

# MANAGEMENT OF SELDOM USED ITEMS

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<p>Abstract</p> <p>Reducing wastes has been introduced to big companies and SMEs, and it has become more and more important. Sustainable operations management is a comprehensive management of companies, including all the management of production, employees training, warehousing, quality and so on. In this thesis, an attempt was made to achieve the goal of reducing the wastes, and even to prevent the materials or services from being wasted at Fluidhouse Oy.</p> <p>Materials control problems at Fluidhouse, Oy were recognized, and the need for developing the current situation was essential in order to improve the competitiveness of the company. The problem was how to deal with zero turnover items, and the aim was to find the fundamental reasons behind the problem in order to prevent it from happening in the future.</p> <p>The project of dealing with the problem started at the end of April, 2012. There was no significant benefit achieved in one month, but several items were re-engineered. There will be even more items that can be used again in the future. This is not the only way to deal with zero turnover items; selling them to others is another approach as well. To prevent the problem from happening, the production strategy of Fluidhouse should be taken into consideration. JIT production can be implemented in the company. In addition, to improve the overall competitiveness of the company, also TQM has to be focused on.</p>		
Keywords Just-in-Time production, Sustainable Operation Management, Total quality management,		
Miscellaneous		

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## **Terminology**

CAO	Computer-assistance Order
CRM	Customers Relationship Management
CSM	Corporate Social Management
ECR	Efficient Customer Response
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
ETO	Engineer to Order
ISO	International Standard Organization
JIT	Just in Time
MRP	Material Requirement Planning
MRP II	Manufacturing Resource Planning
OM	Operations Management
OHSAS	Occupational Health and Safety Advisory Services
POS	Point of Sale
R&D	Research and Development
SME	Small and Medium-sized Enterprise
TQM	Total Quality Management
WIP	Work in Process

## **1. INTRODUCTION**

In the year of 2008, the latest global financial crisis happened, which forced many companies to go bankrupt. To survive the situation of economic depression, companies got more pressure to increase their competitiveness. Different companies could choose different strategies, such as innovation, optimizing enterprise management, and so on, to raise their competitive power, so that they could overcome problems in the doldrums and consolidate their brand position in the market.

To improve the competitiveness of the company, its operations management consists of a variety of measures, focusing on the differentiation of products or services, cost leadership and so on. However, based on the research and analysis, which have been done, the thesis is more focused on explaining sustainable operation management. This can be a preferable way to deal with the problems, such as how to improve the competitiveness, deal with and overcome the depression period, how to build up a better enterprise value and corporate image. It can even prevent the problems from happening in the future.

### **1.1. Objectives and goals of the thesis**

The thesis was based on the situation of a company called Fluidhouse, Oy, Jyväskylä, Finland. The fundamental objective of the thesis was to figure out the useless items at the company's warehouse and then tries to find solutions which the company can take full advantage of those useless items, at the meanwhile, through improving the operation management of the firm, prevents materials from being wasted in the future production.

To figure out zero items, the tool can be ABC analysis. Therefore, through the analysis of the case study of Fluidhouse, Oy, how to use ABC analysis and whether use ABC analysis or not can be pointed out. Besides, to improve the operation management and prevent the problem from re-happening in the future, the thesis

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is mainly focused on the operation management, total quality management involved, and sustainable operation management, which can be illustrated as Lean production, overall the business inside and outside are responded by software of enterprise response planning. Circumstantially, JIT, short for Just-in-Time is a strategy of lean production and promises an efficient work environment with less waste. To gain the advantages from implementing JIT production, how does the inventorying and purchasing management of a company have to be improved in order to match with the production? TQM (total quality management) play as a final check role to evaluate the performance of different departments. While, OM (operation management) as an all-sided enterprise strategy, offering a sort of managerial theories, decisions and conducts for overall departments of companies.

By doing the research of the company, the good combination of theoretical study and practical knowledge could be achieved. The thesis gives the benefits for companies to choose what strategies could be applied and suitable for the situation. For instance, one benefit of making the ABC analysis for standard items is transferring the useful information from data, which can be definitely helpful for the company to improve the management of inventory. ERP system stores information from each department and shares it to each other, offers the systematic work environment with fewer mistakes and problems happening JIT production gives contribution to reducing the wastes, which is exactly matched to deal with the problem Fluidhouse has currently. On the other side, the relevant theory can be perfected according to the analysis of the company.

There is a potential objective of the thesis, which is to providing the solutions and advantages for Fluidhouse, Oy or other beneficiary, which is industrial SME (small media enterprise) with more experience work than the theoretical knowledge applied. Besides, those companies' common character is manufactory for customer's specification. The attempt was made to get the improvement of operation management, make a better strategy of warehousing management system, which would be more suitable for the company's production, form a good

habit of all employees in the company, and if possible, the company could achieve the goals of sustainable development, meaning less waste of all sides. Hence, through the research and analyze of the company's situation, a preferable strategy can be introduced to the company, or try to develop and optimize the existing conducts.

## **1.2. Research methods**

The thesis was based on a case study, Fluidhouse, Finland, dealing with the zero turnover items on hand. By making the ABC analysis of the standard items, those zero turnover items could be found out, and the following analysis and research was according to those items. Suitable approaches have been found, in order to deal with zero turnover items as well as also some suitable strategies for the company to prevent the problem from happening in the future.

Fluidhouse used to be a part of Metso Paper Oy; the production way in the company and the behavior of the employees is still close of Metso Paper. Fluidhouse is one of the small and medium-sized companies in Finland, and it has representative characteristics of industrial SMEs: simplified employee's orientation and training, unstable sales market (including domestic and overseas market), less theoretical philosophy applied in the company, manufacture according to the customers' desires, and earlier experience from working (Boter & Holmquist 1996). The problems that Fluidhouse has may exist in other industrial SME companies as well. Hence, the research can also be applied to other companies, which have similar situation to that of Fluidhouse.

Sustainable operations management is a new subject and has been started to be introduced to companies. Sustainable OM helps firms become more and more nimble and adaptive in an economic downturn period and aligned in balancing human and environment with profits (Paul, Kalyan, & Luk). However, what companies are going to do and how they apply this theoretical idea to the real

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practice and gaining profits, can cause problems to companies. In other words, sustainable OM can bring profits or contribution to companies, but the problem is how to get the benefit. Hence, the research is worth doing. By analyzing the inventory management of a company, reuse can be gained for some potential usable items and production management can be improved as well, and eventually the sustainable operation management of the company can be realized.

### **1.3. CASE COMPANY**

The FH-Group offers automation and special machinery solutions for global industrial markets. The FH-group's services cover everything from project planning and system designing to installations, start-up and after sales services. The products of Fluidhouse are lubrication and hydraulics systems.

The FH-Group is comprised of FluidHouse Ltd. Finland, FluidHouse Shanghai Co. Ltd and Prodatec Ltd, which all have their special expertise areas which complement each other's competences and are able to provide a wide area of expertise and manage large project deliveries.

FH has extensive expertise and the comprehensive project management and service concept guarantee state of the art solutions of impeccable quality – whether for single applications or large systems. The strengths of Fluidhouse rest in more than 30 years of experience in developing fluid power automation systems and in their innovative approach to product development. Fluidhouse has ISO 9001:2000, ISO 14001:2004 and OHSAS 18001:2007 certificates, which indicates the highest international standard for design and manufacturing excellence.

## **2. OPERATIONS MANAGEMENT**

Generally, marketing, finance and operation can be treated as three distinct areas inherent in any business. And the other entire business disciplines, which should be considered by the enterprise fit somewhere at least in one of the areas mentioned above. Hence, an academic theory disciplines can be illustrated into three parts: Financial management, marketing management and operation management. Operations management is the area concerned with the efficiency and effectiveness of the operations in support and development of the firm's strategic goals. The designed and operations of systems to provide goods and services are included in this field, which is concerned to the operation management. In other words, operations management is the planning, scheduling, and controlling of the activities that are transformed from inputs into outputs. Inputs can be regarded as raw materials, while outputs include finished goods and services. An assortment of recognized and well-developed notions, systems, instruments, facilities and techniques belong within the framework which is considered operations management. While the term operations management brings views of manufacturing environments to mind, numerous of these concepts should be applied into service settings, furthermore, certain of them are practically developed for the service organizations, which specifically manufacturing or servicing for customers. (R. Anthony n.d.)

Operations management focuses on the planning, scheduling, using and controlling of manufacturing or a service. Besides, it can also be a method to manage the running of the company. To achieve a triumphant operation strategy of for a company, a good system of operations management can be a furthersome concept to the company, so that the company can increase its competitiveness in the market. (Shim and Siegel 1999:chapter 1 ) Indubitably, there are many different operation strategies that can be applied in different companies. Cost leadership means that more profits are gained than in other competitors' companies. Chinese companies in the international market always take this as their strategy, which is also the reason why the things made in China are so cheap compared with the other

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Competitor's product; keeping sales production on the low level to get more customers; competing on quality refers to the fact products or services of a firm are better than other brands, so that the customer may be willing to pay more to get the good quality goods or service. Flexibility is also a competitive weapon for a company, meaning that a company produces a wide variety of products to meet different specifications of the customers. For the company itself, they can overcome problems caused by the unstable market. On the other side, a fast speed of market entrance can also be a factor of increasing the ability of competitiveness. It might be especially important for service organizations like delivery companies, but the speed also refers to the customers' acceptance, how long they can accept and how many people would like to change from old to new at the first time. Hence, the priority is to make a new product get into the market. Additionally, also the quick response back from the customer side gives a visible demand and market situation to the company. Zara is a good example of applying this strategy, 40% of their clothes are manufactured in the countries of Middle East, where they have been producing the garment, which have the least transient appeal(Fashion Chain - Zara 2007). Moreover, products differentiation makes the company stand out among others and thus get less pressure from competition and market. Proverbially, Apple is a good example. (Goetsch and Davis 2009) What should be mentioned is the strategy or strategies a company picks up must be suitable for the company itself. Copying from others is not forbidden, but it is also not an advisable choice and of conduct. Certainly, creating a new and preferable strategy which is applied to the company is also a wise action.

### **2.1. Lean manufacturing**

Lean production is a name given to a group of highly efficient manufacturing techniques developed (mainly by large Japanese car companies) in the 1980s and early 1990s. Lean production was seen as the third step in an historical progression, which took industry from the age of the craftsman through the methods of mass production into an era that combined the best of the best of both. The strategy of

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inventory decision is always reflected by the production. To reduce the waste of materials use, lean production can be considered. (Black 2008:1–13)

Lean production is calculated to combine the flexibility of production and quality of craftsmanship with the low costs of mass production. In typical assembly-line operations, designing could be undertaken by a specialist outsiders (outsourced) or by a separated team of insiders (designing department). Then purchasing and producing are the following tasks, which are distributed to different departments of the company. The feedback can be got from both the production-line workers and the component suppliers, and that is a long and awkward process. However, lean production runs work hand-in-hand with production workers and suppliers, which is also an uninterrupted two-direction interchange. Therefore, obstacles can be ironed out immediately and at the same time, the task of communication can be simplified. (Idea: Lean Production 2009)

In some books, it is stated that lean production is a concept that has evolved from Just-in-Time concepts (Arnold et al. 2008, 422). In the other words, JIT includes lean production. However, lean production can be identified as a bigger subject than JIT, while, JIT can be a strategy of lean production. Kanban system, Kaizen system, MRP, MRP II, and TOQ those all can belong to the strategy of the company to achieve the goal of lean production.

## **2.2. Total Quality Management**

Quality means user satisfaction: that goods or services satisfy the needs and expectations of the user (Arnold et al. 2008,429). For example, the color, the size, the function, all of those are the elements to evaluate the of a product. Total quality management is an approach to improving customer satisfaction and applying of TQM is a way, in which an organization does business, because TQM brings ideas to the company, including the principles of all of the quality and customer-related process improvement. According to the ninth edition of the APICS Dictionary, TQM

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is based on the participation of all members of an organization in improving processes, productions, services, and the culture of a company. (Arnold et al. 2008,431). TQM highlights and supports to a company how to improve the management to achieve a goal, meanwhile TQM plays a top management's role, leading a total quality effort, which all employees of a company at all level must focus on. Overall, the employees of a company are responsible for continuous quality improvement, and quality is the focal point of all organizational functions.(Russell and Taylor 2003,623). Based on the situation of the company, continuous process improvement and performance measures are worth giving more attention to than other concepts. TQM embodies the same basic principles as quality assurance, total quality control, and company- wide quality control.

