program involves total quality surveillance, JIT manufacturing techniques, and an involvement of people (ibid., 2). Similar to the quality management practices, JIT is also a team-based approach. All parties involved in the internal and external processes have the rights and responsibility to participate in achieving the goals of JIT. Another remarkable feature of the JIT purchasing is that the program attempts to tighten the record keeping, and to carry minimum stocks by receiving frequent deliveries in smaller quantity, aiming at eliminating waste as much as possible. Due to such characteristic of the JIT purchasing, this kind of practice could be applied in the firms closer to the buyer's plant, making frequent deliveries and are considered long-term partnerships with the buying company. (ibid., 2.)

JIT does not exist in isolation and it is usually combined with other inventory control and warehouse management methods, such as Material Resource Planning (MRP), Economy Order Quantity (EOQ), Enterprise Resource Planning (ERP), etc. Instead of replacing those traditional methods, JIT helps emphasize their proper executions. (ibid., 3.)

Potential Benefits and Risks

In terms of both manufacturing and service-orientated firms, the JIT purchasing concept can provide advantages mainly from the following aspects:

- Costs – minimized inventory carrying costs and scrap costs because of the elimination of non-moving or slow-moving inventories
- Quality – fast detection and correction of unsatisfactory quality, and ultimately higher quality purchased parts
- Administrative efficiency – improved communication resulting in a more reliable suppliers partnership
- Productivity – reduced rework; reduced inspection; reduced parts-related delays
- Customer satisfaction – improved customer delivery reliability; better product quality

  (Chung & Bakar 2001, 3-5.)

However, the Just-in-time purchasing and inventory system is not without risks. By nature of what it is, companies using JIT are trying to make a balance between having too much and too little inventory. If company purchases fail to adjust quickly to increased demand or if suppliers have distribution problems, the business risks may upset customers with stock outs. On the contrary, if purchasers over compensate and buy extra inventory to avoid stock outs, the company could experience higher inventory costs and the potential risk for bearing more wastes. Another disadvantage is the costly technology infrastructure required for building the information-sharing channel between buyers and suppliers. Since such kind of coordination is needed for building the reliable partnership, meaning that buyers can put major trust in suppliers by directly monitoring inventory levels to initiate rapid response to low stock levels. Sometimes it is hard to make agreement to build the communication/distribution channel between two parties, alternatively some organizations may lack of budget planning concerning this issue.

Except the issues mentioned above, comparing to the traditional purchasing approach, the JIT purchasing also has tremendous impact on quality aspect. The specific comparison between the traditional approach and JIT approach

from different purchasing functions points of view, as well as the effects of JIT on quality, is illustrated in the following table.

TABLE 1. Comparison between JIT purchasing and traditional purchasing (adapted from Weele 2010, 264; Chung & Bakar 2001, 4.)

Purchasing Activity	**Traditional Approach**	**JIT Approach**	**JIT effect on Quality**
Supplier selection	Minimum of two suppliers; price is central	Single source in close geographical area; frequent deliveries	Rapid and better understanding of quality requirements
Placing the order	Order specifics delivery time and quality	Fixed order period; deliveries called off as needed	Fast detection and correction of relevant quality problems
Change of orders	Delivery time and quality often changed at the last moment	Delivery time and quality fixed; quantities are adjusted within predetermined margins if necessary	
Follow-up of orders	Many contacts to solve relevant delivery problems	Few delivery problems thanks to sound agreements; Quality and delivery problems are not tolerated	
Incoming inspection	Inspection of quality and quantities of nearly every delivered order	Initial sample inspections; Receiving inspections are gradually reduced and eventually eliminated	Quality of at source is more effective and less costly
Supplier assessment	Qualitative assessment; delivery deviations of up to 10% are tolerated	Deviations are not accepted; price is fixed based on open calculation	Suppliers put more emphasis on their product quality

Invoicing	Payment per order	Invoices are collected and settled on a regular basis (normally monthly)	Suppliers can afford cost of long-term commitment to meet quality requirement, and they become more aware of buyer's true requirement
Paperwork	Complex paperwork and documenting system	Less formal system and reduced volume of paperwork	More time available for purchasing team to devote to quality matters

2.4.2 Economic Order Quantity

Reorder Point

Knowing the best timing of placing an order is crucial for the purchasing department regarding inventory optimization. The easiest way to arrange this is to define a reorder level, which can assure that each order can arrive just as existing stock runs out. In the reorder point planning procedure, the inventory control system is intended to compare current available stock level with the reorder level. If available stock falls below the reorder level, an order proposal is generated.

The reorder level (also known as the reorder point) is made up of the sum of the safety stock plus the expected average consumption within the replenishment lead time. Therefore, when determining the reorder level, the safety stock, previous consumption values or future requirements, and the replenishment lead time need to be taken into consideration. See Figure 5.

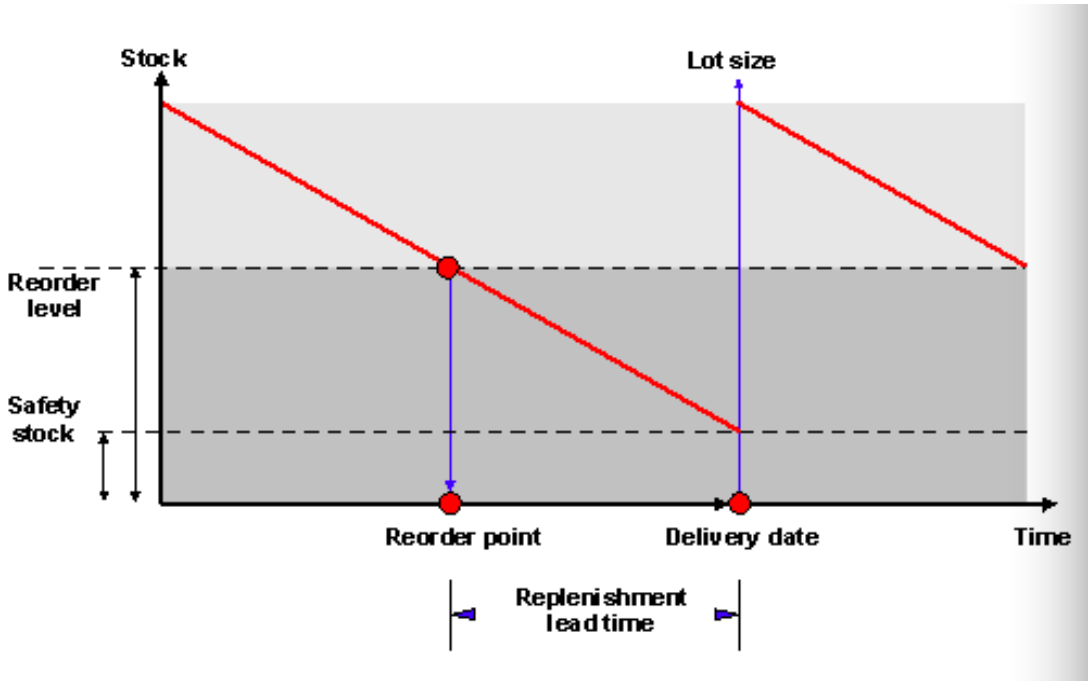

FIGURE 5. Reorder Point

When assuming that both demand and lead time are constant, the amount of stock needed to cover the lead time is also constant, and the reorder level can be defined as:

Reorder level = Lead time demand = Lead time x demand per unit time

ROL = LT x D (Waters 2007, 91.)

EOQ Model

In order to answer another significant question "How much should we order?" building the Economic order quantity (EOQ) Model is one of the effective approaches to calculate the fixed order quantity that minimizes total costs. The EOQ calculation is the most important analysis of inventory control, and arguably one of the most important results derived in any area of operations management (Waters 2007, 66).

One well-known mathematical formula based on the holding costs and the ordering costs to decide the optimal economic order quantity is **Camp's formula**. The variables used in such kind of inventory control model are:

S fixed usage per period

t delivery period

Q order quantity

$\boldsymbol{C_0}$ costs per order

$\boldsymbol{C_i}$ inventory carrying costs for one unit during one time unit

The order quantity Q and a usage rate per period S mean that in a given period S/Q orders are required. The order costs for that specific period will be S/Q x C_0.

The average inventory level over one period is $1/2\ Q$ and the total holding costs for the considered period are $1/2\ Q$ x C_i.

Hence, the sum of total ordering costs and holding costs will be

$$\frac{S}{Q} \times\ C_0 + \frac{1}{2} Q\ \times C_i$$

The economic order quantity can be calculated as

$$Q_0 = \sqrt{\frac{2S\ \times\ C_0}{C_i}}$$

Although the formula has received significant interest from different type of organizations, it is based on the following assumptions:

- the consumption of the item at hand is fairly stable
- the consumption of the item is evenly spread over the course of time
- the delivery time of the product is fixed and not due to fluctuation
- the ordering costs per order are fixed
- the inventory carrying costs do not depend on the ordered quantity, etc.

