LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
LUT School of Business and Management
Master's Degree Programme in Supply Management

Tuomas Törrönen

End User Process for the New Distribution-Center Replenishment Operation: Case Study in a Finnish Retail Company

1st examiner:	Veli Matti Virolainen
2st examiner:	Katrina Lintukangas

ABSTRACT

Author: Tuomas Törrönen

Title: End User Process for the New Distribution-Center Replenishment Operation: Case Study in a Finnish Retail Company

Year: 2019

Faculty: LUT School of Business and Management

Major: Supply Management

Master's thesis: Lappeenranta University of Technology, 91 pages, 25 figures, 2 tables, 3 appendices

Examiners: Veli Matti Virolainen, Katrina Lintukangas

Key words: Replenishment, purchasing, business process, process description, process quality, demand forecasting.

The purpose of this master's thesis is to examine the best methods for creating a user process for a new distribution center replenishment process. The key objective is to conduct the user process for a case company. User process is required in process configuration and end user training during a deployment of the new process. Furthermore, to be able to describe the user process comprehensively this thesis studies the core processes of the replenishment process. Core tasks of the new process are analyzed through the risks related to old process. Process steps and actions which are required from replenisher for different inputs are defined. In addition, process quality measurement and added value from the new process are studied. Process management problems are concerned in the context of inventory management. This thesis is a qualitative case study in which professional interviews are vital source of data for empirical analysis. In addition, action research methods are exploited in the empirical analysis as well. As a result of empirical studies, the core processes of the user process are defined, and process steps are determined. The empirical findings of this thesis provide the user process for the new replenishment process. Furthermore, the optimal meters for monitoring the quality of replenishment process are service level, inventory turnover and inventory days.

TIIVISTELMÄ

Tekijä:	Tuomas Törrönen
Tutkielman nimi:	Käyttöprosessin kuvaus uuteen varastotäydentämisen prosessiin: Toimintatutkimus suomalaisessa vähittäiskaupan yrityksessä.
Vuosi:	2019
Tiedekunta:	Kaupallinen tiedekunta
Maisteriohjelma:	Hankintojen johtaminen
Maisteritutkielma:	LUT-yliopisto, 91 sivua, 25 kuviota, 2 taulukkoa, 3 liitettä.
Tarkastajat:	Veli Matti Virolainen, Katrina Lintukangas
Avainsanat:	Täydentäminen, ostotilaaminen, liiketoimintaprosessi, prosessikuvaus, prosessin laatu, kysynnän ennustaminen.

Tutkielman tavoite on selvittää parhaat menetelmät käyttöprosessin kehittämiseen uutta jakelukeskuksen täydennysprosessia varten. Päätavoite on toteuttaa käyttöprosessin kuvaus tutkimusyrityksessä. Käyttöprosessin kuvausta hyödynnetään prosessin konfiguroinnissa sekä loppukäyttäjien koulutuksissa implementoinnin aikana. Kokonaisvaltaisen käyttöprosessin kuvauksen luomiseksi on selvitettävä täydennysprosessin ydinvaiheet. Uuden prosessin ydinvaiheet kartoitettiin selvittämällä riskitekijöitä vanhassa prosessissa. Prosessin eri vaiheet sekä syötteet joihin käyttäjän tulee reagoida ovat määritelty. Lisäksi prosessin laadun mittaamista ja uuden prosessin tuomaa lisäarvoa on tutkittu. Prosessin hallinnan ongelmia tutkitaan varaston hallinnan kontekstissa. Tutkielma on laadullinen tapaustutkimus, jossa asiantuntijahaastattelut ovat olennainen lähde empiirisen tutkimuksen osana. Lisäksi toimintatutkimuksen menetelmiä hyödynnetään empiirisessä tutkimuksessa. Empiirisen tutkimuksen tuloksena täydennysprosessin ydinvaiheet sekä prosessin työvaiheet ovat määritelty. Empiirisen tutkimuksen tuloksena on käyttöprosessin kuvaus uuteen varastotäydentämisen prosessiin. Lisäksi tutkimuksen tuloksena on määritelty optimaaliset menemät täydennysprosessin laadun mittaamiseksi, jotka ovat palveluaste, varaston kiertonopeus sekä varaston riitto.

ACKNOWLEDGEMENTS

I would like to express my sincerest gratitude for my advisor Professor Veli Matti Virolainen for continuous support, feedback and advice for the thesis. His feedback and knowledge have guided me into right direction when needed. Also, I want to express my gratitude for the case company’s instructor and representatives for your time and support for this thesis.

Special thanks for my dear friends Ghofran and Jarno for your support and for encouraging me, and for the great times at the University as well. Finally, my family and especially my wife Ina deserves my gratitude for care and continuous support!

Thank you!

Tuomas Törrönen

In Espoo, Finland 24.3.2019

Table of Contents

Appendices

List of figures

List of tables

1 Introduction

Retail industry is on constant change and requires continuing development to stay competitive. According to Chikan (2007, p. 54) if anything, the ability to change is the key element of doing business today. Therefore, managing the change is relevant for success. Considering smaller projects and business processes in companies, it is a prerequisite to manage change determinately. Retail-market in Finland is highly consolidated, and as a consequence, the competition of the market share is getting tougher all the time.

For increasing market share, sales and marketing is not the only solution. Especially on retail, determined inventory and material management is a prerequisite, due the inventories affect directly to financials of a company. Furthermore, high volumes of goods and varying profit margins create pressure to manage inventories efficiently. One key element on managing inventories is to have properly qualified order- to delivery processes aligned with functional IT- and ERP-systems to support supply chain management operation. Today, companies are able to collect enormous amounts of data, but only a fraction of it can be capitalized.

In the case company, there is an ongoing large-scale information system renovation. The objective of the renovation is to annex multiple separate information systems together and create efficiency to information and data management. One part of renovation is to implement new replenishment system for distribution center (DC) replenishment operation. This study focuses on the DC replenishment operation process. This process is about purchasing goods from suppliers to the distribution center. The process generates a massive material flow, and even the smallest changes to order quantities impact directly to inventories. The DC replenishment process and information system renovation will be introduced more comprehensively later in this study in the case company part.