### **2.2.1. Basic concepts of TQM**

There are basically six basic concepts in TQM. *A committed and involved management* is directing and participating in the quality program. TQM is a continuous process that must become part of the organization's culture; *Focus on the customer* means listening to the customer, so that goods and services meet the customer needs and with a low cost, meanwhile improving design and processes to reduce defects and cost. *Involvement of the total workforce means that* TQM is the responsibility of everyone in the organization. It means training all personnel in the techniques of product and process improvement and creating a new culture. *Continuous process improvement* means that processes can and must be improved to reduce costs and increase quality. *Supplier partnering* rather than adversarial relationship must be established; *Performance measures indicated that* improvement is not possible unless there is some way to measure the results. (Arnold et al. 2008, 433)

### 2.2.2. Continuous process improvement

In recent years the term continuous process improvement has been used among companies to identify a quality improvement or TQM effort. Continuous process improvement is essentially a matter of nomenclature that reflects not only the functions of TQM, but also a trend of focusing management attention on business processes. However, business is not just a group of separate functions. For instance, filling an order of a customer is a process repeated continuously in the company, and based on this, there are numbers of different functions coming later after getting the order, including manufacturing design, planning, producing, packaging, purchasing, delivery and so on.

The first step is to identify the critical processes in a company and then analyze these processes in order to understand how all the tasks and functions are interrelated. The objective is to determine ways to improve these processes while increasing the quality of the work being performed, and as a result, the product or service. This process for continuous improvement essentially follows the step in the Deming Wheel, shown in the following Figure 1.:

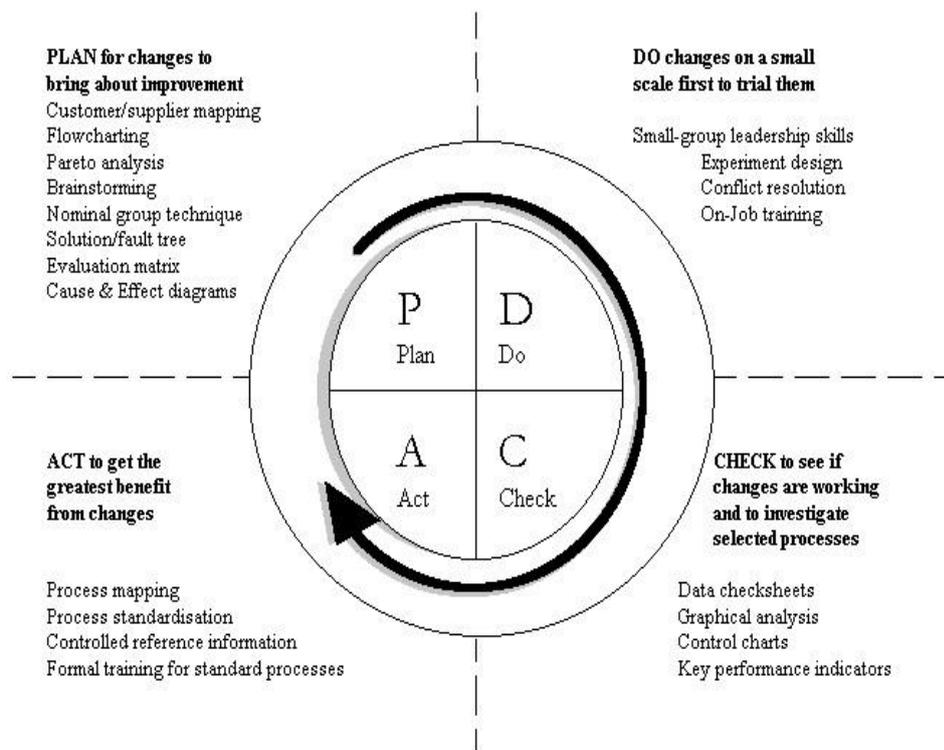


Figure 1. Deming Wheel (PDCA Cycle n.d.)

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Deming is credited for the development of the Deming Wheel, or plan-do-check-act (PDCA) cycle. The first step is PLAN, then following the arrow comes DO, CHECK, and finally ACT, but there is no end, while the cycle moves to work on PLAN again. PLAN refers to identifying the problem and developing the plan for improvement. DO means implementing the plan on a test basis. CHECK step is work on assessing the plan, testing if it is working. ACT means institutionalizing improvement and continuing the cycle.

### **2.2.3. Performance measuring**

To determine how well an organization is performing, its progress must be measured. Performance measures can be used to discover which processes need improvement, to evaluate alternative processes, compare the actual performance with the target, so that corrective action can be taken, evaluate employee performance and show trends. It is really not a question of whether performance measure is necessary, but a doubt of selecting appropriate touchstone. Besides, it is useless to measure something that does not give validity, but what should be focused on is useful feedback on the process being measured. (Arnold et al. 2008, 434). What can be taken into the measurement are Quantity, Cost, Quality and so on. Those can be chosen as the characteristics of the measuring elements. Different corporates should adopt different measurements and measurement elements to analysis.

### **TQM Tools**

Currently, there are mainly seven tools of quality management. As a matter fact, those tools are used by companies measuring the performance and trying to get solutions to deal with all the problems, improving their performance and increasing their competition.

- The Pareto analysis is a diagram for tallying the percentage of defects resulting from different causes to identify the major quality problems. Theoretically, the identification of the Pareto chart is that 20% of the problems produce 80% of products defects. (Russell and Taylor 2003, 651–658). The Pareto analysis mainly works on separating the important from the trivial. The Flow Chart is a diagram of the steps in a process, which helps focus on where in a process a quality problem might exist.
- Check sheet is a fact-finding tool for tallying the number of defects for a list of previously identified problem causes.
- Histogram shows the frequency of data related to quality problems, to get the curve by calculating with standard deviation. A flat and wide curve means stable, rather than vice versa.
- Scatter diagram is a graph showing the relationship between two variables in a process, and it identifies a pattern that may cause a quality problem. It determines the correlation between characteristics, and tests the correlation between process factors and characteristics of production flowing out of the process or two processes.
- Statistical process control chart is a chart 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 diagram or Ishikawa diagram, is a graph of the causes of a quality problem divided into categories. More information will be giving in the following paragraph.(Russell and Taylor 2003,651–658)

### Case-and-effect diagram

A Cause-and-effect diagram, also called a fishbone diagram or Ishikawa diagram, is used to identify the causes of quality problems, so that the problems can be analyzed and corrected. Cause-and-effect diagrams are visible chart, usually developed as part of participative problem solving for a team of employees, supervisors and managers, so that they can easily identify the causes of quality problems. (Arnold et al. 2008, 447). Thereby, the problems can be corrected and even prevented from being happening in the future works.

The following Figure 2 illustrates the general structure of the cause and effect diagram.

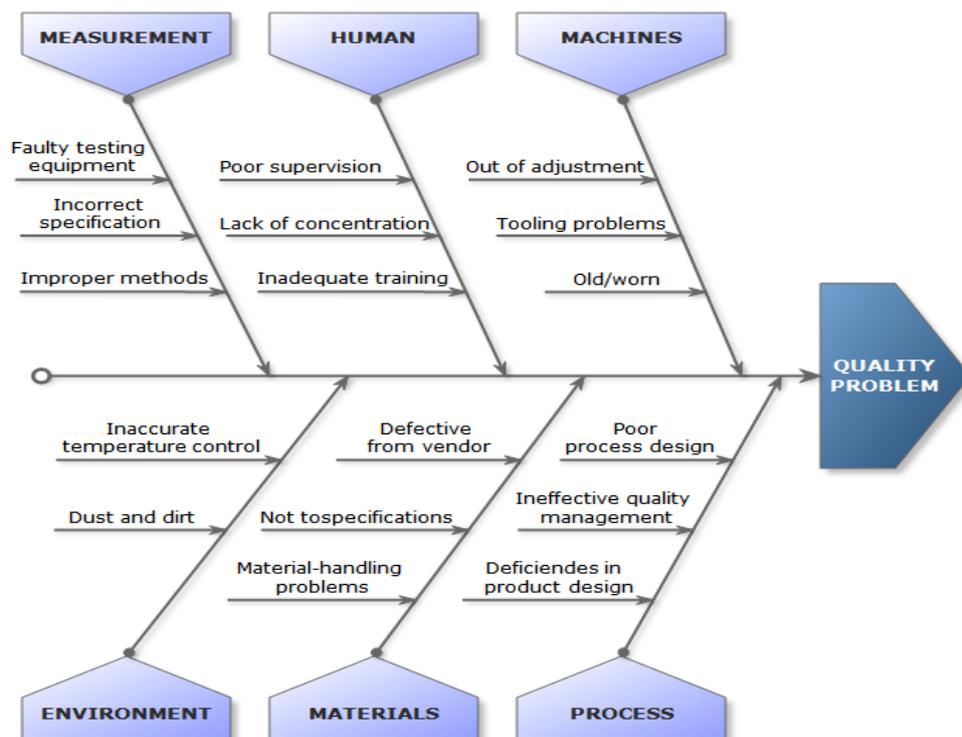


FIGURE 2. Ishikawa Diagram

Usually the above diagram shows the main six parts, which should be separated to be analyzed. The problems should be collected from each department of a company by analyzing the reasons why those problems have happened (the details must be marked in the branches of the bone). Moreover, the branches can have sub

branches or even more under levels, to get more illustration of the causes of problems, since more details give more information of the category, and this means that it is easier to get the important and correct basic causes without making mistakes.

## **ISO standards**

ISO –the International Organization for Standardization- is the world’s largest developer and publisher of international standards. ISO is a network of the national standards institutes of 163 countries, with a Central Secretariat in Geneva, Switzerland, that coordinates the system, one country as a member. (Standardization n.d.)

### MANAGEMENT AND LEADERSHIP STANDARDS

ISO standards provide requirements or give guidance on good management practices, which are among the best known of ISO’s offerings. Many, although not all, are modeled on the management system structure of ISO 9001, which gives the requirements for quality management systems. Nowadays, ISO 9001, as globally implemented, is a firmly established standard for providing assurance about the ability to satisfy quality requirements, and at the same time, it focuses on enhancing customers' satisfaction in supplier-customer relationships (2008). Besides, there is another standard, called ISO 14001, which gives the requirements for the environmental management systems. This standard means to confirm global relevance for organizations, wishing to operate with an environmentally sustainable measure (2004). In a word, this ISO standard devotes itself to quality improving and environment protection, so that the planet people live in and the things people use can be improved.

Additionally, even the management standards are divided into those which can be used for certification, such as ISO9001 and ISO 14001, but those are only certifiable and requirements standards without providing the guidance. Hence, ISO 26000 has been published, which gives guidance on social responsibility. It neither follows the management system model nor is a certification standard. Therefore, any claim by an organization to be certified to ISO 26000 is false and organizations should beware of any offers to certify them to the standard. Moreover, ISO 31000 is not a certification standard either, but it offers experiencing a repaid take-up by the global market, which adapts all aspects of the management system approach. Both Standards were published in 2009. (Standardization n.d.)

#### BENEFITS

Nowadays, ISO standards make a considerable and positive contribution to the lives of people all over the world. In order to meet the expectations of the customers, ISO standards were prepared, which integrated many characteristics to a product or service. However, problems such as poor quality and not working appear, when a product or service has not been approved by standards and does not meet with consumer expectations; problems are never or rarely overlooked. ISO standards guarantee the safety of products and services, by ensuring the reliability, quality and sustainability.

In addition, ISO standards work to improve different aspects of business, such as enhancing the development (manufacturing, supply of products etc.) and services (to be more efficient, safer and cleaner). Besides, they provide principles for health, safety and environmental legislation, which are based on the policy of governments, and share knowledge of technological advances and information on good management practices (The Benefits of ISO Standards for Your Business n.d.).

#### **2.2.4. Benefits of TQM**

Total Quality Management is a philosophy which focuses on the overall improving of a business. A company applies a preferable TQM, which always provides the continuous improvement of processes and products for the company. Moreover, the company can achieve and it enhances the efficiency of people and machines, so that the company is led to developed quality.

One of the most important advantages that TQM provides for companies is to achieve productivity. Besides, process efficiency can be enhanced, through the way of identifying first, then illustrating, and finally trying to find solutions to eliminate problems in work processes and systems. TQM always addresses the key problem area, such as unnecessary tasks, redundant processes, mistakes in work processes, and duplicate efforts. On the other hand, TQM's intervention helps with forecasting and pre-empting mistakes which could be led to happen or directly happen, and offering the suggestions which could be even used in unproductive activities. (M, Charantimath Poornima 2006:78–79)

The contribution of TQM for a company might not be visible in a short term, but for a long term, the benefit is getting more clear or visible to see, especially the cost savings. (TQM as a Long Term Strategy by Rahul Jain n.d.) For instance, the cost savings include elimination of non-confirmation, unnecessary and repetitive work. Furthermore, removing of waste costs and reject products, cancelling of repairs and reworks and reducing warranty and customer support costs-all the above-all are mentioned above can be achieved by the application of TQM. Therefore the process efficiency can be improved, which also leads to improving of the profit per product or service. ( M, Charantimath Poornima 2006:78–79)

TQM frees up management time from readressing problems and directs management time and effort to increase production and extend the range of products and improve the existing products. (McDonough 2011) One of most-watched benefits of TQM relates to customer satisfaction, which include reduction

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of waiting time through the way of changing the method of appointment scheduling or client handling. Other benefits might be making changes in the delivery process, so that the product can be reached by the customers with a faster speed, and the better quality products, which can improve customer's loyalty. Therefore, the impression of a company with high-quality products or services can be achieved.