The economic order quantity is where the sum of the holding costs and the ordering costs per unit is lowest. (Weele 2010, 261.) When ordering large quantities from suppliers, the ordering costs can be spread out over the large amount of purchased items. Therefore, large order quantities will lead to a lower order cost per unit. However, the large quantities of products must be kept in the warehouse for a longer period, and causing higher inventory carrying costs per product accordingly. Comparing to the traditional condition of applying EOQ formula, the JIT environment is more assured by the

advanced settled conditions such as negotiations with the supplier, administrative processing, follow-up of orders and quality inspections, etc. By systematically considering how savings can be accomplished for each item, the purchaser can have more chances to be succeed in reducing the optimal order quantity and the inventory costs (ibid.). The following figure shows the relationship among the order quantity, the ordering costs and the inventory carrying costs, at the same time the reducing trend of economic order quantity and total costs after the adjustment is demonstrated as well.

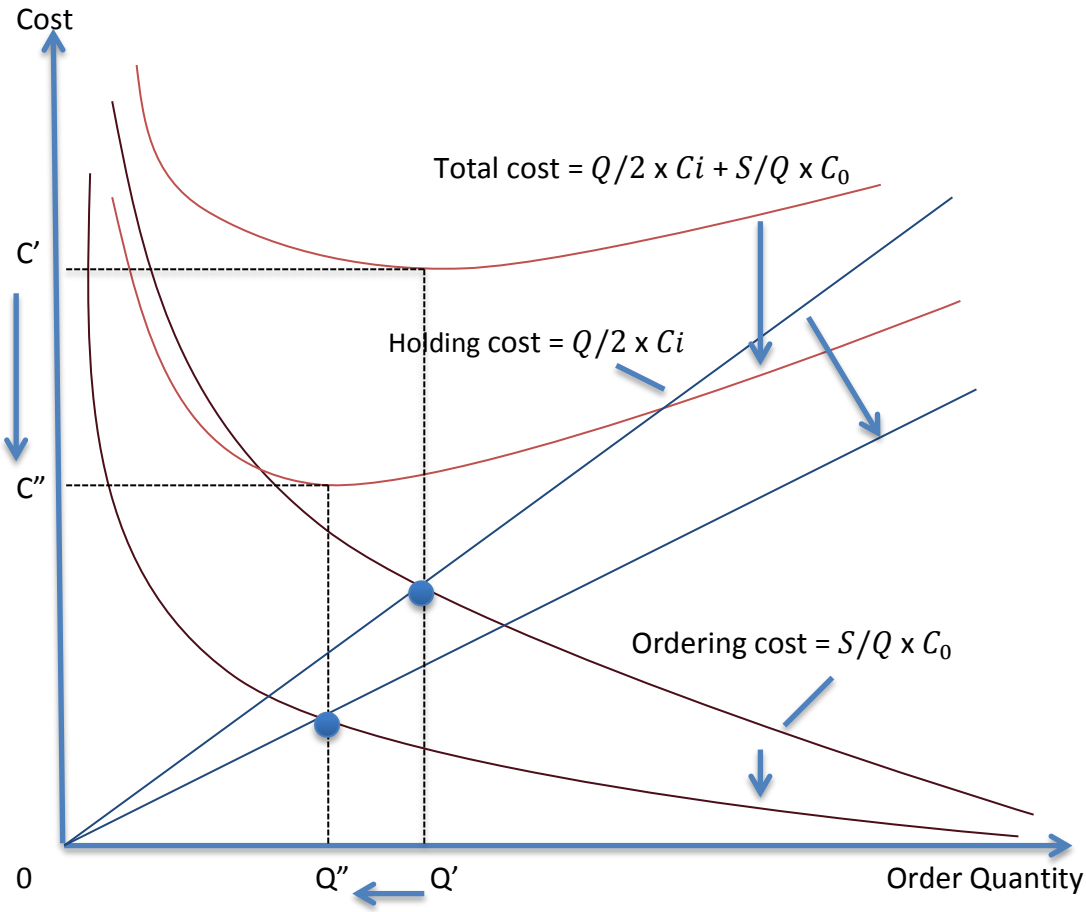

FIGURE 6. Towards a reduction of the economic order quantity (Weele 2010, 262)

2.4.3 QM and JIT

Concerning the relationship between the quality management and the JIT management, except the effects of QM on inventory control and JIT

purchasing mentioned above, the use of JIT practices is also positively related to quality performance improvement.

For example, the JIT practices leading to inventory reduction improve quality performance by reducing waste and decreasing the amount of inventory buffers. Firstly, as finished products spend less time in inventory, the potential risk of spoilage and handling damage is reduced. Meanwhile, the reduced inventory levels also have the impact on quality performance through the related problems exposure. More specifically, the alternative employed under JIT is to gradually lower the inventory level until a problem is exposed. At this point, the surfacing of the exact problems is viewed as an opportunity to improve the overall flow of the system rather than as a detriment. ((Flynn, Sakakibara, & Schroeder 1995, 1330-1331.) The second aspect of the JIT practices affecting on quality performance improvement reflects on their impact on lot size control. Since the JIT practices reduce lot sizes, both quality and timeliness of process feedback increase, leading to a corresponding reduction of process variance. In terms of the setup process, according to Flynn, Sakakibara, & Schroeder (1995, 1332), Goddard (1986) and Wantuck (1989), as JIT encourages the simplification of setup procedures, the setups become more frequent and the feedback loop is shortened, leading to improved quality. And in terms of the benefit of smaller lot size, it helps to prevent the possibility of producing large amounts of undetected quality problems, and thereby minimizing the costs caused by scrap or rework. (ibid., 1332.)

Even though the JIT and QM represent different approaches to improve the effectiveness and efficiency of an organization’s operation, based on related researches, it has been concluded that companies implementing the JIT purchasing along with the QM perform better than companies implementing only the QM or JIT. When companies implement the JIT purchasing and QM together, they achieve a better results regarding financial, market and operating performances than when they implement either the JIT or QM alone. (Kaynak 1997, 111-114.)

According to the research done by Kaynak, theoretically the implementation of the JIT and QM can increase firms’ performance. The benefits include higher

inventory turnover, increased purchasing quality and productivity, which theoretically lead to a reduction in carrying costs that will usually result in lower prices. And finally lower prices can lead to increased market share and profits. Based on the above analysis, a model showing the relationship among the Quality Management, JIT purchasing and business performance is illustrated below.

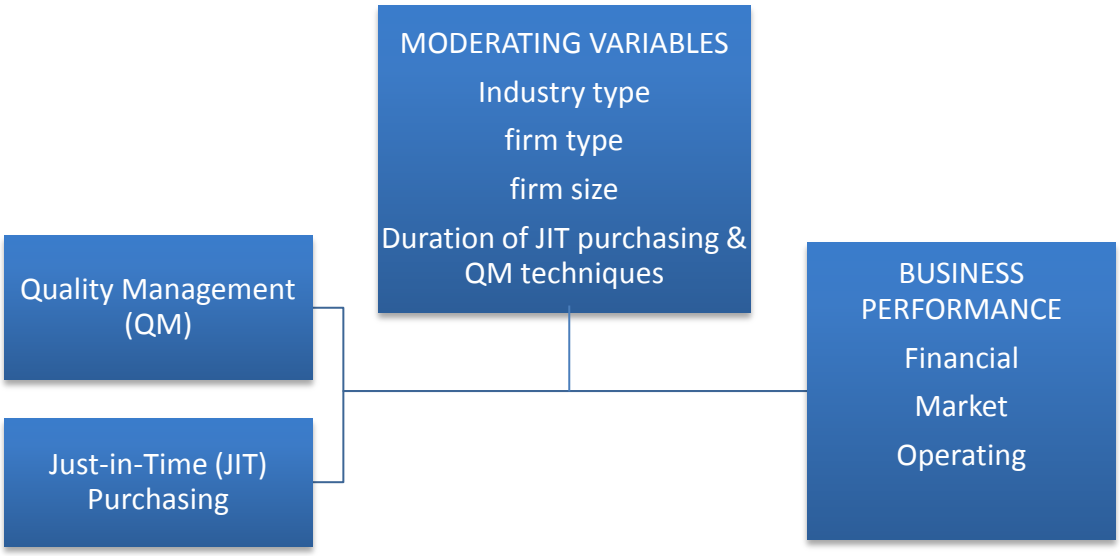

FIGURE 7. Model of relationship among QM, JIT purchasing and business performance (adapted from kaynak 1997, 113)

Based on innovation theories, and their link with realistic strategy and performance, four moderating variables are identified: industry type, firm size, firm type, and duration of JIT purchasing and QM techniques (ibid., 125.) Before implementing the QM and JIT purchasing in a company, those factors should be analyzed carefully for improving the business performance effectively. This thesis will be mainly concentrating on how the combination of QM and JIT purchasing can affect inventory and purchasing activities optimization.

3. Case Company Analysis

3.1 Introduction

In this section the mode of the research procedure and how the analysis was carried out is introduced in more detail. Furthermore the current existing problems of the company are highlighted as well.

Regarding the main research questions defined in the thesis plan, many relevant research questions were formed during the start-up stage of the thesis, and many of those questions were used in the interviews later on. Three main research questions are:

- Have previous inventory situations and purchasing services met the requirements of the customers?
- What are the optimum inventory situations and the optimum purchasing strategies?
- What are the future plans regarding the improvement of the inventory and purchasing performances based on the comparison between the optimum situation and current situation?