The context of this study is inventory management, hence, main research concerns process management more comprehensively. Inventories are considered vital indicators of macro and microeconomics for a long time, however, inventories are on important role as business cycle indicators (Chikan, 2007, p. 59). All companies have difficulties in managing their inventory. The most common cause is inaccurate forecasting. When materials are added to inventory it is expectancy of upcoming demand. Therefore, if demand builds up later than expected or never exists, the outcome is an excessive stock. On the other hand, if the demand builds up sooner or greater than expected the outcome is an inadequate stock. Furthermore, determinants that influence stock reducing are for instance accurate forecasting or shorter lead times. (Tersine, 1994, p. 28). In the context of development of the new replenishment process, focusing in forecasting is more influential determinant for efficient inventory management. Lead time shortening tend to concern more a supplier relationship management instead. However fundamentally, inventories are required when supply and demand do not encounter at same time.

History of so-called modern inventory management goes all the way back to the early 20th century. Probably the most commonly known theory in the field of inventory is the Economic Order Quantity (EOQ) formula created by Ford Whitman Harris in 1913. It determines the optimal value of ordering quantity by aiming to minimize the cost in ordering cycle. (Haneveld & Teunter, 1998, p. 173). Harris (1913) developed the formula since he recognized that every manufacturer had confronted a problem of finding the most economical quantity to manufacture. Later, the EOQ model have been utilized more extensively in retail and other non-manufacturing businesses. The EOQ is still commonly used method as a part of creating replenishment orders, for instance Chang, Kaku and Xiao (2011) have utilized the original EOQ to develop new backordering model.

The first researches which concern inventories not only a goods or products but a manpower as well, was conducted by Kenneth Arrow in 1951, by presenting optimal inventory policy. The optimal inventory policy is one of the first researches concerning demand forecasting with mathematical formula. The study relies on uncertainty models in which a random variable is demand and known probability is distribution. (Arrow, 1951, p. 250). Since optimal inventory policy model, forecasting has been developed a lot, for instance latest novelty is the ability to use weather forecasting in demand forecasting. Inventory and material management will be studied more predominantly in the theoretical part of this thesis.

1.1 Research Problem, Objective and Delimitation

This thesis studies the challenges of implementation of a new process in a case company. The key objective is to create a user process for end users for the new replenishment process. User process is required in process-configuration and end user training during a deployment of the process. Considering the effectiveness of the DC replenishment process for inventories and material management in the case company, it is crucial to achieve successful deployment of the new process. From process users' perspective, learning a new process will be easier when user process is clear and demonstrative and takes all relevant aspects into account. Additionally, user process is a critical tool in process configuration stage as well.

To be able to conduct a valid and demonstrative user process, it is required to identify core processes and sorting them to priority order. One of the objectives of the research is to find out how to measure the quality of the replenishment process. Risk assessment is effective method for analyzing the relevance of different actions in the process. Additionally, one aspiration of this study is to study how the process can create value. The figure below outlines the key objectives of this research. Moreover, by studying the most relevant user inputs for the process, the user process can be created. Additionally, by evaluating output of the user process, the added value created from the process as a whole can be analyzed.

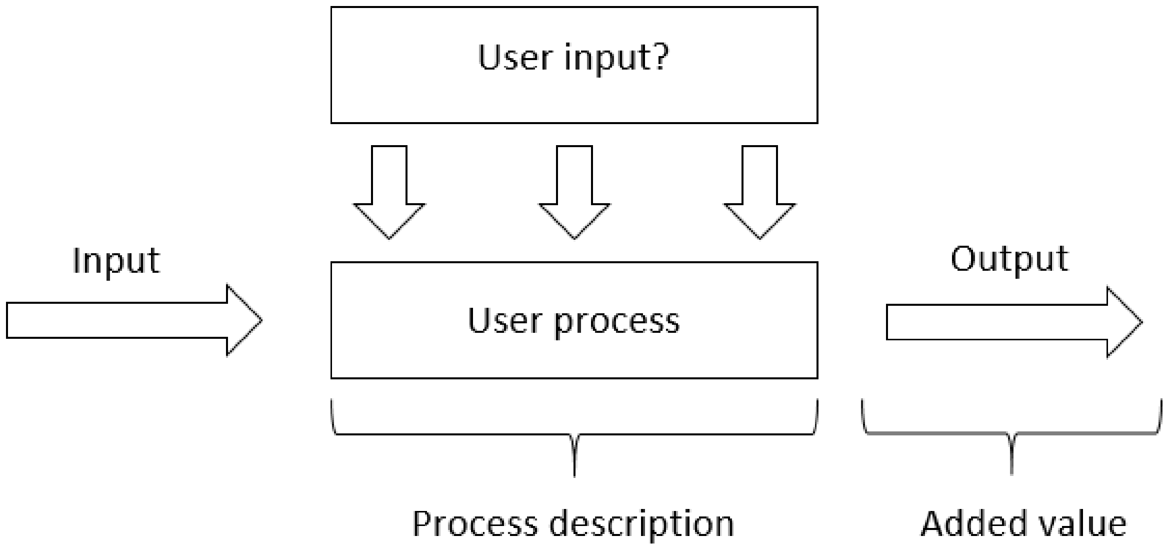

Figure 1. Research objectives framework

Main research question of the thesis:

How to create an end user process for the new operating system to distribution-center replenishment operation?

To be able to create a comprehensive user process / process description, it is required to find results to the following sub-questions:

1. *How the quality of distribution center-replenishment process should be measured?*

2. *What are the main processes of distribution-center replenishment operation, from the replenisher's point of view, to ensure effective inventory management?*

3. *What actions are required from the replenisher to different inputs in replenishment system, to achieve the set objectives?*

4. *What kind of added value does the new process create?*

The sub-questions are closely related to the main objective of research and supports process development in future as well. Additionally, the sub-questions create more theoretical structure for the thesis.