In the field of organization development, the advantage provided from applying TQM is improving communication skills of individual employees and complete overall organizational communication and knowledge sharing. This leads to is deepening and broadening of knowledge and skills of team members or employees. In the human resources of a company, the idea of making of a learning organization can be formed, so that which can offer the flexibility for the organization in deploying personnel, contributing to a developed rightsizing regular behavior for companies, therefore what can be ensured is costs competitiveness. (McDonough 2011) Hence, in a word, through applying TQM, companies receive benefits for the whole company and it gives the organization a stronger ability to compete such as decreased costs and better productivity.

### **2.3. Enterprise Resource Planning Systems**

In the mid-1970s manufacturing industry, MRP is short of Material Requirements Planning, which became the basic concept of production management and controlling. At this stage, BOM (Bill of Material) means purchase and order management, which also focused on the utilized parts list management and parts development. Besides, when his concept sets up order inventory management of materials to plant and personnel planning and distribution planning as mainstream as well, it became to a principle called MRP II (Manufacturing Resource Planning). What should be mentioned is that financial accounting, management accounting functions, human resource management function, and distribution management functions are incorporated and even come to globally cover all areas of the

enterprise, but still mainstay business. Hence, eventually, it became to be called ERP. (Tagliavini M. and P. Faverio, 2002, 18)

Enterprise Resource Planning is a kind of software that organizes and manages a company’s business process by sharing information across functional areas. For instance, Fluidhouse Finland runs the BaanIV system as their ERP software. Currently, in the software market there are different ERP software systems, such as SAP, Microsoft Dynamics NAV and AX 2009, JD Edwards EnterpriseOne and so on. Also more and more companies are going to apply or have been running an ERP system; this means ERP makes some contributions for companies.

In big companies, the ERP market is saturated. Hence, ERP vendors turn to focus on the market of SME small media enterprise. (Tagliavini M. and P. Faverio, 2002) According to the European Commission, it gives the identification of SMEs, which is a company, having less than 50 people can be sorted into the catalogue of small, if more than 50 but less than 250 employees the company can be classified as medium size. (The New SME Definition 2005) The detailed information on sorting the kind of companies is illustrated in the following diagram.

Enterprise category	Headcount: Annual Work Unit (AWU)	Annual turnover	Annual balance sheet total
Medium-sized	< 250	≤ €50 million <small>(in 1996 € 40 million)</small>	≤ €43 million <small>(in 1996 € 27 million)</small>
Small	< 50	≤ €10 million <small>(in 1996 € 7 million)</small>	≤ €10 million <small>(in 1996 €5 million)</small>
Micro	< 10	≤ €2 million <small>(previously not defined)</small>	≤ €2 million <small>(previously not defined)</small>

FIGURE 3. Classification of SME

The situation of the market of ERP in SMEs is as follows: firms with a number of employees between 51 and 250 have a rate of ERP adoption of 68%, while within smaller companies (11-50 employees) this data decreases to 29%. This trend seems to be confirmed by turnover, too: only 17% of respondents having a turnover lower than 7 million € use an ERP system, while the percentage increases to 75% for companies with a turnover between 7 and 40 million €. (The New SME Definition 2005) For SMEs, ERP is applied mainly to support process integration, to enhance the efficiency of order processing, to replace obsolete hardware or software, to avoid data duplication and inconsistencies, and reduce inventory excess.

	%	
<b>Why did your company adopt an ERP system?</b>	Process integration	54%
	Resolve order processing issues	50%
	Hardware and Software obsolescence	50%
	Resolve data duplication and inconsistencies	38%
	Reduce stock/inventory excess	35%

*Figure 4. Why did your company adopt an ERP System?*

ERP is an abbreviation for Enterprise Resource Planning, which means the techniques and concepts for integrated management of business as a whole form for enterprises. The viewpoint of the effectiveness can be achieved by an ERP application offering the abundant usage of management resources and the improvement of the enterprise management efficiency. ERP packages are integrated (covering all business functions) software packages that support these ERP concepts. Originally, ERP aimed at the manufacturing industry, including mainly the functions for general planning and management of the core business, such as sales, production, accounting, and financial affairs, etc. However, in recent years ERP is adapted not only in the manufacturing industry, but also in diverse types of industry or in other fields enterprise. Besides, the expansion of implementation and the usage of a global level become possible. (Tagliavini M. and P. Faverio, 2002:14)

### 2.3.1. Structure of an ERP system

ERP transforms transactional data. For example: sales into useful information that supports business decisions in other parts of the company, such as manufacturing, inventory, and procurement functions. ERP connects with the supply chain and customer management applications, helping businesses and sharing information to both the inside and outside of the company (Russell and Taylor 2003; 541). On the other words, the business and the communication between employees and consumers or suppliers are simplified.

ERP creates a central depository for the company's data, which enables the company to perform various business analyses, as shown in following Figure 5:

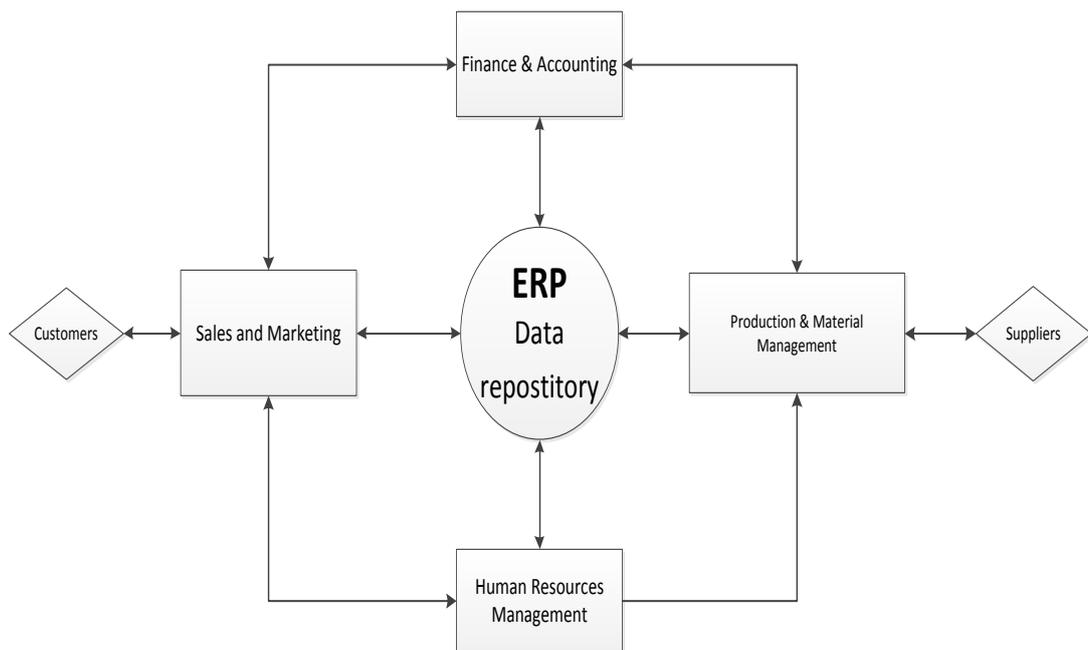


FIGURE 5. Structure of ERP

According to the figure, each department stores and picks up their information to the ERP information warehouse. Employees can freely check the information of other departments. From the right-hand side, what is illustrated is that orders are made by the ERP system, sending the information message to the suppliers, and then suppliers receive orders. On the other side, the diagram shows the relationship

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between the customers and a company. However, this just introduces the basic structure of an ERP system, a company should find a suitable ERP system for themselves, which is in accordance with the idea of the company.

### **2.3.2. ERP Contributions for Enterprises**

Running an ERP system in a company is a brilliant choice. Integration information can be the best benefit of all the contributions that ERP makes. The real project aim for implementing ERP is reducing data redundancy and redundant data entry, while sucking overall useful information or data into the system. If a company treats the information integration as nothing, it leads to the dangerous tendency of having a hard time with applying ERP. Therefore, ERP does not improve the individual efficiency of users, so if they expect it, it will be a big disappointment. Hence, ERP improves the cooperation of users.

ERP brings efficiency for the employees working. Employees can easily manage their tasks by having a computer and a right to access to the internet, even if they are not in the office. Also, with the ERP system, the different departments do not have to waste time having meetings or face-to-face communication with each other, therefore, the efficiency of working is enhanced. Moreover, employees can check all the information that they want in the ERP system at any time. In addition, fewer personnel can manage a large amount of tasks, which is a way for the company to save the labor costs, and at the same time fewer human mistakes will happen. (Chou and Chang 2008, 154–155)

There are also other pros. The other important advantage of ERP is its accounting function. An ERP system can integrate the cost, profit, and revenue information of the sales that are made, and present all of the information in a regular way. Normally, by pressing the export button, all the information is formally transformed to an Excel document, which can be used for employees. ERP also responses to the changes of a product is manufactured. A data structure should be set up and it

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allows companies to edit when their product should be updated. This is important, because it will give the right to companies to keep better track of their products, so that firms can take tracks as their developing root. Besides, ERP's applications of companies lead the products themselves to be produced with a high level of quality. Another area where ERP can be an indispensable tool is the area of security, which protects companies against crimes, such as embezzlement or industrial espionage. (Exforsys 2009)

However, some elderly employees are not really willing to get training to learn how to use the software. And uploading ERP to a company might cost a lot of money at the beginning, which cannot be got back in a short term. Even though there are some cons for a company to run an ERP system, but its application is strongly recommend to apply since the benefits for the companies are more numerous than its disadvantages, which can even be overcome.

#### **2.4. Warehousing and inventories**

Inventories are materials and supplies that a business or institution carries either for sale or coming goods, which are provided by our supplies, to the production process. All businesses and institutions require inventories. Financially, inventories are important for manufacturing companies. On the balance sheet, they usually represent from 20% to 60% of total assets. As inventories are used, their value is converted into cash, which improves cash flow and return on investment. In addition, inventory management is responsible for planning and controlling inventory from the raw material stage to the final stage, whose product can be sold to customers. However, there is an inescapable cost for carrying inventories, which increases operating costs and decreases profits. (Arnold et al. 2008, 233)

What kind of products or goods or freights can be sorted into inventories? Firstly, raw materials are one kind of those, which have not entered the production process. Secondly, WIP (work in process) refers to the materials that have entered the

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manufacturing process and have to be worked on or are waiting to be worked on. Moreover, finished goods are the goods ready to be sold, which are also inventories and should be appropriately kept in warehouses (Arnold et al. 2008:235). Within different companies, different warehouses and inventories could exist. However, the basic form of inventory is mentioned above as three types.

Different inventory or warehousing management systems are determined by different production types of companies. Meanwhile, stocks on hand act as a buffer of the entire supply chain. Warehousing stocks refer more to the mass production, which does not have a clear goal or does not know how much raw materials that production needs and how many final products are going to be produced. In lean production, for instance, Just-in-Time requires less materials or components to be kept on hand. JIT production plans the exact amount of raw materials, the warehouse does not have to keep a lot as a buffer, since a huge amount of raw materials left in warehouse costs inventory expenses, takes the space of the warehouse, and gives a worse refresh cycle. (Goetsch and Davis 2012) However, keeping stock in the warehouse can be a bright choice. A large amount of purchasing gets the discount off the unit price, and with less transportation cost. Moreover, in the unstable market, to keep the inventory can overcome the risk for the future production. Therefore, a company should have an ability of making a good forecast on what goods should be purchased, when the price is low or not increased too much, or what the industry does not have anymore. Also the company can overcome the situation when the supply is smaller than the demand.

#### **2.4.1. ABC Analysis**

Both the ABC and XYZ analyses are tools that can be applied for the analysis of the standard items of the company. In the following there is the explanation for the reasons why the tools are taken into use and the combination of theoretical and practical examples in real work environment.