3.1.1 Research Method

In order to answer and analyze the research question in the best possible way, a combination of qualitative and quantitative methods was introduced. Quantitative research relies on statistical analysis and a high degree of generalization while qualitative research deals with a more complex context aiming at understanding a certain phenomenon more deeply. In this thesis, the quantitative method was adopted mainly for exploring the current existing problems, compared to the qualitative method which helped more in the problem solving process (Fenson & Edin 2008, 22). More specifically, the quantitative methods included an ABC analysis, XYZ analysis, the Kraljic portfolio approach, and the EOQ calculation. On the basis of the quantitative method, the operations management method was used in order to study the deep factors in causing the problems, and also to solve the problems and prevent recurrence. The major management principle implemented for solving

the problems and improving future performance was selected on the basis of the JIT-QM jointly concept.

In addition, by coming close to the information source, all the analysis is based on interpretation and understanding of both realistic and estimated data.

3.1.2 A Case Study as a Research Strategy

The thesis used case study method for investigating and analyzing how purchasing activities affect inventory performance. There are number of reasons for choosing case study as a research strategy. First of all, case study is useful when examining contemporary phenomena within real-life contexts, because it gives an understanding of how people and their actions are connected in different situations (Fenson & Edin 2008, 23). Meanwhile, it is also a good method to test the practicality of the relevant theory or even to challenge the theoretical assumptions. A theoretical method may bring some benefits by way of improving the current situation, while in some cases when comparing to the company's own business strategy, the theoretical way may have an opposite effect and make the situation even worse. Furthermore, the method makes it possible to study complex processes involving many variables, enabling deep insight and exploration. On the one hand, for the case company itself, a comprehensive assessment of a certain phenomenon was firstly made to illustrate possible limitations within a certain period. Thus, some customized solutions or recommendations were designed regarding the current problems and the achievement of a better result in the future. On the other hand, the case study method also provides grounds for generalization of data. For example, the problems that the case company has may also exist in other similar types of industries. Hence it is possible that the research and the solution could be applied more generally.

3.1.3 Data Collection

The practical ways of data collection were direct investigations and interviews in the case company. If the answers of specific questions were not exhaustive enough, some further communications were made later by emails or meetings.

With regard to the selection of the case company, first of all, some problems relating to inventory level control were noticed during the author's practical training in the purchasing department of Company X. For example, too much non-active stock caused extra carrying costs, and some unnecessary problems resulted from increasing backorders, etc. Thus, the company supervisor showed great interest in solving the current problems. Meanwhile, all the other related departments also gave support when needed, aiming at reducing costs and improving productivity through efficient coordination, both within the purchasing team and other functions of the company. Furthermore, confusions about how to handle the inventory level control still exist in similar types of industries, especially in small and medium sized enterprises, even though many related studies have previously been made based on literature reviews. In this case, some further research and innovative solutions were worth consideration.

With the guidance of the research target, the database research was divided into two themes: inventory performance and purchasing performance. Most of the relevant numerical data were in Excel format, which was convenient for massive calculation. Another important research method was interviewing the purchasing professionals and other personnel from the related departments. The themes of the interviews mainly included the purchasing strategy, self-evaluation of inventory and purchasing performance, and future purchasing plans. Sometimes oral interviews were also supplemented by surveys when needed.

Based on the historical data and information from the previous year (2014), an analysis was made for evaluating the current performance, finding the existing or potential defects, and promoting the sustainability of business development.

3.2 Current Situation of Company X

As a remarkable manufacturer and importer, Company X is dealing with oil and water hydraulics components and systems with good reputation. During past decades, however, lots of items left in the warehouse without usage, and nowadays they become so called obsolete stocks. According to the managing director, “Most of those items were the customized components ordered by certain customers some years ago, but for some reason they did not order those items anymore. However, we have already purchased and produced a lot of them.” (Tuominen 2014.) In other words, the reason for causing these troubles can be roughly concluded as the unreliable supply-demand relation and the inaccurate decision making of purchasing activity. To improve the company operations, some related problems are waiting to be solved. More importantly, the company should learn how to prevent the similar problems from happening in the future.

3.2.1 Imbalanced Inventory Structure

The most intractable problem that troubles the company is the imbalance distribution of active items and non-active items. Until December 2014, there were 9380 active items (trading parts only), as compared the estimated 13000 non-active items, which were even more than the active ones. Although the unit value of non-active items is relatively low, the total value still takes its place in the company’s account. In addition, the overstocks cause lots of extra costs, such as inventory carrying cost, increased storage cost, and the cost resulted from quality reduction and product degradation. To some extent, these obsolete stocks become obstacle of company financial performance and even cause some potential risks for company’s future development. In order to get rid of these stumbling blocks more effectively, the current situation was analyzed and corresponding solutions were considered.

3.2.2 Complicated Classification System

Currently, in order to achieve higher profitability and compensate the loss caused by the non-active items, the purchasing team paid a lot of attention on taking care of the active groups. To analyze the overall products more comprehensively, the purchasing team made the ABC Analysis for trading items based on the yearly consumption of products.

All the items were divided into 16 classes, from class A to class P. Although this type of classification can be used for separating the essential from the unessential, it is difficult to manage and time-consuming to analyze. Especially when defining the level of service level, safety stock, and reorder point, etc., and making the specific purchasing strategies according to the item class, the workload for purchasing staff might be increased while the forecasting accuracy could be decreased. Hence, to simplify the decision making process and ensure the correct purchasing actions is significant for company's economic controlling.

3.3 Purchasing Performance Assessment

The purchasing performance can be measured from two aspects: purchasing effectiveness and purchasing efficiency. Purchasing effectiveness is mainly related to the goals and objectives of the purchasing function – obtaining the right material, in the right quantity, from the right source, at the right time, at the right place and at the right price. Correspondingly the evaluation of purchasing activities can be based on price/ cost dimension, product quality dimension and logistics dimension. And purchasing efficiency more relates to the resources which are required in order to meet the objectives of purchasing function, meaning that the way purchasing is organized, the guidelines of management and the performance of purchasing staff, etc. (Idea: Weele 2010, 306 – 307.)

Based on the evaluation standards mentioned above, by cooperating with the purchasing department of Company X, a survey was conducted. The assessment was on the basis of self-evaluation made by purchasing

executives and the author's own research and analysis. The result reflects the general purchasing performance during the past years, mainly according to purchaser's experiences. The evaluation results are demonstrated in the following table.

TABLE 2. Purchasing performance evaluation

Factor		How Measured	Score
Price/ Cost	Budget situation	Best = 5 Worst = 1	3
	Price control	Best = 5 Worst = 1	3
	Cost reduction	Best = 5 Worst = 1	3
Product quality	Reject rates of incoming goods on average	Lowest = 5 Highest = 1	4
	Number of quality claims to suppliers	Smallest = 5 Largest = 1	4
	Number of ISO certified suppliers	Largest = 5 Smallest = 1	3
Logistics	Delivery reliability of suppliers	Highest = 5 Lowest = 1	4
	Inventory turnover	Highest = 5 Lowest = 1	4
Organization	Staff	Best = 5 Worst = 1	3
	Management	Best = 5 Worst = 1	2
	Information system	Best = 5 Worst = 1	2
Customer satisfaction	Product reject rate on average	Lowest = 5 Highest = 1	4
	Delivery reliability	Highest = 5 Lowest = 1	4

	Number of backorders	Smallest = 5 Largest = 1	3
Total		70	**46**

According to the evaluation, the purchasing performance of Company X scored 46 out of 70. Such result suggests that the current situation of purchasing is “ok” but there is still a large space for making improvement.

More specifically, the price/ cost aspect scored 3 out 5, meaning that some measures relating to cost reduction and price control can be taken. The reduction of total cost can be achieved from reducing both purchasing cost and management cost. Hence, in both aspects of buying process and management system, some potential improvements could be made.

Regarding the product quality aspect, the number of ISO certified suppliers gained relatively lower score, meaning that more relationship with ISO certified suppliers could be established in order to improve the product quality and contribute to the implementation of quality management.

The weakest aspect required for concern is the organizational dimension, as all factors of this dimension scored lower than 4. The main problems are the unsound management guidelines and poor information system. Moreover, the training and education of purchasing staff also need to be continued in the future. In terms of the whole structure of purchasing department, some adjustments regarding the imbalanced-distributed workload are also suggested to be made. Especially when it comes to the new acquisition between Company X and its new partner, the quality improvement of purchasing team is expected to be made as soon as possible, in order to ensure the working efficiency and maintain the personnel motivation.

Except the factors mentioned above, the customer satisfaction is another important issue. The relatively weaker part is the situation of backorders, meaning that the delivery reliability can be improved in the future. And it is all about the accuracy of purchasing process and the cooperation along the supply chain.

4. Performance Improvement

4.1 Inventory Performance Improvement

With regard to the current issues, some adjustments could be made referring to the product classification. Meanwhile, certain new policies or strategies relating to obsolete stocks reduction and wrong decision-making prevention are expect to be suggested.