1.2 Conceptual Framework

The conceptual framework of this thesis is outlined below in Figure 2. The key message of conceptual framework is that the quality processes will lead to improved inventory management. This study focuses in implementation of a new process in the context of inventory management. The framework lies on the prediction that an effective process quality assessment and management creates quality to the process which leads to creation of added value. Added value comes from improved inventory management processes. For instance, added value can be improved service level throughout improved replenishment processes. This development chain is studied under the context of inventory management.

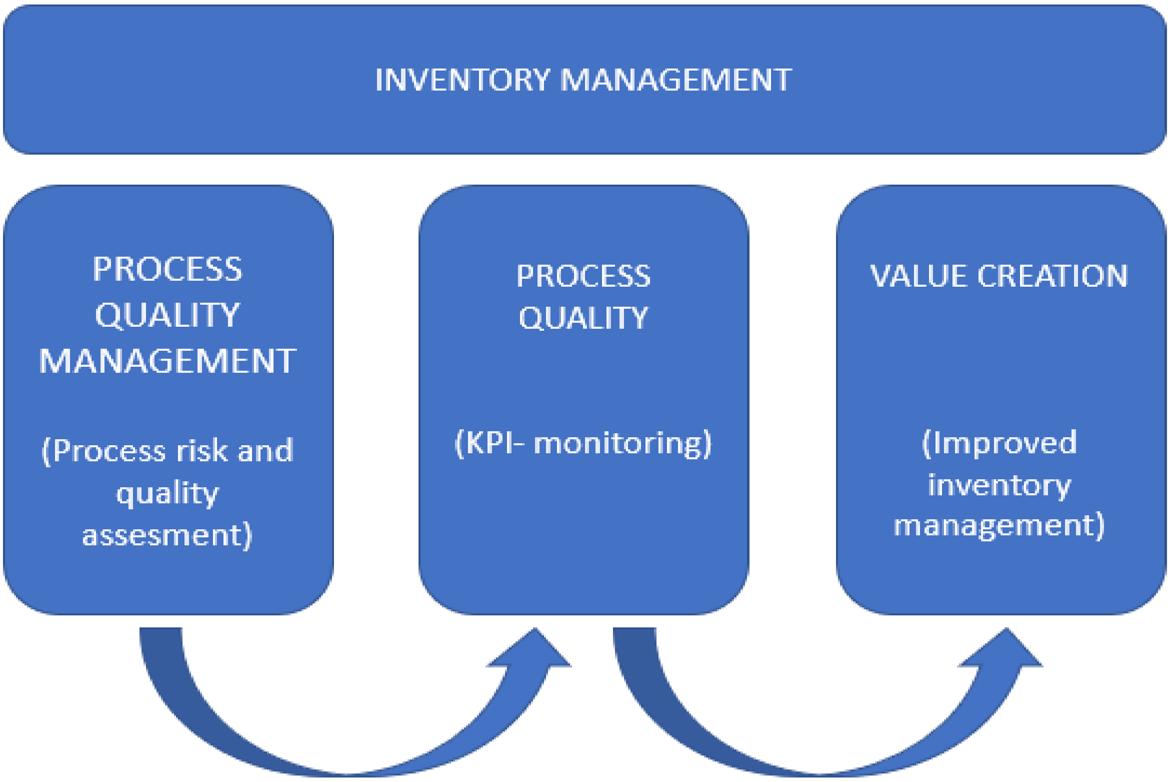

Figure 2. Conceptual framework of the thesis.

In this thesis inventory management is studied from retail business point of view, and the focus is in the demand forecasting and replenishment processes. The process quality management is conducted throughout process risk assessment and further in quality assessment. Process quality is concerned to analyzed by measuring how well the process meets the set objectives. Process quality can be measured by key performance indicators (KPI). Conceptual framework outlines that a well conducted process quality management will eventually lead towards process quality which creates value to inventory management processes.

1.3 Definitions of Key Concepts

This chapter defines all the key concepts of the thesis. The definitions are relevant for the study and defined in perspective of the context relying on academic literature and internal terms used in the case company. The concepts are further discussed in the theoretical and empirical part of the thesis.

Inventory

An inventory can be referred by several meanings. It can refer to stock on hand of materials at a specific time, or it can refer to itemized list of physical assets. Usually inventory refers to the value of stock of goods owned by organization at specific time. (Tersine, 1994, p. 3). In the context of this study, inventory mainly refers to the value of stocks of goods owned by case company at specific time. Even though, inventory can also mean the value of one item or specific category owned by case company at specific time.

Inventory Management

Managing inventories can be defined by opening up the properties of inventory, which are demands, replenishments, constraints and costs. Demands are units taken from inventory, replenishments are units put into inventory, constraints are all limitations appointed by management or general demand situation for instance. Costs are all costs for either keeping or not to keeping inventory. (Tersine, 1994, p.12). In other words, inventory management consists of managing all properties of inventory efficiently. The relevant objective of the inventory management is minimizing the costs.

Process

A process is a chain of different actions which can be related to almost any operation of business. A process can be considered in a few ways. First, a progression, in which company defines objective to aspire, and the process itself is the progression-path towards the objective. Second way to see the process is the chain of actions in which different actions are repeated continually and inputs and outputs are defined. (Laamanen 2005, p. 151-153). This context refers process as a second definition, in which focus is on actions and inputs and outputs of repeating process.

Process Quality

Process quality refers to the coherency of the process to the requirements and expectations set in the process definition (Guceglioglu, A. S. & Demirors, O., 2011). In other words, process quality can be called process performance. In this context, process quality concerns how well the output of process meets the general quality / performance requirements of the process.

Value Creation

Value creation can be defined as a completion of multiple actions which increment the value of goods offered as a whole. Companies today spotlight value creation not only a stakeholder but as well as customers. (Business Dictionary, 2018). In this context value creation refers to value created from replenishment process to stakeholders and further to customers.

Replenisher

In this study, the term replenisher refers to the end user of the distribution center replenishment process. User process created as a result of this study, is for supporting replenisher's process training. The replenisher has high influence on efficient inventory management by its actions and decisions.