#### **2.4.1.1. Background of the ABC analysis**

The ABC inventory classification system determines the importance of items and thus allows different levels of control based on the relative importance of items. Most companies carry a large number of items in stock. To have better control at a reasonable cost, it is helpful to classify the items according to their importance. Usually this is based on the annual dollar usage but other criteria may be used. The ABC principle is based on the observation that a small number of items often dominate the results achieved in any situation. This observation was first made by an Italian economist, Vilfredo Pareto, and is called Pareto's Law. As applied to inventories, it is usually found that the relationship between the percentage of items and the percentage of the annual dollar usage follows a pattern in which:

- A. About 20% of the items account for about 80% of the dollar usage.
- B. About 30% of the items account for about 15% of the dollar usage.
- C. About 50% of the items account for about 5% of the dollar usage.

The percentages are approximate and should not be taken as absolute. This type of distribution can be used to help control inventory. (Arnold et al. 2008; 250)

According to the measures of inventory items and transformed measures, a company could get a suitable classification.(Ng 2007)

#### **2.4.1.2. ADVANTAGES AND DISADVANTAGES OF MAKING THE ABC ANALYSIS**

There are many advantages in applying the ABC analysis, being described in the following:

##### **Better Control of High-Priority Inventory**

The ABC inventory analysis places inventories tighter. Besides, more frequent controls on high-priority inventory. High-priority inventory or class A inventory, which refers to the inventories that customers request most often. In manufacturing, class A inventory includes the items most often used in the production of goods. Because of class A inventory, which is directly leading to

companies whether they can get success or not, it is important to uninterruptedly monitor the demand of A class goods and ensure that stock levels match that demand.

With the ABC analysis, companies can prioritize control the high-priority inventory, so that companies will be not ignoring the most important element of productions. While companies can properly lose cares of other inventories, which are not playing as a determined role in production. Therefore, employees' works are more efficiency than before, when companies did not investigate their goods by applying ABC analysis.

Within the other words, ABC analysis helps a company to see which items are important and must have be focused on, and which are not important and not too much time has to be spent on them.

### **More Efficient Cycle Counts**

Under the ABC inventory analysis method, resources of companies can be allocated more efficiently during cycle counts. A cycle count is the process of counting only certain items on scheduled dates. The frequency of cycle counts and the items, which are choose, including depends on how often inventory fluctuates. Once inventory is organized by class, regular cycle counts class A inventory should be focused on. Depending on needs, it may be necessary to count class B inventory as infrequently as twice per year and class C inventory only once per year. The ABC analysis method saves time and labor to count only the inventory required by the cycle for the class of inventory but not counting all inventory items each cycle. (Advantages and Disadvantages of ABC Analysis Inventory n.d.) However, what should be mentioned is, this counting task can not be always follows the result of ABC analysis. The reason is, year by year, the items will be sorted into which class, will be changed.

However, every coin has two sides, therefore, at the opposite side of advantages are disadvantages, which are illustrated as following paragraph:

#### **Conflict with Other Cost Systems**

The ABC inventory analysis does not meet Generally Accepted Accounting Principles (GAAP) requirements. Besides, it is also conflicts with traditional costing systems. Companies apply ABC methods must operate two costing systems. One is for internal using, which is under the ABC method, while another for compliance with GAAP. Traditional costing systems generate the figures, which allocate cost reasons, through the way of the actual unit cost not the activity percentage of the cost reasons, required by GAAP. As a result, ABC cost assignments often differ from traditional cost system assignments. (Advantages and Disadvantages of ABC Analysis Inventory n.d.) In the other words, applying ABC analysis give invisible press for employees, who always got the confusing results.

#### **Substantial Resources Required**

The ABC method requires more resources to maintain than traditional costing systems. (Advantages and Disadvantages of ABC Analysis Inventory n.d.)To making an accurate ABC analysis, what should be definitely well -done is collecting all the information and updating allover data of each item, which are required for productions.

Actually, in companies, they prefer that the things are not too complicated. By conducting this ABC analysis, and getting the update data, then move the inventory place much be changed from one to another. They might have no time to do this.

#### **2.4.1.3. Solutions of Dealing with Different Level of Product**

The ABC analysis is just a basic way to sort out all the standard items of a company, what is really useful for the company is not making conducting the ABC analysis, but

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making the analysis according to the result of the ABC analysis. That means getting the useful, understandable information out of the data source.

### **A LEVEL ITEMS**

Here, A level items can be treated as the most essential items, since fewer items costs high value. What can a company achieved after separate more attention on the A category items is the managerial effectiveness can be maximize.

Theoretically, because of a high consumption value of A items costs, those items require very strict control, such as frequent ordering, no safety stock left in warehouse, weekly control statements, as many sources collected as possible for each item, strict value analysis of A items, precise indicate in its materials planning, minimize the waste obsolete and surplus and while maximize the efforts to reduce lead time. (Rama 2009) Only follows points are mentioned above, A items can be took charge of in a good way.

However, a company cannot stop problems from happening, when the company has problems with its A items, such as several items are left in a warehouse, or an order to a supplier is too long to be set up and it is too long to receive the freights, what are ordered. Hence, to deal with problems of those items leading to, JIT can be applied into the production plan. Just-in-time production will be described in the 5.1.1. Just in Time. Moreover, it is better than the lack of the A items' details, so the employees should take notes down as clear as possible. At the same time, purchasers should cooperate with designers, try to find a better substituted products to instead of the old one, so that the costs can be decreased, the lead time can be shorted, the quality or performance of final production can be raised up.

### **B LEVEL ITEMS**

B level items are the second most important items. *Rama Rao* states that B' items formalized inventory system with periodic attention to purchase and stores

management. Also he mentions that B items are placed in the moderate value level, which requires moderate control, low safety stock, monthly control reports, two or more reliable sources, and moderate value analyses. Besides, present plans should be estimated based on past data and employees give B items quarterly control over surplus and obsolete item. (Rama 2009) B items are not the most important items, but still occupy a big part of all over values, which also determine the successful of a company. What should be taken care of are the top ranks of B items, when an employer makes an analysis of all the B items.

In my point of view, EOQ Economic Order Quantities can be a good solution of improving the purchasing the performance of B level items. About EOQ method, there is more information in the chapter 2.4.3. Even though, in the B item, not all of them are important, but there are still some, which should be focused on. Hence, companies can base on the unit price or purchase price to set up a level, if an item' price is over the level, then it should be sort to the important group, but the others can get less attention by employees.

### **C LEVEL ITEMS**

C level items are less important items which have be paid less attention to. In an article, Advantages and Purpose of ABC Analysis, *Rama Rao* also gives the light of the characteristics of managing C items. Those are low consumption value, which requires low control but high safety stock, bulk ordering once in a long period, quarterly control reports, and two reliable sources for each item. Besides, minimize value analysis of C items, rough estimates for planning, annual review over surplus and obsolete materials and minimum efforts from employees. (Rama 2009) C item always take the majority of the all items that a company owns, normally there are half of items are sorted into C group.

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A company should prevent problems from happening. For example, less analysis of C items or less attention to the quality of those items purchasing, year by year, leading to costs are increased and on hand stocks are raised up. To overcome a wickless, a company should have a good relationship with those items suppliers, so that the company can give more trust to those supplier companies. Or for a type of item, company should know more than one supplier, who can give this type as support, so that the company can avoid over rely for one or only one supplier.

In a real case, the result of the ABC analysis cannot be trusted without any consideration. Reviewing each item must be done after getting the result of the ABC analysis, some might be easily broken, some might have a cheap unit price but have to be purchased in a large amount so that the total value is high. For instance, screws and similar staff were purchased in a big amount; therefore, based on the value high, they can be sorted into B items or even to A level. Hence, in practice, not all A level products are important items on the other side, the most essential item can be on A level and also on B level. Based on the situation of the company, the unit price which is lower than 100 Euro can be picked out of the most essential items.

#### **2.4.2. Background of XYZ analysis**

The XYZ analysis is more used in relation to the customers' demands for FG (finished goods); X is high demand, Y medium demand, Z very low or esoteric demand. The XYZ analysis is calculated by dividing an item's current stock value by the total stock value of the stores. The items are first sorted on a descending order according to their current stock value. The values are then accumulated till the value reaches the 60% of the total stock value. These items are grouped as 'X'. Similarly, other items are grouped as 'Y' and 'Z' items based on their accumulated value reaching another 30% & 10% respectively. The XYZ analysis gives an immediate view of which items are expensive to hold. Through this analysis, the amount of money locked up can be reduced by keeping as little as possible of these expensive items.(Gebel et al. 1998)

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The idea of XYZ is similar to the ABC analysis, but it is more focused on the finished product. Companies should base on their own situations and pick a right measure.

### **2.4.3. Economic Order Quantity**

Bill Roach explains how the origin of the EOQ began in his article, "Origin of the EOQ formula: transcription or transformation?" published in 2005. Roach explains there the Economic Order Quantity. He also mentions how the contribution of Ford W. Harris to the EOQ formula was significant. The classical EOQ theories have been often concerned with the case, in which a day's holding cost per unit of product, set up costs and a day's demand for the product, which are constant. With the condition the inventory policy is planned, a day's average inventory cost may be decreased (Gonzalez and González 2010).

Nowadays, the Economic Order Quantity formula has been used in both engineering and business disciplines. Engineers also study this philosophy -EOQ- in engineering economics and industrial engineering courses, or similar lectures. On the other hand, business disciplines study the EOQ in both operational and financial courses. In both disciplines, EOQ formulas have been practiced and applied specific in illustrating concepts of cost business, which is more specifically applied in inventory management. (Keisuke 2001)

EOQ is short of optimal order quantity, which minimizes total inventory costs. There are several variations of the EOQ model, depending on the assumptions made about the inventory system, which are introduced in following paragraph.

### 2.4.3.1. The Basic EOQ Model

The basic EOQ model is a formula, which is used for determining the optimal order size that minimizes the sum of carrying costs and ordering costs. The model formula is got under a set of simplified restrictive assumptions, which is given in the following:

- Demand is known with certainty and is constant over time.
- No shortages are allowed.
- Lead time for the receipt of orders is constant.
- The order quantity is received all at once.

(Russell & Taylor 2003, 464)

The following Figure 6 shows the relationship between EOQ and costs:

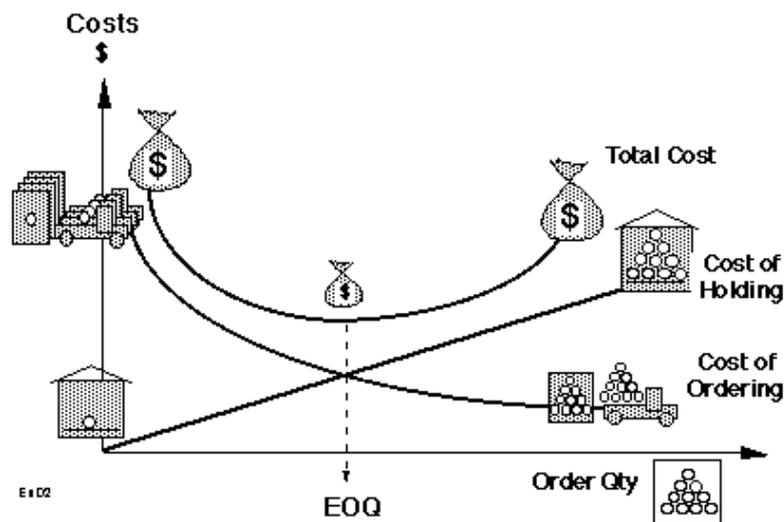


FIGURE 6. EOQ

If the holding cost, and reorder costs are fixed, and the demand for a certain period is clear, we can get EOQ by making the calculation. Using the following formula is:

$$EOQ = \sqrt{\frac{2 \times RC \times D}{HC}} \quad RC = Co * D / Q \quad HC = Cc * Q$$

Where: RC= reorder cost    Co=times of order per year  
 HC=holding cost    Cc= annual per unit carrying cost  
 D= demand    Q= order size

(Waters 2003; 72)

### **2.4.3.2. Advantages and Disadvantages**

The EOQ model is a commonly used element of a continuous review inventory system. It is based on the formula to calculate the most economical number of items to minimize costs and maximize the value of the re-stocking inventory. However, owners of companies should evaluate the pros and cons, before applying this inventory model.

#### **Minimized Storage and Holding Costs**

Inventory costs might be expensive for a small company. The EOQ model provides the most economical number of units per order for purchaser to make orders. Even though purchasing a large amount, companies can get discount by bulk buying and low order costs. But companies should base on self's situation and then make decisions whether spend more holding costs or whether optimize the unit price of ordering.