4.1.1 Standard Item Reclassification

To make the management process easier, some new classifications were made according to different variables, such as yearly consumption (sales), yearly transaction volumes, and the combination of sales and transactions.

The classifying steps are as follows:

First of all, the ABC classification was made based on yearly consumption values. Considering the complex composition structure of items, the classification standard is made as follows on the basis of ABC analysis principle:

A-items = first 50% of the sales or consumption
B-items = next 30% of the sales or consumption
C-items = next 18% of the sales or consumption
D-items = next 2% of the sales or consumption
E-items = no sales or consumption

Practically, there are 9380 active items in total, 0,5% means that 43 items are classified as A items. 249 items are sorted into B items, which is about 3% of the total amount. The next 1149 items belong to C class and representing about 12% of the total consumption, while the D class consists of 2061 items, representing about 22%. And the rest of those, 5878 items are E class items, meaning that there is no sale of those items during the year 2014.

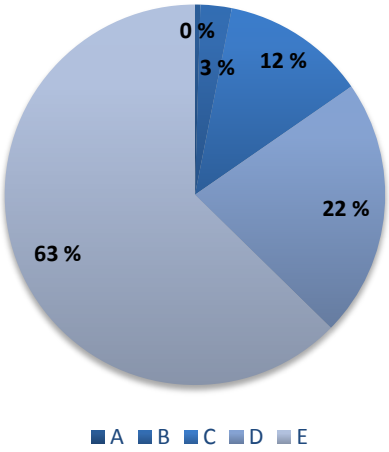

FIGURE 8. ABC Classification of standard items

Secondly, the XYZ classification was made based on yearly transaction volumes. Similar to the ABC Analysis, the classification standard is:

A-items = first 50% of the transactions

B-items = next 30% of the transactions

C-items = next 18% of the transactions

D-items = next 2% of the transactions

E-items = no transactions

Practically, about 0,3% means that 30 items are classified as X items. 126 items are sorted into Y items, which is about 2% of the total amount. The next 752 items belonged to Z class and represent about 8% of the total consumption, while the Zz class consists of 2839 items, representing about 30%. And the rest of those, 5633 items are Zo class items.

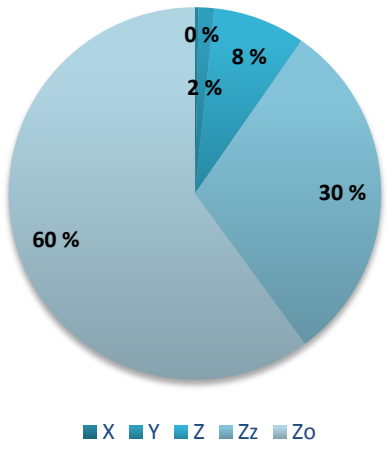

FIGURE 9. XYZ Classification of standard items

Based on the XYZ Analysis result, 60% of the items had no transactions during the year 2014. But by considering that some of the items had sales during the past years and may still have sales in the future. It would be wise to handle those products separately in order to reduce the complexity of the work.

Thirdly, when taking both consumption volume and transaction times into account, the AB-XY Analysis was made, laying a basis for making the portfolio-based purchasing strategies. The amount of AB-ZZz, AB-XY, CD-ZZz and CD-XY items are 181, 111, 3140 and 45, which represent 5,2%, 3,2%, 90,3% and 1,3% respectively. The classification can be also used for making assessment about profit impact and supply risk later.

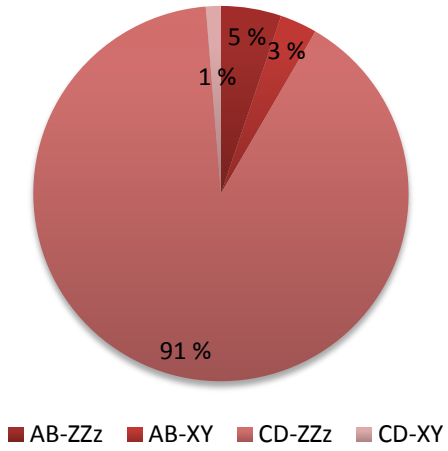

FIGURE 10. AB-XY Classification of standard items

4.1.2 Non-active Inventory Management

First of all, learning the root cause of non-active inventory is fundamental. According to Romanov (2013, 23), Crandall & Crandall (2003) has grouped root causes of excess inventory into the following six greater categories, as shown in Figure 11. Each category contains three sub-causes. However, each company has its own situation, since the actual conditions of supply chain and the causes of excess inventories vary from one to another.

Based on the case company interviews, the three aspects for causing the obsolete stocks could be categorized as customers, strategic planning, and demand forecasting. Obviously the direct reason for causing this problem is

the change of orders from customers. This could be also defined as the unreliable demand-supply relationship. Internally, the inaccurate demand forecasting is unsound as well, leading to the wrong production decisions. Moreover, the ineffective communication between the case company and its certain customers is another important cause. If there were correct and timely coordination, the situation would be entirely different.

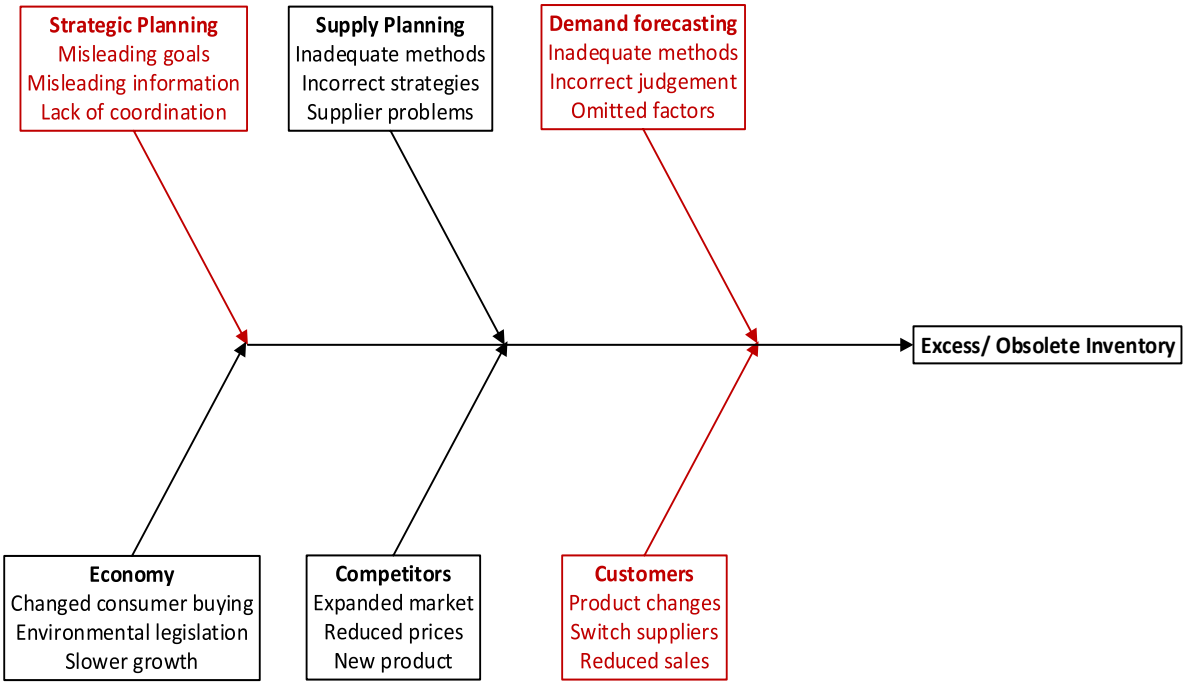

FIGURE 11. Obsolete inventory cause and effect diagram (Romanov 2013, 23)

When it comes to the disposition of the obsolete inventory, the following methods could be considered and judged:

1. Use as is – means that if the original customers no longer want the inventory that has been produced for them, the company could look for other customers and determine if they need the product similar to what is on hand. However, in the case of Company X, since most of the obsolete stocks are customized, it might be difficult to find customers who require the similar type of products. So this method may not be the most judicious choice.
2. Sell at a discount – this is one method that Company X is currently using. The sales department is trying to sell the non-active items to

other companies or secondary industry market. Although getting some part of the original value in cash is certainly better than annually counting obsolete items, as the agreed prices are extremely low, Company X is not willing to keep using the same way.

3. Use as components – this way could be considered if there are some assembled or sub-assembly products, and it might be possible to reuse them in producing other products or sell as spare parts. However, the possibility of applying this method depends on the actual type and condition of the items.
4. Re-work/ modify – means that some part of the items could be involved into the new design and updated specification by communicating with designers and personnel from production workshop. Even though this approach seems insignificant due to the reason why those items have been left in the warehouse, if there is any opportunity for reusing, sorting out the items with good quality is a critical task to do.
5. Remarketing globally – this way seems relatively innovative but also more risky. In brief, Company X could cooperate with certain reliable service provider and implement auction on a global-based platform. By making a pre-agreed revenue sharing agreement, such as a 60 – 40 percentage (Company X – service provider), both parties could gain some benefits. Through this way, the service provider can perform some value-added processes, such as detailed inspection, product sorting, repacking, and labeling, etc., which also help to reduce the workload of workers in Company X. However, the most challenging step for using this method is to cooperate with a reliable third party logistics service provider. But this method is at least worth trying, as there will be more opportunities for selling the special products based on an international platform, especially regarding the market of developing countries.
6. Donate for tax credit – once the case company notices that there is no way to use any method mentioned above, the last choice would be donating the non-active inventory for a tax credit. But again, this approach depends on the specific tax policy and should be studied deeply in order to make a wise decision.