Distribution Center Replenishment Process

The key function of the process is to create purchase orders from suppliers to warehouse. Objective of the process is to provide a required service level of goods for stores nationwide. For instance, the process includes forecasting, order setup, delivery monitoring. The process also consists of multiple other sub-processes which are studied more comprehensively later in thesis.

Case Company

The case company in this study is an employer of the researcher and this study is executed for the company. The case company is a large Finnish retailer.

Service Provider

A service provider in this study mainly refers to a company which provides the information system / software for new process to be implemented. Service provider, as can be expected, is on key role in implementation of new replenishment process.

1.4 Delimitations

Limitations of the empirical part of the study will determine the focus of the theory as well. Delimitations of this study inside the case company are defined at first on the divisional level, secondly on the departmental level inside the divisions. At least the limitations are defined especially inside the replenishment process. In order to understand delimitations of case study, it is relevant to describe the general view of the case company's material management and purchasing operation. Sourcing division is a separate department, which manages supplier relationships and contract negotiations for instance. Sourcing perspective is left out of this research. Additionally, assortment and space management are separate division as well, it is left out of this research also. Moreover, perspective of this study is on supply chain management operation.

At first, there is two operationally separated DC-replenishment departments. One department is responsible for consumer goods and the other for groceries replenishment. This study focuses only on groceries DC replenishment. Secondly, it is important to separate distribution-center -replenishment and store -replenishment operations from each other. This study focuses mainly on the DC-replenishment process. Store replenishment is responsible for creating orders and ensuring material flow from DC to stores nationwide. Moreover, DC replenishment is responsible for creating purchase orders from suppliers to DC. The most important responsibility of DC-replenishment operation is to provide best possible service level of goods for the stores nationwide.

Considering limitations inside the groceries DC-replenishment process, the focus of the study will only be in new replenishment system. Focus is in the process and what are the actions and decisions required from replenisher for different inputs. Also, what are the outputs created from different actions of replenisher. To sum up this delimitation of the empirical part, the study concerns only an implementation of new groceries DC replenishment process. Hence, store replenishment is essential part of forecasting development which directly affects to DC-replenishment and forecasting as well. Moreover, these details will be presented more comprehensively in the case company presentation.

It is decided not to use companies' names in this thesis. Instead of real names, the following terms are used to be able to describe the study and processes: "case company", "service provider" and "replenishment system". These terms were defined in the definitions of key concepts in Chapter 1.3. As said, the empirical part mostly determines delimitations of the study. Because of the focusing in process, the theory is delimited to focus in process. Process as a phenomenon will be studied from a few of the most relevant viewpoints, for instance, from process quality measurement and process risk management viewpoints. Additionally, because the DC-replenishment process has a high impact for inventory management, it is considered as a context of this study. It is beneficial to perceive the key elements of inventory and material management especially on retail field of business.

1.5 Structure of the Thesis

The research consists of theoretical and empirical part. Theory relies on main topics of the research, which are inventory and material management and process quality. Theory is gathered mainly from previous academic literature. The theoretical part is structured in a way that it supports further the empirical part of the thesis. The empirical part is to be created by utilizing qualitative case study methods and focus is on seeking answers for sub-questions in order to define user process as a one key result of the study. The data for empirical studies is gathered mainly from case company's internal sources. Additionally, stakeholder interviews are one of the important sources of valid information. Moreover, a lot of data and thoughts are gathered purely by observing case company's internal sources and by attending project meetings for instance. It can be argued that empirical data to be collected and researched is relatively wide-spread. Collecting the data requires observing, interviewing and going through case company's internal data.

In the first chapter the structure of thesis and research objectives are introduced. The second chapter presents the inventory and material management literature. Since inventory management is the context of this thesis the chapter provides overall insight for managing retail industry inventories. Additionally, the order-to-delivery process and demand forecasting are studied. Hence, the second chapter is all about general view of context of this study instead of focusing to precise details. The third chapter presents literature related to managing quality of business processes. Quality of process is concerned from process risk and quality assessment point of view and the key performance indicators are studied as well. The fourth chapter describes research methodology and data collection methods of this thesis. The fifth chapter is the empirical part of the thesis and it includes case company presentation, and the answers to the research questions are strived. Findings are summarized in the fifth chapter as well. The sixth chapter includes discussion and conclusion part of the thesis, and additionally further research possibilities are discussed.

2 Inventory and Material Management

This chapter focuses on literature relating to the features of retail inventory management on a general level. The objective is to describe the context of this research, hence not to dive into most precise details. Additionally, objective of this chapter is not to study all inventory management fundamentals, since the focus of the thesis is in the process management, and thus, there are relevant themes which are required to study in context of the research. In this chapter, the principles of inventories and the two schools of demand forecasting are studied.

2.1 Principles of Inventory Management on Retail Industry

Managing inventories are extremely valuable especially on retail industry. End customer's increasing requirements are pushing retailers towards lower prices and efficiency in all costs (Hubner et al., 2013, p. 513). In order to stay competitive and keep growing, inventory management has to be under control. According to Tersine (1994) effective material management can have impact for the finance, production and marketing function of any organization. The objective of inventory management is to have right number of products in the right place at the right time (Ehrenthal et al., 2014, p. 527; Tersine, 1994, p. 20). Furthermore, retailers lose sales because of their incapability to manage replenishment and demand, despite the forecasting methods are improving all the time (Ehrenthal et al., 2014, p. 527; Agrawal, N. & Smith, S., 2009; Friend, S. Walker, P. 2001, p. 133). "It is estimated that 8% of items customer come to buy are out of stock, and that a third of all goods are sold at marked-down prices" (Friend, S. & Walker, P., 2001, p.133).

The ultimate problem with inventories is that the inventories tie up money. Traditionally inventories have been concerned only as an unavoidable problem since management focus has been on sales and other more profitable factors. Large portion of companies' total assets are tied up into inventory, which can create negative cash flow and limit expansion of company. (Tersine, 1994, p.20; Chikan, 2007). Furthermore, competent inventory management frees up cash to more profitable operations. However, Chikan

(2007, p. 54) points out that “zero inventory” is not possible by any means. Efficient inventory management is about making compromises and balancing between excess stock or decreasing availability percentage. For instance, by ordering frequently it decreases inventory level but increases shipping costs and other uncertainty aspects. On the other hand, if orders are created less frequently the shipping costs decreases due the larger batches sizes hence, inventory level and cost increases. (Agrawal, N. & Smith, S., 2009, p. 21). In other words, inventory management challenges evolve from mismatch between supply and demand which can be analyzed with expected costs of excess stock and out of stock situations. (Choi, T. & Chiu, C., 2012, p. 1).