#### **Complicated Math Calculation**

The EOQ model requires a good understanding of algebra, which is a disadvantage for small business owners, who lack of math skills. Additionally, effective EOQ models require detailed data to calculate several figures. For example, the key formula of the model calculates the square root of  $2DS/H$ , where  $D$  is the number of units purchased annually,  $S$  is the fixed ordering charge, and  $H$  is the holding cost per unit. Rent or mortgage payments, utility costs and property taxes are required just to calculate  $H$ .

#### **Based on Assumptions**

The EOQ model assumes a steady demand of a business product and immediate availability of items to be re-stocked. It does not account for seasonal or economic fluctuations. It assumes fixed costs of inventory units, ordering charges and holding charges. This inventory model requires

uninterrupted monitoring of inventory levels. The effectiveness of the basic EOQ model is most limited by the assumption of a one-product business, and the formula does not allow for combining several different products in the same order. (The Advantages & Disadvantages of Economic Order Quantity n.d.) On the other side, more checking tasks are given to employees and all the data information should be corrected without any mistakes.

Actually, some companies do not use the EOQ model. It is hard to calculate, and especially, to monitor the assumptions, which makes difficulties for the company. And even though the company can get all assumptions for calculating, the demand for different items is changing frequently. For instance, the production of Fluidhouse, Finland, is based on the customer's specifications. The components for products might be different for this customer- they need small pressure pump, but the other customer needs a large one. Basically, they cannot monitor how much they want for a year or they do not even use in a year, next year or later on. Nevertheless, the demand of a year is mandatory to be included in the EOQ formula, if a company has no clear demand of a year, how can they get the optimal order size. However, in Fluidhouse, for some standard items can be used for all the production, which can get optimal order size by the calculation. For instance, the screws, switches and fittings are needed for all the production, and those can be got an optimal order size.

### **3. SUSTAINABLE OPERATIONS MANAGEMENT**

Sustainability is an increasingly relevant issue for a wide range of organizations, and therefore sustainability management strategies and practices are of growing significance. Because many sustainability impacts are strongly influenced by operations management decisions, it is critical that the operations management function, including the requirements of sustainability management. This has implications for decisions and processes which are associated with all aspects of operations management including strategy, design, planning and control, and improvement. For example, appropriate environmental and social performance objectives, targets and indicators need to be integrated with quality, cost and other more conventional performance measures. The perspective of a closed loop supply chain must be adopted the requirements of other stakeholders. Besides, customers must drive operations decisions. Thereby, with implications both of the professional development of managers and the research, the operation management is expanded considerably, and at the same time, the nature of the operations management is changed. (Bettley and Burnley 2008a, 53)

Nowadays, Operations management researchers and practitioners are facing a new challenge, which is integrating the issues of sustainability with the traditional business interest. During the past 20 years, there has been growing pressure on businesses to pay more attention to the environmental and resource consequences of the products and services. One symptom of this pressure is the movement towards triple bottom line reporting (3BL), which is concerning the relationships of profit, people, and the planet (environment). Integrating environmental, health, and safety concerns with green product design, lean and green operations, and closed-loop supply chains, those, overall, can be the resulting challenges. (Paul, Kalyan, and Luk 2005:482) A company that has got a sustainable operations management system signifies that the company has a high ability of competitiveness.

The conventional definition of sustainable development is kind of development which meets the requirements of the present without compromising the future

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generations, who need to meet their own needs, although this tends to be interpreted differently in different contexts. Typically, at present in industry, it is environmental sustainability that is the focus of attention, but sustainability is actually a rather broad concept, which comprises a wider set of “corporate social responsibility”, including e.g. financial, social and environmental concerns, or “quality of life” (Bettley and Burnley 2008b:2). Hence, in many cases, sustainability might lead people to thinking about the environmental field. However, in the thesis, the focus is more related to the sustainability of a company’s operation, which also should be valued, especially in the economic crisis period. Moreover, sustainable operation management makes the company’s long-run development dreams come true.

Over the recent years, the research has focused on sustainability in operations, which has been attracting much interest of companies. This situation also means that people or entrepreneurs take interest in the sustainable operation, and they realize companies grow up healthily by applying the management of sustainable operation. As is to be expected in this wider field, there are many approaches which researchers have taken. Applying CSR in whole supply chains is to achieve an aim of examining the implications of sustainability for different parts of the supply chain or value chain. Work in the former area means those companies tend to be more focused on the societal and human aspects of business behavior, often at the industry level. (Lawrence 2009:4)

As companies developed their core competencies and included them in their business processes, the tools and concepts of TOM and JIT were applied to developing new product development and managing supply chains and their typically involved multiple organizations. Generally, they first incorporated JIT between suppliers and production units, then moved optimized logistics (including deficient consumer response (ECR) between producers and distributors, then to CRM customer relationship management finally to global fulfillment architecture and risk management

### **3.1. Sustainable Manufacturing-JIT**

Taiichi Ohno, a former shop manager and eventually Vice President of Toyota Motor Company, is the individual most credited with the development of Just-In-Time. Just-In-Time (JIT) is a word, which is devote itself to illustrates the Toyota production system which is widely recognized today as one of the most efficient manufacturing operations in the world. In its simplest form, JIT requires only necessary units to be provided in necessary quantities at necessary time. The idea of JIT is that producing one unit extra is even worse than being one unit short, and completing production one day early is not better than finishing one day late. Besides, all required items are supplied only when needed. Therefore, “Just in time” was created. (Russell & Taylor 2003;511)

JIT production is defined in many ways, but the most popular approach is including the elimination of all waste and continuous improvement of productivity. Waste means anything that is over than the minimum amount of equipment, parts, space, material, and a worker’s time must absolutely necessarily add value to the product. This means there should be no surplus, there should be no safety stocks, and also the lead time of transporting or manufacturing or producing should be minimized (Arnold et al. 2008, 398).

Anything in the product cycle that does not add value to the product is waste. In Fluidhouse, Finland, this waste is one of problems of inventory department. There are more than 700 items are left on hand which are wastes, since they do not use them anymore, and some items are just new without being used. For many years, those have been left in the warehouse. The purpose is to overcome this poor situation and not let it happen again in the future. Applying JIT can be a way to prevent that waste.

By making an analysis of the company, it became clear that the waste can be caused by poor product specification and design. Actually, Fluidhouse manufactures the products based on the customer specification, different customers have different

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requirement. They have to design for each customer separately, if they do not order standard products. Hence, to achieve a better performance, they test products during the design period, and they may change some components. Those substituted components have been left in the warehouse, waiting for whether they can be used in the future, but in fact, they are waste. This is almost impossible to be overcome, since to get good quality, the tests must be done and the changes must happen. What they could do is try to minimize the waste. Here, components standardization can be applied for some that can be shared. Part standardization creates large quantities of specific components that allow longer production runs. This, in turn, makes it more economical to use more specialized machinery, fixtures, and assembly methods. Standardization reduces the planning and control effort needed, the number of items required and the inventory that has to be carried.

Also there are wastes that are caused in the manufacturing, involving manufacturing planning and control, quality management, maintenance and labor relations. Toyota has identified seven important sources of waste in the manufacturing. The process of machinery, methods or decisions, movement of stocks or components, product defects, waiting time of operator or materials, overproduction, inventory costs of stocks.

Compared with mass production, JIT requires more elements to support the production running: tight schedule of production from the beginning to the output end; right amount of components for manufacturing; no inventories, but getting component just before the production. However, more benefits from JIT production can be achieved. For instance, funds are tied up in inventories and can be used elsewhere; spaces previously used, to store inventories can be used for other more productive uses. Moreover, throughput time is reduced, while resulting in greater potential output and quicker response to customers. Also, JIT leads to defect rates reduction, which results in less waste and better customer satisfaction. (Lyu and Gunasekaran 1997)

### 3.2. Sustainable Supply Chain-ECR

ECR is short for Efficient Consumer Response, which uses Just-In-Time principles to pull materials through the series of organizations in a supply chain. ECR aims to improve product flow by minimizing inventory of a supply chain and make cash flow faster. Quick Response is a strategy of supply chain management, started at United State food industry in the year of 1992. Then, Japanese food and commodity processing industry began to apply this strategy and forming a system so called Efficient Consumer Response. After that, ECR Europe was launched in 1994 gave the definition of ECR, which is *ECR is the realization of a simple, fast and consumer needs with the lowest possible cost.* ECR highlights the cooperation between suppliers and retailers, especially, increased competitiveness of firms among the different companies all over the world and satisfied the variety demands of companies. (Christopher and Peck 2003:92)So they have to build a trustable relationship by using modernized information and strategies to coordinate production, operation and logistics management, to achieve the different requirement of customs in a short time.

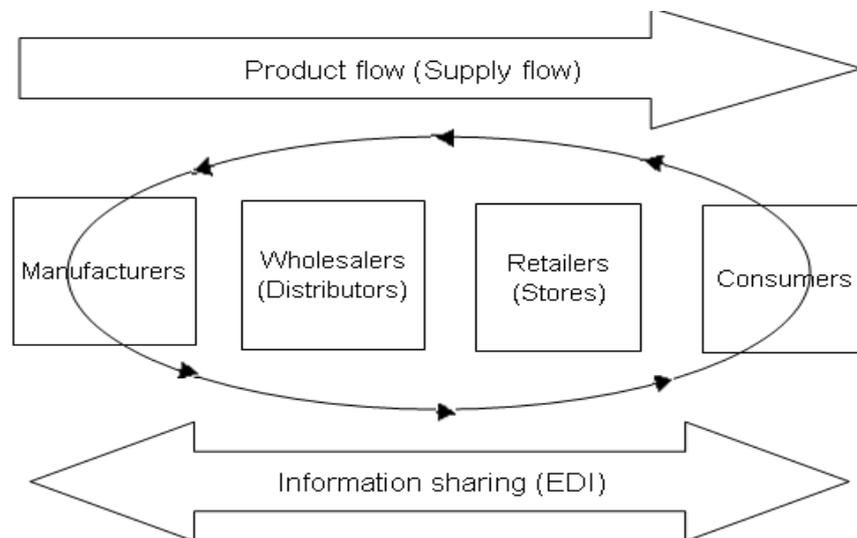


Figure 7. ECR

The idea of ECR system is to make efficient product introductions, efficient store assortment, efficient promotion and efficient replenishment.

The ECR concept focuses on four branch specific core areas:

- Efficient store assortment (category management)
- Efficient replenishment
- Efficient promotion (sales campaigns)
- Efficient product introduction.

(Jespersen and Skjott-Larsen 2005:96.)

### **ECR system applying new technology and new method**

At first, the ECR system uses advanced information technology, developing a Computer Assisted Order (CAO) system between production enterprisers and distribution firms. The CAO system works with Point of Sale (POS), gets sales information, then ordering requirements are transferred to a distribution center automatically. This is a way to try to make the inventory of retailers decreased to zero, and reduce the life cycle from ordering and receiving, increasing the freshness of the products. In addition, manufactories can figure out whether the new product can be adopted in the market or not, in a short time.

Besides, ECR system applies two new managing methods, category management and placing management. The idea of category management is not to focus on any specific product, but focus on a type of products to get an optimized rate of return. Placing management means optimized the layout of commodities and place of counters compared with the analysis of category management, the purpose is to increase the amount of sales and gross margin.

### **Stable relationship**

In traditional commodities supply system, the producer, wholesalers and retailers have no tight relationship between each other, the ordering happens quite randomly. This makes commodities flow in an unbalanced situation between the producer and sellers, so that the costs are increased. However, ECR systems overcome this weak point, offering a good relationship among the companies in the supply chain to realize the coexistence and co-prosperity.

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### **No documents work**

The ECR system uses the advantage of information handling technology to make information transfer without any paper documents. The benefits are: easiness to check out the products' details, automatically dealing entrance of warehouse, quick replenishment of the warehouse, increased precision of forecasting and reduction of costs.

#### **4. CURRENT SITUATION AT FH**

Fluidhouse used to be the part of Mesto Paper Mill. After the separation, Fluidhouse is an independent company, which is producing lubrication and hydraulics systems for the paper machines. However, lots of items have been left in the warehouse without being too much used until now. And according to the bill of material list, there are a series of items are related to the premier production. Year by year, with the growth of the company, there have happened some problems. To improve the operations management, the problems are waiting for the solutions.

##### **4.1. Problems**

Currently, the company faces the problem of having too many components on hand. Those on hand materials are of high value, zero turnover, and being unused, and even not going to be used in the future. Those items cause a lot of costs, such as the costs of purchasing price, inventory keeping, and occupied space in the warehouse. The thesis task was to use the ABC analysis to find out those items and check their quality, and then try to find ways to deal with those items. In addition, based on the theoretical study and according to the situation of the company, it was attempted to create some strategies of operation to get better performance, overcome the problems and get sustainable development, in other words, to prevent the problem from happening in the future.