In terms of how to prevent obsolete stock in the future, it is crucial to learn the lesson from the previous experience of gaining obsolete stocks. Firstly, it is essential to create agreement or sign contract specifying the penalty of breach performance with specific customers, in order to prevent the unexpected order changes. Moreover, it is wise to introduce an electronic data interchange (EDI) system that can help to promote the timely communication with customers or suppliers. This kind of system could reduce material lead time, improve the accuracy of demand forecasting, and make sure that the right part design specifications are required by the customers.

Most importantly, to avoid carrying excess and obsolete stock, the company needs to optimize the strategic planning, demand forecasting and replenishment processes. After all, inventory management is primarily concerned with maintaining a proper inventory level to satisfy customer demand at an acceptable service level and at minimal costs. So the core theory of inventory management are the concepts of economic order quantity (EOQ), safety stock principles, and reorder point, which together form inventory policy and can be implemented in purchasing activities (Romanov 2013, 26).

4.2 Purchasing Performance Improvement

4.2.1 Inventory Replenishment

To make the inventory input more accurate, consistent and complete, it is crucial to decide when to order and how much to order. According to the result of purchasing performance assessment, some improvements could be made regarding budget control and cost reduction. From the buying process point of view, the action could start from optimizing the reorder level and order quantity, in order to assist the purchasing decision-making in the future.

Reorder Level

To reduce the inventory costs while preventing the potential stock out, determining a good reorder level is essential. One of the important steps is to

reduce the level of safety stock, which dramatically affects the company's business. Since too much safety stock can result in high inventory carrying costs, while too little safety stock can cause sales loss. Thus, finding the balance between too much and too little safety stock is significant.

Regarding the previous economic situation and business performance, Company X has done some purchasing strategy adjustments to A class of product – lowering the safety stock level by 20%. To assist the future inventory control decision, some further calculations based on the theoretical formula were made to determine the optimum safety stock level and reorder point.

The calculation of safety stock was implemented based on sales forecasting, which was on account of the sales history of the case company. The theoretical formulas used are demonstrated as follows:

$$Safety\ Stock = SD\ in\ the\ past\ sales\ X\ Lead\ time\ factor\ X\ Service\ level\ factor\ Z$$

$$Reorder\ Level = Lead\ time\ demand + Safety\ Stock$$

SD = Standard Deviation

Lead time factor = Square root of lead-time to forecast ratio

Service level factor Z = NORMSINV (Service level), for example Z = 1,64 for a 95% service level

Comparing to the current safety stock and reorder level, some reductions (from 4% to 78%) can be achieved for most of the standard items by using the theoretical replenishment method. The results were calculated with the service level of approximately 95%, which equals a z-value of 1,64, and with the estimated lead time according to different class of items, meaning that 2 months for A item, 1,15 months for B item, and 1 month for C and D items. The reductions percentages of safety stock and reorder level are shown in the following table.

TABLE 3. Safety stock & Reorder level reductions

Item Class	Percentage reduction
A	6% - 27%
B	60% - 69%
C, D	4% - 78%

However, some data used in calculation process, such as lead time, service level, standard deviation of demand are mere estimates, based on the general situation. As a result, the practicality of such replenishment method needs to be tested in the practical life. Nevertheless, the outcomes and benefits of this thesis are not limited to the result, as the formulas illustrate how service level and lead time affect the stock level control, offering a more direct viewing for the case company to define the optimum service level and to deal with the lead-time problems caused by suppliers in the future.

Economic Order Quantity

In terms of the order quantity, finding the appropriate quantity for replenishment that minimizes total inventory costs will contribute to the company's budget performance. From a theoretical point of view, the convenience of small and frequent deliveries was analyzed based on the EOQ model. As a calculating method to minimize purchasing cost, inventory carrying cost, and ordering cost, the EOQ method is complementary to the safety stock optimization that focuses on finding the optimal threshold to trigger the reorder (Vermorel 2012).

Alternative 1

The theoretical formulas relating to the EOQ calculation have been addressed in the chapter 2.4.2. According to the practical calculation, about 10 000€ of ordering cost can be saved by applying the EOQ method. And in the end, about 1 million Euros of total inventory costs can be reduced annually. These results were calculated with the estimated fixed ordering cost 135€/order,

which is based on the estimated initial total ordering costs and fixed numbers of annual orders, and with the inventory carrying cost percentage of approximately 30%.

However, as the result of total savings seemed unrealistic because of the inaccuracy of some data involved into the calculation process, another calculation was made in order to define the “ideal” result of the inventory carrying cost.

Alternative 2

Another alternative calculation was made based on the recommended situation where more realistic result is presented. By applying the EOQ method, 73 589€ of annual ordering cost can be saved. And in the end, about 380 000€ of total inventory costs can be reduced annually. These results were calculated by keeping the same fixed ordering cost 135€/order, but with the internal interest rate of 10%, which means that the initial total carrying cost can be reduced.

By following the normal EOQ principle, the smaller order quantities will result in lower inventory levels but more orders, which will lead to the increase of total ordering costs. However in this case study, as the initial ordering costs were roughly defined by the case company X and not based on the real number of orders made, the ordering costs and inventory carrying costs were reduced synchronously in both Alternative 1 and 2.

Comparison between Alternative 1 and 2

Comparing with the calculation of Alternative 1, the second calculation illustrates a more realistic situation in terms of the carrying cost percentage and annual savings. As the carrying cost percentage (30%) involved into the Alternative 1 calculation is merely a rough value based on estimation, the results cannot be entirely trusted. However, in terms of the EOQ values and suggested annual order numbers, the results of the Alternative 2 can be questioned, especially regarding some A class items which are normally

ordered more often than suggested. In this case, both alternatives have their own defects regarding the accuracy of the results.

Nevertheless, the EOQ provides a reference value of the ideal order quantities to the purchasing executives. Moreover, the mathematical formula of EOQ reveals the relationship between ordering cost per order, holding cost per unit, and the number of units purchased annually, leading the purchasers to care more about some previously ignored factors that may affect purchasing and inventory performances. In the future, the purchasing executives should define the relevant values more precisely according to the realistic conditions, since a small aberration of the data involved can lead to totally different results, and thus influence the accuracy of the buying decisions.

In addition, the EOQ method can be implemented according to different class of items, in other words, to evaluate the demand frequency of different group of items in order to manage the order frequencies and order quantities more effectively. But because of the specific conditions of implementing JIT principle, some negotiations need to be conducted with the suppliers who do not comply with the JIT conditions, in order to apply optimized ordering quantity and ordering process in a JIT environment.

4.2.2 Purchasing Strategy

When defining the general purchasing strategy, the Kraljic's purchasing product portfolio-approach can be used as a helpful organizational tool. Since the Kraljic matrix is convenient for purchasing executives to understand the structure of the purchasing items because of the visualization of different product categories in a specific time span (Fenson & Edin 2008, 34). Meanwhile, the model is a risk-analysis tool, which can display critical buyer-supplier relationships and thereby build up relations based on the profit impact and supply risk. Moreover, the model itself is easy to understand and does not require any funding commitments, so it is also preferable from a budget and investment perspective (ibid.,42). By developing such purchasing strategies, the awareness of purchasing possibilities and the accuracy of purchasing

decisions will be improved, thus some remarkable savings could be achieved in the long term.