Are the inventories only a necessity or can they be utilized somehow? Chikan (2007) introduces a paradigm for the new roles of inventories, which seeks to extend the viewpoint of inventories away only from traditional cost focus. The paradigm argues that inventories can be seen as a more influential element of companies’ strategies. Chikan (2007, p. 58-60) points out three main points of new roles of inventory management:

1. Inventories as contributors to value creation
2. Inventories as means of flexibility
3. Inventories as means of control

The first point, inventories as contributors to value creation, looks inventories from networking point of view. Element of total inventory of two companies can be called relationship inventory. Companies are in partnership. However, the level of utilizing inventories are related the condition of each relationship. The second point, inventories as means of flexibility, is created due increased process orientation and vertical integration brings each process-stage closer to each other. For instance, the determination of which levels of stocks are kept, has direct impact for customer service level provided. The third point, inventories as means of control, introduces ratio of input and output of inventories of manufacturing. It can indicate overall situation of demand and supply. Further, in countries where inventory ratio is low, companies’ inventories are higher. This can be called oversupply condition. On the other hand, when ratio is high, scenario can be described, easy to sell but hard to buy. (Chikan, 2007, p. 58-60). Moreover, it is clear that inventories these days hold much more influence and strategic importance than decades ago.

Considering the variation of inventory costs, they can be divided to purchase cost, order setup cost, holding cost and stockout cost. In this study, the focus is on order setup cost and holding cost. Order setup cost includes for instance the making purchasing orders and following up orders. Order cost vary typically with the number of orders placed instead of size of the order. Holding cost can be defined as maintaining a physical investment in storage. (Tersine, 1994, p.14). The reason to focus a set up and holding cost, is that the DC replenishment operations includes creating and monitoring orders, and additionally it effects directly to holding cost as a result of inventory levels. Furthermore, cost of under stock should be analyzed as well. (Choi, T. & Chiu, C., 2012, p. 1) Hence, it can be argued that analyzing the costs of under stock can be difficult to analyze. Considering a retail inventory management and usually high volumes of goods. It can be argued that relevance of inventory emphasizes especially products with small inventory turnover. If the demand is not at the expected level, then the excess stock actualizes.

Retailers have thousands of different products in category, customer base is broad, and the number of suppliers is high as well. Therefore, it is vital to consider internal variation of specific target group to avoid any false presumptions. (Sakki, J., 2009, p. 89). For inventory control ABC and XYZ analysis are methods for classification. ABC analysis classifies items based on sales and quantities (Scholz-Reiter et al., 2009, p. 445). According to Sakki (2009) products can be classified by following percentage:

A – products = first 50% of sales volume
B – products = next 30% of sales volume
C – products = next 18% of sales volume
D – products = no sales

One of the most common rule for classification is found by Vilfredo Pareto a century ago. The rule is called Pareto 20/80, in which assumption is that 80% of products holds only 20% of turnover, and 20% of products creates 80% of profit. (Sakki, J., 2009, p. 90). XYZ analysis supports ABC analysis and it demonstrates 20/80 rule (Scholz-Reiter et al., 2009; Sakki, J, 2009). For instance, XYZ classification can be following:

X – products = holds 50% of all transactions

Y – products = holds 30% of transactions

Z – products = holds 18% of transactions

zz – products = holds 2 % of transactions

z0 – products = no transactions

For inventory management development the results can be interpret like the X-products holds most steady demand. Therefore, for X products the inventory turnover can be maximized. On the other hand, zz-products should be critically evaluated from category management viewpoint. ABC and XYZ analysis can be exploited together when both methods fulfils each other. (Sakki, J. 2009, 96).

Inventory distribution systems can be divided into two methods, push and pull methods. Pull system refers to pulling inventory itself, as an example, each distribution center / location orders for its own requirements. In push system, the central distribution center determines the needs of locations and operates by pushing the inventory to the local centers. Common characteristic of pull inventory is that each location draws stock from central distribution center. Furthermore, each location is independent and doesn't regard other locations inventory situation when placing the orders. Usually each location maintains own safety stock. (Tersine, 1994, p. 460). Hence, Fernie et al. (2010) argues that retail supply chain management has been developed towards demand driven inventory management in which distribution is shifted from push to a pull inventory.

The pull inventory system reacts to the demand without anticipation and distribution center does not know about upcoming replenishment orders in advance. This might lead to dramatic stock depletions because demand can impose simultaneously and unexpectedly from multiple locations. Push inventory systems are opposite to pull systems. Replenishments are centrally planned and allocated with consideration of supply for all locations. In order to conduct locational stock replenishments, the stock status of total location network is used. The benefits of the push system are that the replenishments can be sent directly to each location from factory / supplier if there is no need for distribution centers activities. The pull system might be the most beneficial if material and capacity is quickly ready when needed. The push system is the most appropriate when material production or supplier requires longer lead times. (Tersine, 1994, p. 461). Considering push and pull inventories further, it can be argued that in retail industry both methods can be utilized. For instance, by utilizing broad store location network, products with excess stock in distribution center can be pushed to stores to avoid requirement of scrapping the excess stock.

When the replenishment is studied, one key question is when to reorder and what quantity? Inventory models in general can be divided into stochastic and deterministic models. (Chen, S. 2011, p. 3856). There are multiple different types of inventory replenishment strategies, for instance Re-order point (ROP) and Material resource planning (MRP). In addition, as discussed earlier, the EOQ is one of the most commonly exploited models for analyzing optimal value of ordering quantity. (Haneveld & Teunter, 1998, p. 173). The Re-order point (ROP) is a formula for managing timing of re-order and as method it is considered decentralized. (Suwanruji, P. Enns, S.T. 2006, p. 4607). Suwanruji & Enns argues that when supplier capacity to deliver is not restricted the ROP performs in the best way. Furthermore, the MRP is argued to perform best when demand appears to be seasonal. Hence, the MRP requires a high amount of data and it needs to be integrated to work functionally. (Suwanruji, P. Enns, S.T. 2006, p. 4610). Moreover, it can be argued that larger companies could exploit more than one inventory replenishment strategies, due to the variation of business operations.