According to the ABC analysis, until March 2012, in Fluidhouse, there were 26159 standard items in total and 2642 items on hand, in addition, 710 items had zero turnover per year( account of the time before March 2012) , which cost almost 150000 euros, as shown in Figure 8.

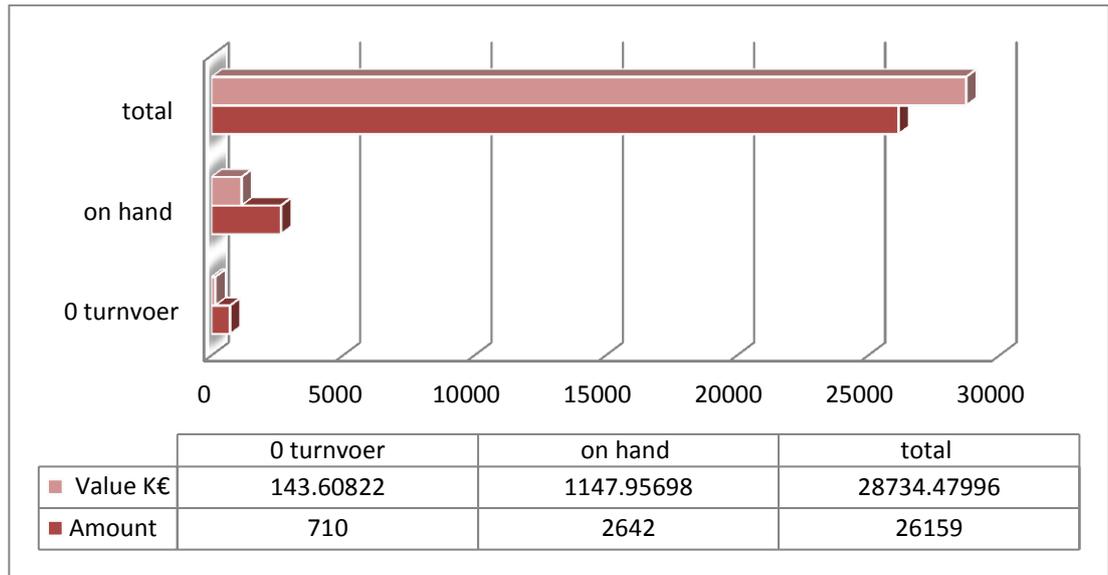


FIGURE8. analyze of standard items

#### 4.2. Baan IV - ERP System

The Baan Enterprise Resource Planning (ERP) system is a generic and comprehensive business software system based on a distributed computing platform including one or more database management systems. It combines a global enterprise information system covering large parts of the information needs of an enterprise implementing all kinds of business processes that are vital for the operation of an enterprise. The system helps an organization to deal with basic business functions such as inventory, purchase, sales, distribution management, financial accounting and controlling, and HR management, as well as with advanced business functions such as project management, production planning, supply chain management, sales force automation. All the information from different departments can be shared in this system platform, employees having the rights to access in to use all the information from different sectors.

#### 4.3. Data Analysis - ABC Analysis

At Fluidhouse, Finland, the products are manufactured directly to the customer, so there is no or little final product kept in the warehouse. Normally, they transport

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the final products to customers immediately after packaging. What they have to stock in the warehouse is the components which are processed into final products. Technically, they order as much as they are going to use for the production, but during the period of designing, they might order some components or different type of materials to ensure the quality of final products. Hence, there are some components which cannot be used for machines and which are left in the warehouse. Year by year, those are still on hand with a zero turnover.

To figure out which item can be sorted into the list of zero turnover, there are few steps to do:

1. Get the standard items sheet and make the ABC analysis based on these standard items.
2. Get the turnover sheet and pick up the zero turnover items.
3. Combine two sheets together to get the level for all of zero turnover items.
4. Work on the different level of items to get a suitable solution for classified items.

In a real case, such as the situation of Fluidhouse, this classification is not suitable for the company: only 20% of the items are A items but account for more than 90% of the total value. Hence, based on the distribution, a classification like the following can be suitable for Fluidhouse, theoretically:

- A About 10% of the items accounts for about 68.6% of the total value.
- B About 20% of the items accounts for about 23.3% of the total value.
- C About 70% of the items accounts for about 10.1% of the total value.

Practically for the company, the following classification could be used:

- A About 10% of the items accounts for about 71.5% of the total value.
- B About 20% of the items accounts for about 17.2% of the total value.
- C About 70% of the items accounts for about 11.4% of the total value.

The data are close to each other. Hence, this is a reasonable analysis of the company.

However, in this case, since Fluidhouse produces less finished products, which are immediately transported to customers, here, XYZ is not being taken into the consideration.

In Fluidhouse, Finland, there are 2642 items out of the total number of standard items left in warehouses, 10% of 2642 items means that 264 items are classified as A level items. 528 items are sorted into B level, which is 20 % of total on hand items. The rest of those, 1849 items are C level.

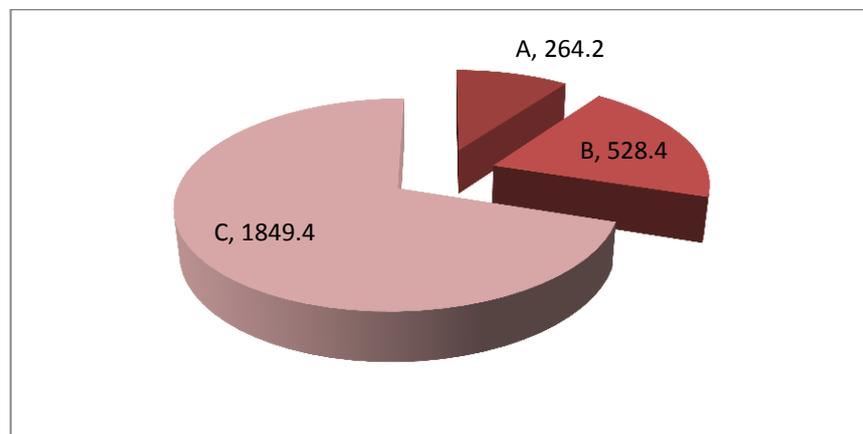


FIGURE 9. The amount of each A, B and C level.

There are 710 items with a zero turnover included into those 2642 items, costing almost 150,000 euros. And 39 items are A level, 101 are B level, the rest are C level. However, to get the essential items, the unit price lower than 100 euros are not involved into the essential item list. Hence, 257 items are out of the rest, jump into the essential item list, which takes the 89% of the total value of zero turnover items.

## 5. RECOMMENDATIONS

The purpose of the research and analysis was mainly for to solve the problem that Fluidhouse has currently. To deal with the problem that the company has, the

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solution can be separated mainly into two categories, direct approach and indirect approach.

### **5.1. Direct Approach**

The direct solutions are more like the corrective maintenance of a machine. After problems have happened, a suitable way is attempted to be found to deal with it and fix it. This can be an approach to deal with the essential items especially, and can also be implemented for other zero turnover items.

#### **5.1.1. Re-engineering**

Re-engineering means the zero turnover items can be involved in the new design. This is a way to get reuse for those items. By communicating with designers, the possibility of reusing those items can be attained. This approach may not be significant for dealing with all the items, because the reason why those items are stocked in the warehouse is they cannot be used for the production. However, if goods are involved in the new design, checking the quality of the goods before using is an important task to do, because some of them have stayed in the warehouse for long time.

The data analysis was finished in the middle of April, 2012. One and half months to deal with those zero turnover items are still short. However, until now there are 7 items have been agreed to be uses in a new design and production. Moreover, there should be more items getting reused in the future.

#### **5.1.2. Sale**

Zero turnover items were considered to be sold to other companies or other countries or secondary industry market. Even though by selling those items a good price cannot be expected, but it is still better than just leave them in the warehouse. This is a way to get some money back.

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This approach was being considered for a period of time, but the company gave it up since the agreed price was too low. Hence, they were not willing to spend time on the less valuable tasks. Even though the company was not set up this to the agenda, they still would like to keep this as an approach, if they have a good opportunity to sell those items out.

## **5.2. Indirect Approach**

In a way, the indirect solution, which is similar to the predictive or preventive maintenance of a machine, can also be a way to deal with the problem. This preventive task refers to the sustainable operation management of the company. To prevent the situation or problems from happening in the future, what should be done is not only developing the performance of the production department but the whole company has to be improved. The warehouse and inventory play a service role in the production, hence the efficiency of inventory and the type of warehouse are influenced by the strategy of the production. EOQ can be applied into dealing with B level item. Therefore, to get a better warehouse, lean production can be introduced into the company. To achieve lean production, JIT can be a suitable tool for the company to make the situation better, to reduce the wastes especially. JIT can make a short term benefit for the company. Beyond that, TQM as a total performance evaluation gives effort to the long term strategy of the business. The Ishikawa diagram can be a good tool of TQM for the company, since the tool is a normal part of the problem-solving activity of quality circles and teams. TQM can evaluate the whole company, not only the department of production and inventory.

### **5.2.1. EOQ**

Economic Order Quantity, which can be applied in Fluidhouse, has been addressed in the chapter of 2.4.3. However, the real situation of Fluidhouse is that customers set all the specifications and involved in the production design, which can be called engineer to order (ETO). Hence, all the items of Fluidhouse cannot be satisfied by calculating EOQ, because some items are involved in the customer's specification but not into others. Nevertheless, there are some semi-finished and unit product that are manufactured as standard production, the items included into that production can be purchased according to EOQ calculation.

In the real case, Fluidhouse gets data from the Baan IV system, which can support calculate EOQ calculation. For instance, by calculating EOQ for a project of Fluidhouse, the significant benefit can be seen by comparing the total costs with the EOQ total cost. For this project, 21,355 euros means that 6.7% of cost can be saved. Actually, according to this project, the reduced cost is not the most important thing for the company, but the essential contribution for the company is reducing the rate of production interruptions.

However, the company does not entirely trust the result of the EOQ calculation. Normally, the company will go through each item, they may add or reduce the EOQ result. For example, EOQ calculation gives the quantity 60 of a kind of pump which is, but base on the experience, they may reduce it to 50. There is no specification of how much there will be minus or plus to the result of the EOQ calculation. No matter if the calculation is exactly or not, the EOQ at least offers a quantity number for each item. All the following data analysis that the employees did are according to the result of EOQ. Hence, EOQ is important for the company, and worth to being focused on.

### **5.2.2. JIT AND KANBAN SYSTEM**

JIT production is a way to enforce the lean production and sustainable manufacture, which has been introduced in chapter 3.2. One of mainly objectives in implementing

JIT service is to achieve the common goal of companies. A major thing to start with in implementing JIT in any company is to enhance the level of education and training, and to encourage suitable incentive schemes.

The basis of JIT is 5S's:

- a. Seiri(sorting): classify materials in the warehouse based on their usefulness
- b. Seiton(stabilizing): place the value-added materials in handy positions
- c. Seiso(sweeping): clean up the non-value-added materials
- d. Seiketsu(standardizing): maintain the factory in good looking shape
- e. Shitsuke(sustaining): let the employees have good habits and follow the rules.

However, there might be a question of applying 5S with a preferable way, which should be definitely suitable for the company. Besides, all the employees should learn the new ideas, and get used to them. Moreover, at the beginning, employees should monitor the regular of 5S, therefore, reducing the potential mistakes from happening, and at the same time, a better idea should replace the old one. During the research, my recommendations of setting up the 5S rule are illustrated as: Firstly, sorting: based on BOM of Fluidhouse, which already did the checking of all the material on hand in warehouse, and then calculated by the measured of the ABC analysis within a regular time, half a year or one year, which could be according to the situation of a project. Secondly, Stabilizing: based on the first step, the frequently used items are placed in places where it is convenient for workers to pick them. After that, Sweeping: at this stage, useless items from those which are already placed in the corner, and paste stickers on those items, which showing the information of items. Then, Standardizing: identifying the definitely unuseful items from those, which are already placed in the corner, and deal all of those. The measure could be re-engineered or sold out, which are introduced above in chapters 5.1.1 and 5.1.2. Finally, Sustaining: all the employees should be trained and got the used of having the habit to following the rules of 5S.

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With 5S activities the working environment in Fluidhouse should be cleaned up to improve the safety, quality and productivity. With those activities, the company can set up a solid foundation for the JIT system, so that the production system can be operated smoothly, without any interruption, therefore, safety, quality and productivity can be enhanced overall, over the years. (A and J 1997) Besides, all the employees form good habits of working, thus decreasing the human errors and increasing the efficiency of working.

Employees, machines and materials are integrated efficiently using standardization of various processes and material flow, so that the result of the application of JIT and maintenance of any improvement project can be realized without wasting any resources in the entire process.