Based on the original idea of Kraljic matrix, some attempts were made in order to find possibility to adapt the model to the case of Company X. As the AB-XY Classification classifies the standard items based on their sales values and transaction volumes, which are closely related to the financial results and supply risks, a combination of Kraljic model and AB-XY analysis could be feasible. Taking the AB-XY items as an example, these are normally high-volume products and also represent a high share in the cost price of end product. As a result, in order to ensure the availability and quality of these products, the company tries to build up a mutual partnership with certain reliable supplier. However, the supply risk is increased correspondingly because of the limited amount of the suppliers. Because of the features of AB-XY products, they can be grouped as strategic products, meaning that both purchasing's impact on financial results and supply risk of them are highest. And the similar analysis can be done to identify other groups of commodities. The assumed model of classification is shown as follows:

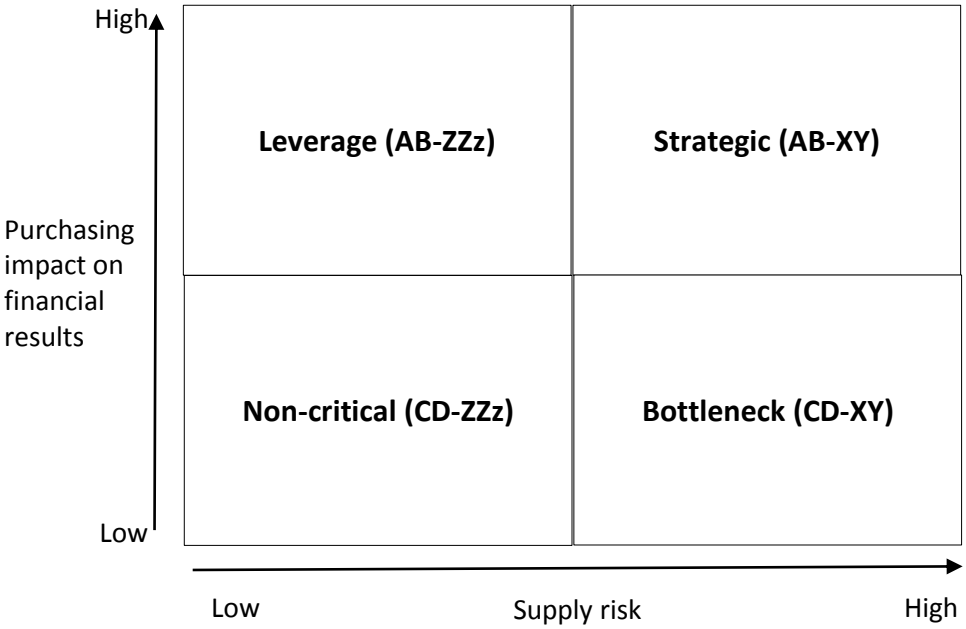

FIGURE 12. Combination of Kraljic's purchasing product portfolio-approach and AB-XY Analysis

Bottleneck Items

These items represent a relatively limited value in terms of the financial results of a firm but they are vulnerable with regard to their supply. Suppliers have a dominant power position for these products. (Caniels & Gelderman 2005, 145) In the case of Company X, the bottleneck products account little proportion of the total item amount and they are not hard to be managed. In order to reduce the dependence on certain suppliers, increasing buying power and developing new opportunities are crucial. For this group of product, a new positioning is "better bottleneck", which pursues minimizing supply risk on the one hand and obtaining a better negotiating position on the other. In terms of some part of the bottleneck items, the reason for causing them fall into this category is over-specification, which leads to complicated purchasing processes. Hence, the idea is to de-complex those items, in order to make them follow the generic specifications. (Idea: Gelderman & Weele 2002, 33.) However, the possibilities of standardization are expected to be investigated based on the specific case.

Non-Critical Items

There products usually have a small value per unit and many alternative suppliers can be found. These products produce only few technical or commercial problems. However, the problem with this group is that the costs of handling are even higher than the value of the product itself (Weele 2010, 198). Normally the items require 80% of the purchasing department's time, only represent less than 20% of the purchasing turnover (Caniels & Gelderman 2005, 146).

Nevertheless, in Company X there are about 90% of the total products belonging to this group, the importance of well managing this group is obvious. On the one hand, the case company should consider lowering the level of non-critical products, and on the other, the purchasing of these items should be organized as efficient as possible, in order to spare more time for the other crucial products. Thus, the main idea for handling this group of items is to reduce the logistics and administrative complexity. To standardize the purchasing process, the e-procurement and an electronic catalog and ordering

system could be implemented, at the same time the purchasers can order directly from the pre-selected suppliers. However, in terms of some customer-specific items, the business unit is locked into a higher level of dependence, and the individual ordering could be used by means of a purchase card, aiming at reducing the indirect purchasing costs such as ordering cost and invoicing cost.

Leverage Items

Generally these are the products that can be obtained from various suppliers. Leverage items represent a relatively large share of the end product's cost price while the supply risk of them is relatively low. Since a small change of price usually involves large sums of the money, the buyer has strong incentives for sourcing and negotiation. When building a desirable relationship with a supplier, a comprehensive assessment of supplier's performance is essential. Meanwhile, the price performance becomes one of the key factors in current global market.

For Company X, one strategy that could be applied is competitive bidding, meaning that there is no need for signing long-term supply contracts with certain supplier for this group of products, since suppliers and products are interchangeable. The orders could be divided to different suppliers in order to reduce the supply risk and the dependence. In terms of some special business unit, some corporate agreements could be justified with certain preferred suppliers by negotiation. However, the closely monitoring is required to estimate the price changes caused by demand and supply changes. (Weele 2010, 199.)

Strategic Items

This group of items represents a considerable value to the company in terms of the large impact on profit and high supply risk (Caniels & Gelderman 2005, 144). Because some of these products have limited amount of suppliers, meaning that the supply risk is significant and the reliable cooperation with suppliers should exist.

In terms of building up a mutual strategic partnership with certain supplier, buyer and supplier need to be both involved into the partnership regarding the improvement of product quality, delivery reliability and cost reduction. Especially in this complex global market, choosing a reliable partner with excellent technical and economical performance become increasingly challenging. In case of any unacceptable supplier's performance, Company X should still keep on searching alternative suppliers in order to make it-self less dependent on single supplier. Meanwhile, related purchasing activities that are suggested to be done include accurate forecasting of the needed products so that supplier could be informed timely and meet the demand, and supply risk analysis meaning that the purchaser should monitor the service level of current supplier constantly, etc. In short, maintaining the balance of power between both parties involved is the key issue to establish reliable long-term relationship.

4.2.3 JIT- QM Joint Strategy

From the inventory management point of view, the inventory stocks act as a buffer to continue the operation of production or trading even when some problems occur. However, with the implementation of JIT Purchasing, the entire operation may shut down because of the occurrence of a small problem. In this sense, the JIT Purchasing has two sides. On the one hand, JIT is a useful tool to help organization expose problems and identify the root cause. Correspondingly the organization can take measures to eliminate the causes and make improvement in time. But on the other hand, the risk of stock out of either raw materials or finished goods may increase, reducing the efficiency of the whole supply chain and thus leading to customer dissatisfaction.

In order to compensate the inherent defects of JIT, some improvement strategies from other aspects may support the JIT operations. One suitable concept is quality management. As the applicability of QM is much broader than that of JIT, the actions of quality improvement can be taken from different views such as organization, infrastructure and even top management. In this

sense, the following hypothesis can be made: The performance of firms implementing both JIT and QM is better than the firms implementing JIT or QM alone. Since the application of the JIT principle improves the quality performance through problem exposure and process feedback, and in turn, the use of QM improves the JIT performance through process variance reduction and thereby provides the levels of quality that allow the minimum inventory (Pardeep N.d.). Hence, the JIT-QM Joint strategy could be implemented for improving the effectiveness of quality and productivity, as it shown in the following figure.

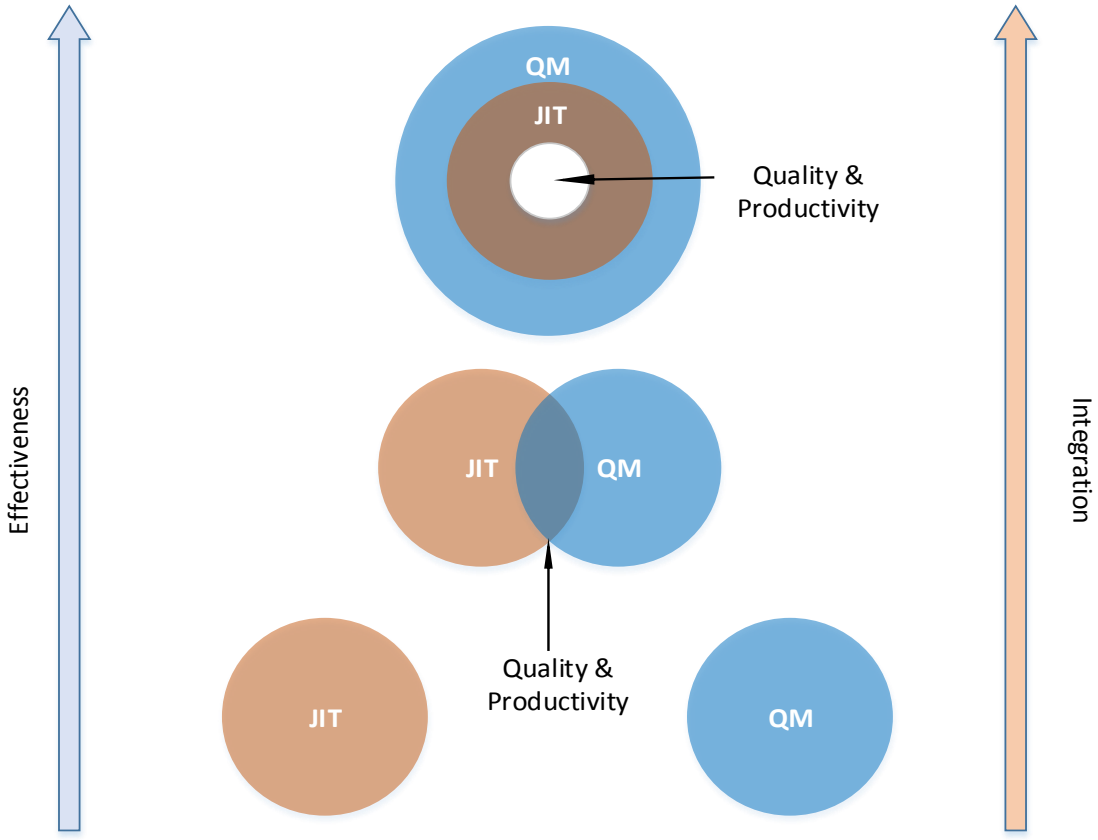

FIGURE 13. JIT-QM Joint strategy (adapted from Vuppalapati, Ahire, & Gupta 1995, 92.)