2.2 Demand Forecasting

Demand forecasting is a highly effective component of supply chain, and forecasts play major role for instance in scheduling, resource planning and marketing functions as well. (Fildes, R. Goodwin, P. Lawrence, M. 2006, p. 351). Demand hasn't always been the driver of the retail supply chain. In the early days, retailers have been passive party in supply chain and goods have been allocated to the stores without necessity of actual demand. However, in these days, retailers tend to be controlling the whole supply chain and they are capable to react to the customer demand. (Fernie et al., 2010, p. 895). Challenge of demand forecasting affects all parties of supply chain.

(Finne & Kokkonen, 2005, p. 288). Considering supply chain from end to end it is always a very complex system as a whole. It comprises multiple separate units and variables, and therefore, all issues cannot be solved by analytical methods. (Shao & Lizhong. 2010; Hubner et al., 2013, p.513). Demand forecasting is a big part of inventory management and order-to-delivery process. According to Caniato, F. Kalchschmidt, M. Ronchi, S. (2010) there are two main viewpoints for forecasting in general, qualitative and quantitative forecasting. The quantitative forecasting refers to statistical analysis of data. The qualitative forecasting refers to more judgmental analysis which relies on professional expertise. (Caniato et al. 2010, p. 413).

Forecast can be determined as an extension of historical patterns based on future assumptions (Östring, P. 2003, p. 96). Demand forecasting is always based on available information, which is utilized for creating demand forecasts. However, traditionally retailers have determined forecast based on previous year sales. Hence, the method only shows what retailer has sold, not what could be sold. Therefore, by analyzing historical data more comprehensively the key information can be exploited, for instance, price, inventory levels, promotions, seasonality. If there are not available data for some product, then some similar product is used as a reference. These causal methods are more accurate than traditional forecasting methods. (Friend, S. & Walker, P., 2001, p.134). In addition, type of forecasted demand can be difficult to characterize (Li, X; Xu, X., 2017, p. 737). Fildes et al. (2006, p. 352) have listed the types of information available for creating forecasts. As it can be seen from the list below, there are multiple different sources of information to be used for demand forecasting.

- **Time series data –** at various levels of correlation for instance: past sales by product group, pack size, country, individual customer, quarter, month or week. Time series data requires cleaning from past special events or effects because of risk of distortion of statistical extrapolations.
- **Information on customers activities** – such as price promotions or delisting the products.
- **Information on other relevant variables** – such as weather forecasts, the timing of major sporting events and competitor's activities and sales.
- **Forecasts made on earlier periods –** supply chain companies commonly use a rolling forecast system where earlier forecasts are updated as the forecast period approaches

- **Statistical forecasts** – forecasts made by account managers on the basis of their contacts with customers and forecasts of the effects of price reductions derived from offline econometric models.
- **Information on errors** – associated with past forecasts which can provide feedback to the forecasters.

(Fildes et al. 2006, p. 352-353).

Considering the two schools of demand forecasting, there is probably not one and only correct way to forecast demand, Shao & Lizhong (2010) tries to combine qualitative knowledge with quantitative forecasting results in their study. Problems with qualitative forecasting usually concern inconsistency because of unsystematic judgements which might decrease forecast accuracy. Considering qualitative forecasting, possible problems arise mainly because of inflexibility and awareness of fluctuating situations, especially when the number of variables is high. Furthermore, qualitative forecasting is the most beneficial when exploited as a supportive method for quantitative forecasting. (Caniato et al. 2010, p. 414). However, in today's dynamic environment the combination of dynamic and analytical approaches is recommendable, hence the problem is how to conduct the combining of these two methods. (Baecke, P. De Baets, S. Vanderheyden, K. 2017, p. 85).

There is relatively a lot research related to combining two ways of forecasting. Baecke et al. (2017) have researched added value from integrating human judgement to statistical demand forecasting. Fildes et al. (2005) have researched improving the results of integrating qualitative and quantitative forecasts. Also, Chao & Lizhong (2010) and Caniato et al. (2010) have researched integrating the qualitative and quantitative methods in order to improve forecast accuracy. According to Caniato et al. (2010) the previous research has mainly focused in comparing qualitative and quantitative methods instead of creating real life implementation plan to integrating these forecasting methods. In order to create integrative model, Caniato et al. researched three step method which consists of three cycles: 1. towards quantitative model, 2. additional information from the field; and 3. integrating the quantitative model and the judgement process.

In the figure below, the integrated forecasting model can be seen, in which the field information is used to support qualitative forecast by for instance cleaning the weather effects from historical data to ensure validity of forecast. Then both forecasts are evaluated and compared in order to seek differences. The process of conducting the final forecast was centralized to reduce human inconsistency in result of final forecast. (Caniato et al. 2010, p.417-421). According to Caniato et al. as a result of the case research of integrated model, there was higher accuracy on forecasts and greater awareness and better control of forecasting systems. However, it can be argued that considering the case was related to Italian cement company, the model is not straightly comparable to retail industry because of lack of variables.