JIT provides a routing production, a balance production and the rationalization of resource allocation. To implement JIT, the Kanban system acts as a tool for companies, especially for industrial enterprises, to achieve the aim of the seven points of less waste. These points are waste of over production, waiting waste, waste of transport(inside), waste of inventory, waste of actions, waste of planning work or processing, waste of bad quality products. Kanban in Japanese stands for Card, and, in the production enterprises, cards are full of information of the situation of the products on them, and they should be put with the items after each stage of production from the beginning to the final step. Kanban cards only give commands for the current process for value-added produces. Based on the situation of Fluidhouse, there are three types of cards, which could be created: Production Card, Withdrawal Card and Information Card, which are showed as following figure:

Production card	
Items No.	
Items Name/Description	
Warehouse	
Place	
Amount	
Production Mode or Processing	

Withdrawal card	
Name	
Placing (From-To)	
Project	
New Items No.	
Amount	
Current Production Mode	
Following Production Mode and Processing	

Signal Card		
Date		
Finished Date		
Urgent	Yes	Not
Quality Check	Good	Not

FIGURE10. Kanban Cards

An item could wait with the Production Card with a Signal Card, workers could pick the item up and read the card, then do what the cards says. When the item has been manufactured, a new card - Withdraw Card - should be signed, so that the item can be transported to the following step for machining. But the quality check before machining should be done and only when the mark of Quality Check is Good, then the following add-valued process can be implemented. Moreover, if the products are in the urgent situation, then mark as Yes in the Urgent line. This is illustrated in the following example:

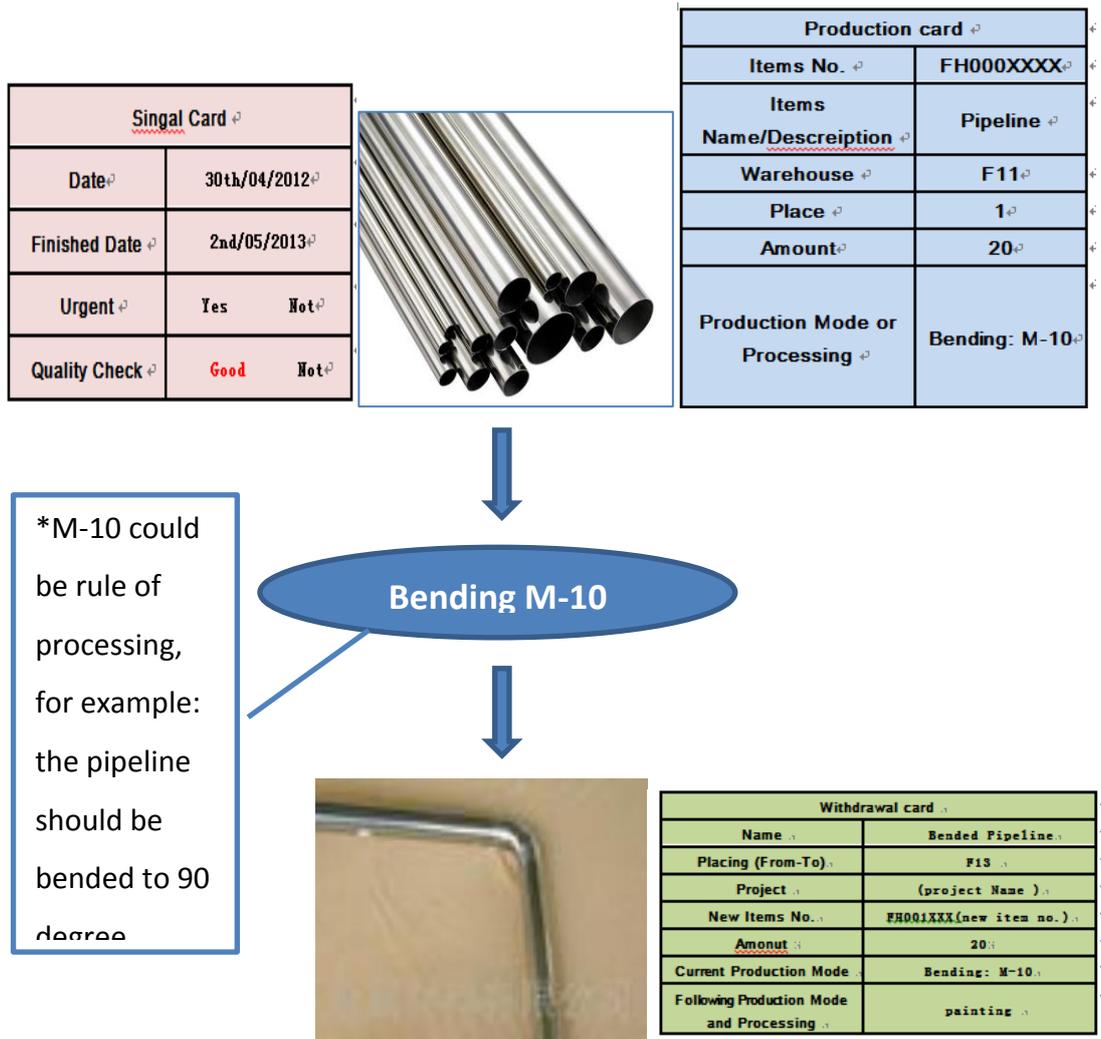


FIGURE11. Kanban Applications

However, the beginning of implementation of JIT may have many difficulties occurred, since having the right amount and the right product at the right time is hard to manage. For example, in a new project, the production plan should be made in advance, including all the activities from the beginning to the final action of the finished product. JIT production requires that all the things, which are related to the production, should be involved in the plan. The plan can specific to the daily plan as well. The tight schedule of purchasing, early suppliers involvement R&D and producing, every action and department is required to participate in the JIT can has been instructed to investigate how to make the operation in a simpler and more efficient way.

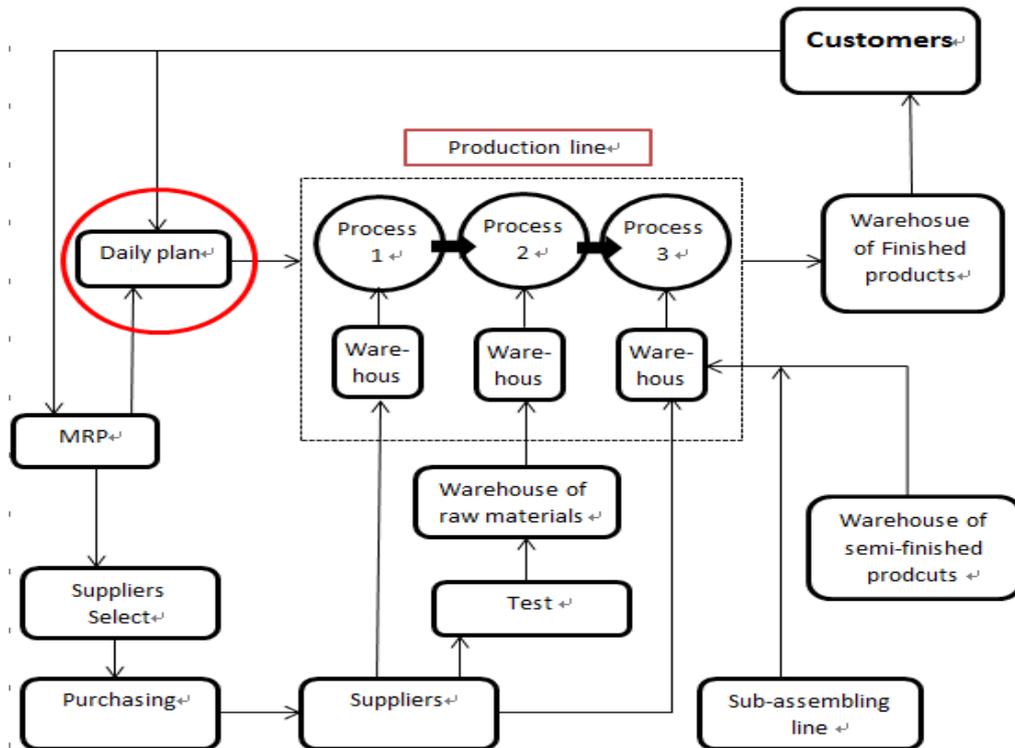


FIGURE 12. JIT production

Because all the things are planned, the inventory amount of parts or items should be reduced, and JIT provides a rotational level of items to eliminate unnecessary spare parts and allow the moving of materials smoothly. One example of a Taiwan company, Daioku, has got a major success in the implementation of the JIT system is the reduction of the amount of inventory. The work-in-process inventory level has reduced from a market value of 30 million NT (accuracy of Taiwan) to 5 million, parts inventory has reduced from 130 million NT to 60 NT.(A and J 1997) Then, the idea of the JIT production system of mainly producing the necessary items of produces at the necessary time with necessary quantities could be achieved.

### 5.2.3. TQM

Total Quality Management has also played an important role in implementing the sustainable operation system. The theoretical part has been illustrated in the above chapter 2.2. Compared with the JIT production, TQM is more like a long term strategy. In other words, within a year, the company may not figure out the

significant contributions from the implementation of TQM. However, according to different situations of companies huge money savings will be happening. For instance, a company, MLE Mid-Atlantic region, implemented TQM over three months and they generated cost reduction initiatives worth of \$600,000 and implemented over \$300,000 of cost savings. (Siddharth Nath 2009)

At the beginning, the suggestion to the company is to establish a training programme to let all the employees get to understand what total quality management is. Then, Fluidhouse can also implement the idea of the company MLE, set a team, corrective action team, mainly focus on five critical areas: customer focus; team work; problem solving, wastes elimination, continuous improvement. (Siddharth Nath 2009) After that, all the tasks should be done by following the Deming wheel, PDCA Plan-Do-Act-Check, in order to achieve the continues process improvement.

Moreover, the Ishikawa theory can be involved; the idea of the Ishikawa diagram is to help employees figure out what causes the problem. For example, in the Fluidhouse inventory department, safety stocks, accuracy of forecast, zero turnover stocks, information of items, maintenance of stock and stock locations can be reasons that lead to the problem, as shown in the figure 12.

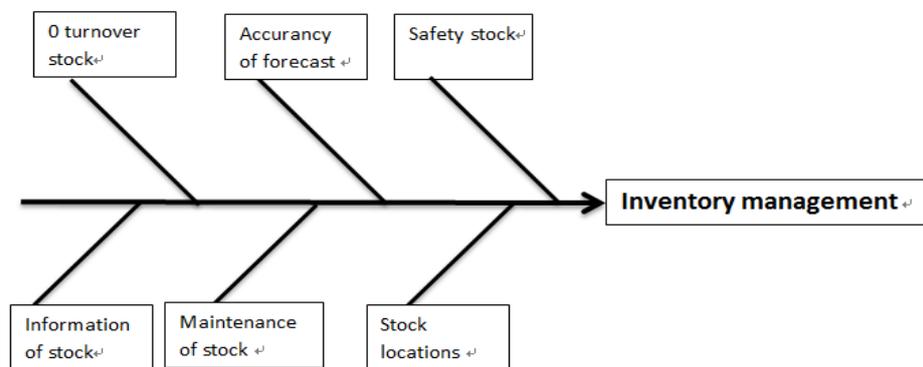


FIGURE 12. Fishbone of analyzing inventory department

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For example, to try to reduce the cost of inventory, the company can focus on those six points:

**Safety stock:** too much safety stock means unnecessary stocks are kept in the warehouse, which increases the cost.

**Accuracy of forecast:** refers to the right amount of items are used into the production without waste.

**Zero turnover stock:** some left on hand, without usage over than a year.

**Information of item:** the accurate information of each item reflects to the efficiency of work.

**Maintenance of stock:** some special stocks require special environment or protection, the good maintenance of stock are needed to keep the good situation of items before it has been used for the final machine.

**Stock location:** the company can optimize the location of inventory of all the items, and they should be located based on the usage of items.

Those six branches are not enough and there should be more or even sub-branches, which should be figured out according to the real situation of company.

The Ishikawa diagram can also be implemented into other department also.

According to the situation of Fluidhouse, there are mainly three parts of performance that can be measured:

- Customer: Measuring the satisfactions of customers, number of complaints, on-time delivery, to gain the market trust
- Production: Measuring the inventory turns, to get achievement of less cost and less waste, during the production
- Suppliers: Measuring whether deliveries are made on time, and the quality of performance, billing accuracy and so on.

## **6. CONCLUSION AND SUMMARY**

The thesis is focused on the sustainable operations management according to a case study. By the research, an attempt was made to find a solution of the problem that Fluidhouse has, to improve the entire operation management.