In terms of the functions, the JIT and QM are well coordinated with each other regarding problem exposure and correction, as well as waste prevention. Thus, one strategy considered to be applied in Company X is the combination

of JIT and QM, aiming at optimizing inventory and purchasing activities through qualifying the supply chain, meaning promoting the cooperation between suppliers, purchasing department of Company X and customers.

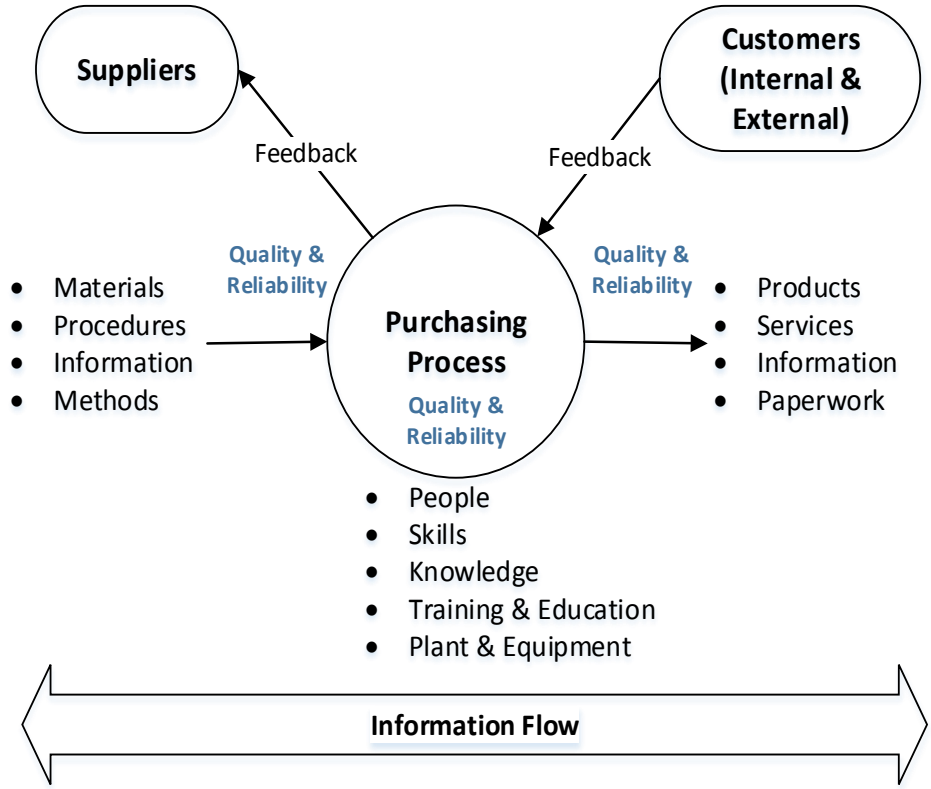

FIGURE 14. Quality improvement of supply chain

According to the quality improvement model above, the following practices could be considered the essential operations of the JIT-QM joint strategy.

Develop a reliable relationship with suppliers

To achieve a more efficient process in inventory management and delivery system, the main task is to assure that the supply is stable and available when needed. The following practices are recommended regarding the current situations of Company X.

Electronic Data Interchange (EDI)

In order to achieve the small batches purchasing and ensure the quantities as exact as possible, the exchange of orders and other related information is expected to be done more frequently between suppliers and purchasers. In this case, the implementation of electronic data interchange (EDI) is highly recommended. Since EDI has been an excellent tool for promoting the exchange of updated plans and coordinate deliveries, a large amount of inventory wastes can be prevented and remarkable cost savings can be achieved as well. Even though such action requires the negotiation and coordination with partners, the benefits of implementing EDI is attractive for all parties involved.

Geographical Concentration

Obviously to concentrate the distribution of suppliers helps reduce the need for transportation and thereby reduce the costs and lead time. In the case of Company X, this strategy may be applied to domestic suppliers, but it seems unrealistic regarding the others, as currently many remote suppliers are under cooperation. In order to compensate the lack of concentration, some methods such as shipment consolidation and communication improvements are suggested regarding the cooperation with international suppliers. The major targets focus on the attempts to reduce the ordering cost, transportation cost, and replenishment lead time values.

The main outcome of the implementation of above two strategies are improved flexibility and reduced inventory, since the company will be easier to react to the changes from customer orders and thus increase the competitiveness.

Building Long-lasting Relationships

As one of the important characteristics of the JIT Purchasing, signing long-term contracts assures the stable cooperation to some extent. This kind of relation is built based on a high degree of trust, meaning that both buyers and suppliers should share information but also protect its confidentiality

(Gunasekaran 1999, 78). Accordingly the adequate supplier sourcing and selection become essential. Currently in Company X there are more than 300 suppliers, and more than one third of them are international ones, thus, it would be difficult to organize all the JIT operational activities and establish effective relationships with all the suppliers. Instead, selecting limited amount of suppliers and establish reliable partnerships with them would be more effective regarding cost savings and quality assurance. In terms of the assessment of supplier's quality and competence, the ISO9000 standards are the most popular criteria. Such kind of quality certification provides guarantees to the capacities of supplier before initiating a relationship to some extent (Benito & Spring 2000, 1045). However it is still significant to assess and control suppliers' performance constantly. For instance, by recording the percentage of on time delivery and irregular visits to suppliers' plants, the reliability and quality can be monitored and controlled. Moreover, it is also possible to rank the suppliers periodically in order to renew contracts or develop new suppliers.

Identify and response to customers' needs

Knowing the needs and expectation of customers is the core principle of the quality management. The end users will satisfy if all parties along the supply chain can satisfy the needs of their backward users. Previously in Company X there were several quality problems resulted from inadequate communication between the company and the end customers. Hence, remodeling the relationship with end customers can help improve the operation efficiency of supply chain system and achieve the win-win situation.

For a customer-driven industry, the principle of PDCA cycle (Figure 15) can be used. When understanding the requirements of customers, the strategic planning should be made regarding the process of realizing the objectives. Based on the initial plan, the process performance should be continually improved to meet the changing requirements of clients. For instance, to improve on-time performance, reduce errors and costs, enhance quality of product and service, and regulatory compliance system, etc. Next, according

to the customer feedback which is crucial for the company to learn the level of customers' satisfaction, some corresponding actions need to be made to recheck the performance and thus improve client loyalty.

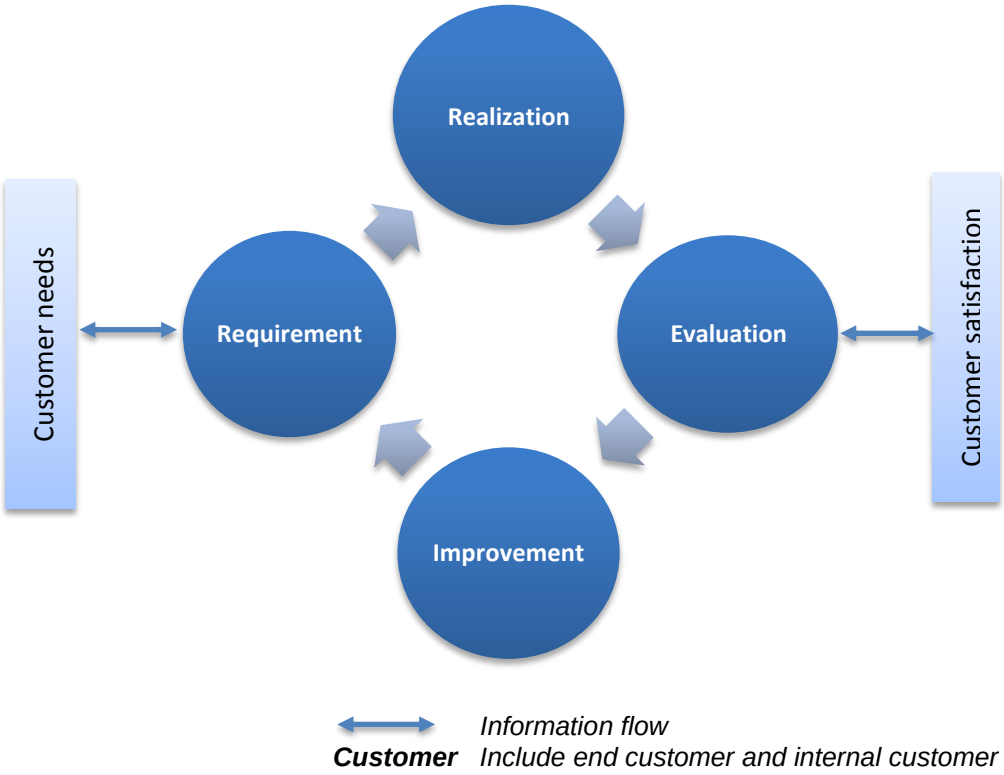

FIGURE 15. Supply chain quality management system

Although establishing a relationship based on trust is important, in today's complex business environment, some other measures should be taken as well in order to safeguard the rights and benefits of the company itself. For example, the benefit/risk sharing is one strategy to make the corporation with customers more sustainable. The benefit/risk sharing can be achieved through signing pre-agreed contract, which specifies the incentive or penalty regulations according to the actual performance of both parties. Moreover, if the supplier (Company X) manages to improve the productivity with lower net production costs, part of this improvement will accrue to the customer from price reductions and part will accrue to the supplier itself in the form of benefits. And the same should happen when productivity decreases. Through this way, both suppliers and customers get benefits and have motivations to enhance their performance. (Idea: Benito & Spring 2000, 1042.)