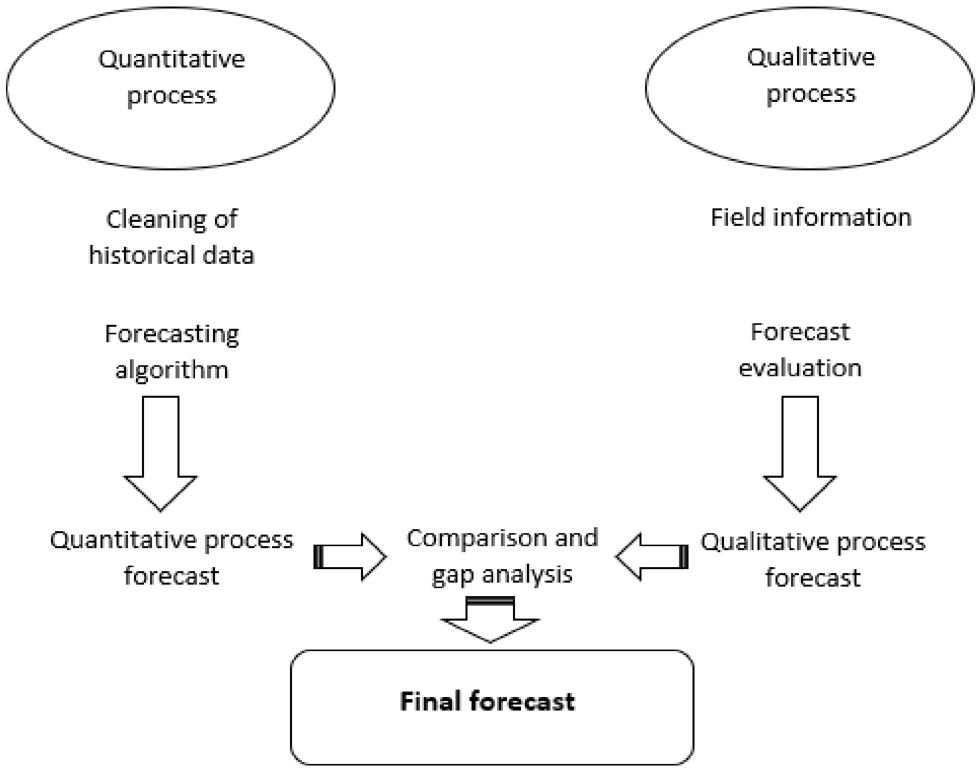

Figure 3. The final forecasting system. (Adapted from Caniato et al. 2010, p. 419).

Fildes et al. (2005) have identified characteristics of typical time series analysis:

- Regular patterns or relationships (e.g. trends, seasonality, stable relationships between advertising expenditure and sales)
- Irregular components arising from foreseeable events like promotions, either transitory or leading to non-reversionary changes in the medium term.
- Noise – which is unpredictable

(Fildes et al. 2005, p. 353).

If the judgmental forecasting is utilized as a regular component, it is not that accurate as quantitative forecasting method, because of human inadequate of processing the information from multiple sources. However, quantitative forecast cannot accurately provide forecast from irregular component. Therefore, the combination of qualitative and quantitative forecast could be more accurate. However, when conducting judgmental changes or adjustments to quantitative forecasts provided automatically by the system, there are risk of making unnecessary and damaging adjustments to qualitative forecast. Furthermore, when forecasters have adjusted the forecast, they have stronger believe on accuracy of the forecast. (Fildes et al. 2005, p. 354).

To achieve an optimal balance between human inputs and system's statistical forecast, according to Fildes et al. (2005) there are several reasons for why the most accurate forecasts could be expected. Human input can filter "noise" out of from statistical forecasts to increase accuracy. The best use of human forecaster's effort is to confine the attention of irregular component. Moreover, also Baecke et al. (2017) found out that the major problem with judgmental forecasting is overcompensated adjustments from human input. Furthermore, it is shown that beneficial results were achieved from integrative model. Integrative approach improved forecasting accuracy and gave insight about financial consequences as well. (Baecke et al. 2017, p. 95).

3 Managing Quality of Business Processes

At first this chapter determines the concept of business process. Later the process description and business process modeling are described. For the sake of clarity, in this chapter term process description refers to the term user process, which is used in other chapters in this research. Then the focus is in risk and quality assessment of risks in order to seek methods to quality assessment for empirical study. Lastly, the literature of process key performance indicator development is presented.

3.1 Concept of Business Process

As said, the focus of this research is on business process management, hence, inside the context of inventory management. First, to define a business process, it is a repeating series of functions and resources (input) which are converted to product (output) with the aim to achieve the set objective of specific business process. (Laamanen, 2005, p. 154; Ould, M., 2005, p. 32). Furthermore, process management can be defined as recognizing, modeling, evaluating and improvement of tools and knowledge. (Laamanen, 2005, p.154-155). Martin Ould (2005) defines process as a coherent set of activities carried out by collaborative group to achieve the set objective. According to Trkman (2010, p.126) the success of business process management is that the process continuously meets the pre-determined objectives. General core issue of processes is to evaluate whether the resources spend to the process are efficient enough compared to added value created from the process. In other words, operative efficiency is what processes are all about. (Laamanen, 2005, p.155).

Considering a process divided into parts, it consists of input, active process and output. Further, process usually holds a supplier and a customer. The customer can be internal or external. These parts create commonly used term SIPOC (supplier, input, process, output, customer). (Laamanen, 2005, p.153). Moreover, all processes include responsibilities which refer to a role, actors who carry out the required actions as determined by business rules. In addition, each role has props which are used to achieve responsibilities. Each role has interactions to collaborate. These concepts can be called RIVA: role, actor, action, interaction. (Ould, M., 2005. p. 32).

3.2 Process Description

Processes are described in order to help people to comprehend consequences of actions throughout the whole organization. (Laamanen 2005, p. 155). Furthermore, Laamanen (2005) argues that processes exist whether they are described or not. Therefore, processes should be described, to be able to manage and develop them. In order to describe the process, the process steps need to be captured and represented and formalized (Al Fedaghi & Alahmad, 2017). From the process management viewpoint, process description is essential because it allows people to comprehend what actions are required to obtain an efficient process. Processes play important role on companies' business functions and they allow systematic development. (Laamanen 2005, p.156, 161).

The figure below describes creating a functional operation system by utilizing process thinking methods. It can be seen that at first the core processes need to be identified before the creating process description. Furthermore, the figure provides insight concerning the importance of process description also in further development of the process. Continuous improvement is rendered vital for business development and therefore business process management applications should be exploited (Laamanen, 2005, p156; Hedge, 2007, p. 33). Furthermore, in accordance with the previous, especially processes which are managed by ERP system should not be interpreted as a static. Since the process is defined, the process should be improved continuously. (Quiescenti et al., 2006, p. 3798).