The contribution for company is dealing with the zero turnover items, and eliminating the really requirement of each item, reducing the unnecessary wastes, in order to preventing the problem happening in the future and enhancing the performance of operation, and achieving sustainable operation management.

To prevent this bad situation from happening in the future, what the company has to do is to find the fundamental reasons. The strategy of inventory department set up is always following and getting influence from the production of the company. Hence, JIT is worth to implementing in the company. The Kanban system gives support for JIT. TQM set up helps the company achieve continuous improvement. TQM is a long term strategy, which gives less significant benefit back to the company in a short term. However, in the future, the cost savings include elimination of non-confirmation and repetitive work, waste costs, reject products, repairs and rework. With also reduced warranty and customer support costs, process efficiency will lead to improved profit per product or service and fiscal discipline through elimination of unnecessary steps and wasteful expenditure. Eventually, a virtuous circle can be set up.

In conclusion, all the approaches are introduced and recommended to the company with a purpose to improve the performance of the company and get higher ability of competitiveness to overcome the unstable market and maintain a good and responsible reputation.

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## APPENDICES

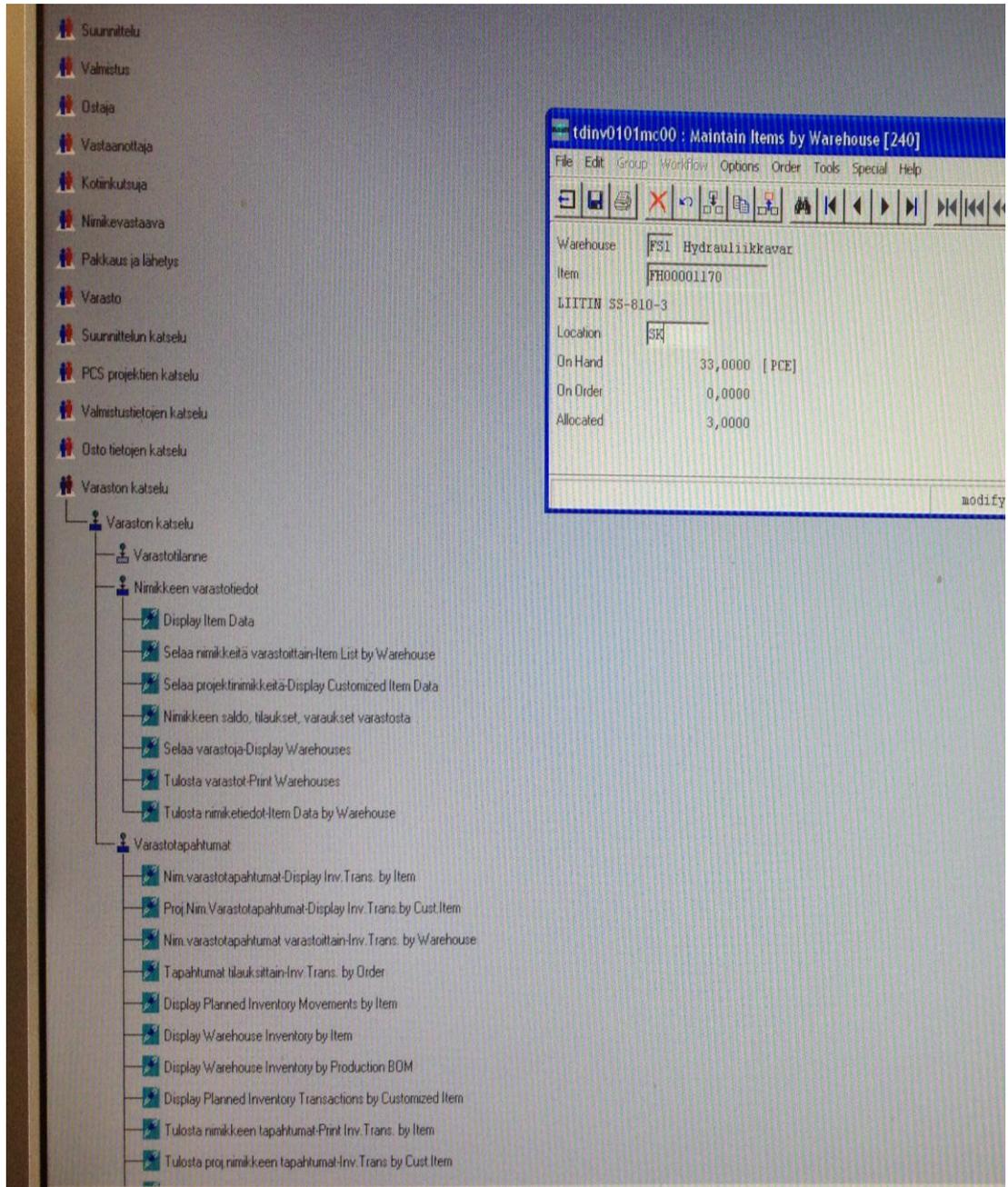
### Appendix 1. ABC analysis of standard items

P	Q	R	S	T	U	V	W	X	Y	Z	AA
Standard	Contr.	War	Purchase Price	On Hand	Unit Price	Value	accumulative value	ABC level	Location	Inv./Item trans.	Lead Time
MASAKI	0 F31		1245	63	1257.61	79229.43	79229.43 A		U-14	2012/5/3	40
KERS	0 F31		1113	56	1137.34	63691.04	142920.47 A			2012/5/3	60
KERS	0 F31		1547.32	22	1480.99	32581.78	175502.25 A			28-02-12	40
LS	0 F31		964	27	1100.8	29721.6	205223.85 A			2012/5/3	20
KERS	0 F31		928	32	928	29696	234919.85 A			23-02-12	20
	0 F31		10850.71	2	10596	21192	256111.85 A			28-02-12	20
	0 F11		1841	9	1768.84	15919.56	272031.41 A			20-01-12	20
FAR	0 F31		103.8	143	104.3	14914.9	286946.31 A		RC.25	2012/5/3	120
TECH	0 F31		460	29	460	13340	300286.31 A		RC.21	2012/5/3	40
KOGAWA	0 F11		900.2	13	900.2	11702.6	311988.91 A		0.34	19-11-08	20
JER-DA	0 F11		870.54	18	648.41	11671.38	323660.29 A			31-01-12	20
LS	0 F31		55.5	188	57.13	10740.44	334400.73 A			23-02-12	20
TM	0 F31		9.9	930	10.42	9690.6	344091.33 A			2012/1/3	20
LS	0 F31		99	90	95.24	8571.6	352662.93 A			2012/5/3	20
KKSMA	0 F31		490	18	435	7830	360492.93 A		RC.19	2012/5/3	60
AGELOK	0 F31		43.3	177	43.3	7664.1	368157.03 A		C 54/4	2012/9/2	20
LS	0 F31		1840	4	1840	7360	375517.03 A			2012/5/3	20
	0 F31		91.67	78	91.64	7147.92	382664.95 A		RL13	2012/5/3	20
	0 F31		110	64	110.92	7098.88	389763.83 A		RC.20	2012/5/3	120
AGELOK	0 F31		13.3	493	13.3	6556.9	396320.73 A		C 61/2	23-02-12	15
LS	0 F31		46.5	141	46.3	6528.3	402849.03 A			23-02-12	20
	0 F31		35.33	106	59.96	6355.76	409204.79 A		E/7	2012/5/3	30
	0 FP9		1440	4	1560	6240	415444.79 A			2010/2/7	20
LS	0 F31		40.5	151	40.76	6154.76	421599.55 A			31-01-12	20
LS	0 F31		99	62	99	6138	427737.55 A			2012/5/3	20

## Appendix 2. Zero turnover items

em	Description	Usage per Year	Last Tr.Dt.	On Hand	Turn Over
AL0220300	PAINELÄHETIN EIX530A-EDS8N-	0	2008/11/19	13	0
-100000546	AC-MOOTTORI 14BG258-4AA B5	0	2010/7/2	4	0
100180	HYDRAULIC OIL TANK HP3-2X	0	2011/1/24	5	0
-100000548	AC-MOOTTORI 14BG283-4 B5	0	2009/6/10	2	0
AL01771200	PROP.V D691-2702G	0	2007/4/11	2	0
20180_C00	KONEIKKO PERUSKOOTTUNA	0	2008/3/13	1	0
AL0191396	SÄÄTÖSEGMENTTIV C05-RAA025AS-	0	2011/1/3	2	0
0A1088256	PERUSLEVY 5 X CES	0	2008/9/4	2	0
AL0081698	JOUST.KYTK ROTEX 65 GG 95SHA	0	2008/2/11	12	0
-100000902	VASTUSVASTAV ZZFS6-5-4X2QV	0	2009/10/27	10	0
1100004918	LOHKO VG321 5XNG10	0	2007/8/23	2	0
AU4E29558	MOOGIN VALMISKAAPELI	0	2009/6/15	19	0
AL0059108	KIERRETANKO M6-10.9	0	2010/9/30	75.5	0
AL0008365	LITIN G25S71	0	2008/1/10	27	0
-100000056	AC-MOOTTORI M2QA 90 S4A B35	0	2006/12/14	16	0
AL0158079	LOG.VENTT.PATRUUNA LC40DB20E7	0	2008/11/17	3	0
20224_C00	VASTAVENTTILLOHKO, NG25/1	0	2010/2/17	15	0
AL0150574	SUUNTAV 8240320.9169.02400	0	2010/9/22	8	0
AL0015718	SUUNTAV DPBC-LBN	0	2010/12/2	10	0
AL0151711	SUOJALETKU SPUL40/GR	0	2007/12/21	25	0
AL0070889	SUODATINPATR HC9604FKS16H	0	2007/3/8	9	0
AL0218555	SUUNTAV 4WE6G6X/EW230N9K4,	0	2008/11/17	13	0
-100000497	SUPISTUSNIPPA M50/M32	0	2010/12/4	94	0

### Appendix 3. Baan IV---ERP system



## Appendix 4. EOQ Calculation

Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
Ostamisen kustannus=		25 €					/haus		Varastointikustannus=		10%		
			Earlier Order				usage per working day		No of purch	Re order point	order quantity	EOQ total cost	Money saved
of Pur	Total €	Total pc	Quantit y	total cost	Need per system	Annual need = Need per 20 systems	EOQ	MEW					
8	658.23	270	34	860 €	16	320	1.2698	8	38.7	25.39683	0.213858	661 €	199 €
17	4890.6	247	15	5,316 €	16	320	1.2698	95	3.4	19.04762	28.08989	4,894 €	422 €
5	68.46	350	70	197 €	16.4	328	1.3016	29	11.3	26.03175	2.555976	71 €	126 €
11	1204.33	327	30	1,481 €	17	340	1.3492	220	1.5	26.98413	142.8571	1,214 €	267 €
11	1014.15	402	37	1,291 €	17	340	1.3492	261	1.3	26.98413	200	1,027 €	264 €
4	607.46	133	33	709 €	17	340	1.3492	193	1.8	26.98413	109.4092	616 €	93 €
10	1877.93	239	24	2,129 €	18	360	1.4286	164	2.2	28.57143	74.62687	1,885 €	245 €
4	7927.5	198	50	8,030 €	21	420	1.6667	73	5.8	33.33333	12.53133	7,931 €	99 €
11	7246.62	399	36	7,523 €	21	420	1.6667	112	3.7	33.33333	30.12048	7,251 €	272 €
10	15248.5	265	27	15,500 €	21	420	1.6667	62	6.8	33.33333	9.009009	15,252 €	248 €
10	367.2	459	46	619 €	31	620	2.4603	622	1.0	49.20635	625	403 €	216 €
10	474.46	885	89	729 €	36.3	726	2.8810	26	27.9	57.61905	0.932662	480 €	249 €
20	9476.85	366	18	9,978 €	4084.193149	16.2071	290	290	14.1	243.1067	20.63558	9,502 €	476 €
7	1907.71	384	55	2,085 €	40	800	3.1746	9	89.2	63.49206	0.100644	1,914 €	171 €
7	13424.5	1253	179	13,608 €	42	840	3.3333	206	4.1	66.66667	50.50505	13,434 €	175 €
2	4442.2	334	167	4,501 €	60	1200	4.7619	212	5.6	71.42857	37.59398	4,451 €	49 €
16	4006.73	860	54	4,409 €	88	1760	6.9841	17	101.6	139.6825	0.170474	4,021 €	389 €
10	392.04	1100	110	648 €	97.7	1954	7.7540	52	37.3	155.0794	1.402918	408 €	240 €
			<b>SUM</b>	<b>314,720 €</b>								<b>293,365 €</b>	<b>21,355 €</b>

Appendix 5. Structure of JIT production