Qualify internal purchasing activities

As another crucial member along the supply chain, the organization itself also plays an essential role for improving the quality of whole system. To qualify the internal performance of purchasing department, the improvements could be done from the following aspects.

Commitment & Awareness

Guided by the ultimate goal of “satisfy customers”, the company should start from strengthening the awareness of quality. In order to make it easier to understand and accept the new idea, the target of improving quality needs to be interpreted according to the realistic situation and the concept of quality should be compatible with the company’s own culture. In the end, the commitment of quality should be transmitted to every member of purchasing team and even the whole organization.

Education & Training

Even though the purchasing executives are equipped with professional purchasing knowledge and skills already, the company should still provide opportunities for continuous staff training, in order to strengthen the techniques and improve the implementation of purchasing tools.

Organization

In terms of the structure of purchasing department, the specific task delegation defining who, what, how, how much, and who is responsible is required to be updated in time. Meanwhile, the efficient and continuous internal communication is necessary as well. When analyzing the current situation in Company X, the performance of internal communication is on a good level, and the communication atmosphere is also excellent. However, the proportion of the number of employees and workload allocated is not that optimistic, especially in terms of the new acquisition, it is highly recommended to make some adjustments regarding the personnel structure and workload distribution.

Investigation & Corrective actions

Another helpful method is to set up a system for investigating problems from procedures, forms, documentations, etc. points of view, in order to investigate the root cause of problems and even the accountability of employees. Regarding the actual causes, some actions could be made to correct the problems and also prevent recurrence.

Recognition

Last but not least, setting up the mechanism of achievement measurement is also a wise action to maintain the motivation of employees, meaning that achievements of individuals or groups should be rewarded periodically. Currently, Company X has similar mechanism and it can be used still in the future. But since the concept of quality is introduced, some adjustments should be made regarding the evaluating criteria when needed.

In conclusion, the core idea of the JIT-QM joint strategy is to increase the flexibility of the supply chain activities while maintaining or even improving the quality of the whole supply chain performance. And for Company X, this strategy can help to commit a long-term continuous improvement throughout the organization and its partnership with both suppliers and customers. As a result, the company will gain better reputations and remain competitive over the long run.

5. Conclusion and Summary

In conclusion, the thesis is focused on operations management in order to achieve inventory optimization and purchasing activities improvement for the case company X. In general, the thesis is of great reference and the output of it is useful, since some recommended solutions were found to solve the current existing problems through in-depth investigation and comprehensive research, and some attempts were made to improve the current performance and prevent the problems recurrence in the future.

The contribution for the company is optimizing the current inventory structure, eliminating non-active stocks, and improving the quality of purchasing activities and organization. And from a scholar point of view, the thesis deeply analyzed the relationship between purchasing activities and inventory level control. Since the purchasing activities are dealing with the input of inventory, the purchasing executives have the responsibility to ensure the input to be correct, consistent and complete. And in turn, the purchasing decisions have to be made based on the accurate analysis of the present inventory situation. The specific case analysis provides further evidence that the study for understanding the interactions between purchasing and inventory management is worth making.

To improve the current performance and enhance the overall business competitiveness, the specific strategies and methods of operations management were stressed in the thesis. More concentrating on purchasing strategies, the JIT Purchasing principles were suggested in order to minimize wastes and maximize cost savings. Meanwhile, regarding the current performance of purchasing department, the concepts of quality management and JIT-QM combined strategy were presented for qualifying the purchasing organization and establishing the optimized relationships between the suppliers, case company and customers.

All the improvement approaches were recommended to the company with an ultimate goal to promote the sustainability of the whole business of Company X in the long term. And the relevant approaches can provide reference to the SMEs in the similar industry field if the solutions work out.

6. Discussion

Results Reliability

In general the reliability of the research results can be questioned since many variables were defined according to estimations or experiences of purchasing executives instead of the precise data, as some information was not available.

Safety Stock & Reorder Point Calculation

In order to define the accurate level of optimized safety stock and reorder point, it would be advisable to perform a detailed analysis of some relevant factors such as service level, lead time, and demand standard deviation. Meanwhile it would be also useful to know the earlier reorder levels accurately so that they can be compared with the theoretically optimized levels. However, because of the unavailability of precise data, the service level was assumed to be the same for all products, the lead times were defined depending on the class of items, and the demand standard deviations were estimated based on the consumption trend of products generally. Moreover because the reorder level of Company X was defined according to different suppliers and different lead times or even some other factors, it was challenging to know the accurate reorder point for every single product.

EOQ calculation

The process of determining the economic order quantity turned out to be more complicated. Like mentioned before, unfortunately some variables are mere estimates such as ordering cost, carrying cost percentage, and average inventory value. The total ordering cost for the year 2014 was defined as the sum of ordering making cost, monitoring and control cost, warehouse personnel cost, transportation cost, purchasing invoicing cost, and the cost for entering data into the system, etc. And the ordering cost per unit was assumed to be fixed, and it was calculated by the total ordering cost divided by the estimated number of yearly orders. However, some other issues may also affect the ordering cost. Taking the costs of materials handling as an example, the costs were generated not only by the working hours put in, but also the potential risk of damage to the items. In this case, the calculating process became even more challenging. And the inventory carrying cost was

calculated by multiplying the estimated inventory value by the estimated inventory carrying cost percentage. As the thesis considered the stocks situation of trading parts only, currently it is too hard for the company to exclude the manufacturing parts from the total stock. The estimated inventory value used for calculation is the total stock value of trading parts on the data collecting day.

Contributions to the case company

Due to the complexity of the calculation according to the theoretical formulas, it is common that companies usually use their own calculating methods or traditional benchmarks. But based on the calculation process demonstrated in this thesis, the case company may start performing a detailed analysis to the fields it neglected previously, such as service level, demand standard deviation, ordering cost, and inventory carrying cost etc., in order to make the decisions about purchasing and inventory level control more accurately in the future. Meanwhile the new defined reorder point will hopefully gradually reduce the current high stock value and help to increase the inventory turnover rating. And the cost parameters defined in the thesis may support to decide the amount and the workload of personnel when performing purchasing activities. And the more precisely defined inventory carrying cost percentage could be used as a benchmark when comparing to the other companies in the same industry field.

Benefits for personal development

From professional development point view, the biggest gain of the author from the thesis process is the improvement of researching and analyzing skills. Moreover, the skills of combining and comparing theoretical knowledge and practices were strengthened as well. As an excellent opportunity to connect the theoretical knowledge gained from the past three years to the real working life, the thesis implementing process provided a good chance to understand how logistics affects businesses and even our daily life more deeply.

Some other personal transferrable skills were developed at the same time. For instance, ICT skills were improved by practicing Excel and some related software programs. Furthermore, the researching process cooperated with a Finnish company has further developed the author's cross-cultural communication skills. Even though some delays occurred because of the new acquisition of the case company and some misunderstandings caused by language barriers, the expected results were achieved and the whole process was definitely unforgettable. Thanks for everyone who gave supports during the thesis implementation process!

Remark:

Due to the confidentiality agreement, all confidential data of the case company such as values and numbers are not demonstrated in the thesis.

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Appendices

Appendix 1. Terminology

EOQ	*Economic Order Quantity*
EDI	*Electronic Data Interchange*
ERP	*Enterprise Resource Planning*
ISO	*International Standard Organization*
JIT	*Just in Time*
MRP	*Requirement Planning*
OM	*Operations Management*
OEM	*Original Equipment Manufacturer*
ROP	*Reorder Point*
SME	*Small and Medium-sized Enterprise*
QM	*Quality Management*

Appendix 2. Survey about purchasing performance of Company X

Purchasing Performance Evaluation of Company X

Price/cost

Budget situation (purchasing materials, tooling, department/organization)

Price control

Cost reduction

Product quality

Reject rates of incoming goods (due to quality problems) on average

Number of quality claims to suppliers

Number of ISO certified suppliers

Logistics

Delivery reliability (in general) of suppliers

-on-time delivery

-late delivery

-backorders

Inventory turnover ratio

Organization

Purchasing staff (training & motivation)

Purchasing management (rules, guidelines, communication…)

Purchasing information system

Customer satisfaction

Product reject rate (due to quality problems) on average

Delivery reliability

Number of backorders (per buyer)