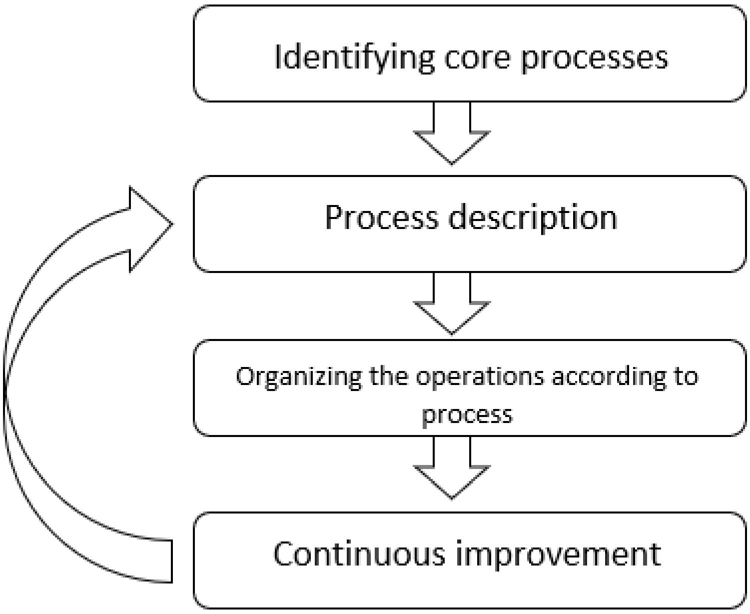

Figure 4. Development steps of operations system. (Adapted from Laamanen 2005, p. 156).

A process description includes for instance the describing of inputs, outputs and critical success factors of the specific process. (Laamanen, 2005, p. 161; Hedge, 2007, p. 31). Hedge (2007) outlines the process modeling steps as follows: prepare, model, validate. The preparing phase includes the defining of the process scope and customers and participants. Basically, the defining of the process scope requires defining the whole process. The modeling phase includes determining the initiating event, defining the output of the process, developing the process charts and determining the expectations from the process as well. The validating phase aims to ensure that what has been captured is in accordance with the actual process. (Hedge, 2007, p. 32). Below Laamanen has created a model for standardizing a process description which is possible to be adjusted in order to fit the needs of different organizations.

1. Limits of application
    - For what is the process exploited and what is left outside?
    - From where does the customer process begin and where does it end?
    - How the process planning is executed and how the efficiency is measured?

2. Customers, their needs and requirements?
    - Who are the customers and stakeholders of the process?

- What is the customer's process and what are the requirements they have?

3. Objective
   - What is the objective of the process (goal, function and mission) and how is the succeeding measured?
   - What are the critical steps on the way to accomplish the objective and how is the succeeding measured?

4. Inputs and outputs
   - What are the inputs and outputs of the process?
   - Who holds the information and how it is managed?

5. Process chart
   - What are the rough steps of the process?
   - What kind of process chart is it?

6. Responsibilities
   - What are the fundamental roles and the most relevant tasks and decisions related to the roles?
   - What are the teams related to the process and what are the most relevant tasks and rules?

(Laamanen, 2005, p. 160)

Laamanen (2005, p. 160), states that the process description should be presented in a way that it only includes rough steps of the process. Highly specific process descriptions are intended mostly on software development problem solving. In other words, the process description is supposed to support the understanding of the selected process. When the process description is created, the process should be captured from the passive process and described and further divided into events or core processes. The actual process controlling is conducted within an active process. The figure 5 is demonstrating the relationship between the process and its model. (Al Fedaghi & Alahmad, 2017).

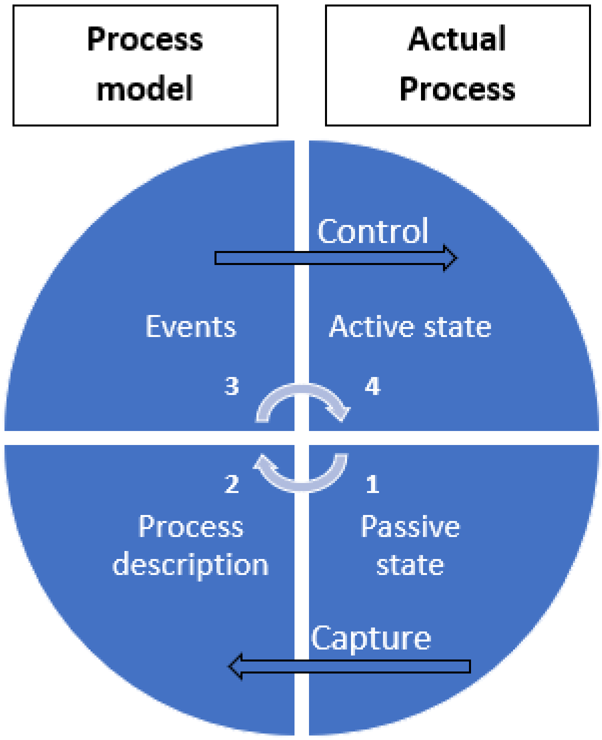

Figure 5. Relationship between actual process and process model. (Adapted from Al Fedaghi & Alahmad, 2017).

To be able to do a process description, it is important to recognize the critical steps and the core purpose of that specific process. Laamanen (2005, p. 166) argues that the purpose of the process can be perceived as follows:

1. Purpose of the process is to accomplish a task or a mission
2. Purpose of the process is to produce output
3. Purpose of the process is to produce benefits or to create an impact

When critical steps are identified, Hedge (2007) proposes to conduct the steps in several iterations in which all craziest ideas are gathered a side. After completing the identification of the steps, the earlier gathered ideas should be reviewed again (Hedge, 2007, p. 32). Furthermore, the critical steps of the process can be defined as a bottleneck. These steps require a lot of expertise and resources, but on the other hand, these steps are creating plenty of added value for the process. One common feature of the critical steps is that they hold a lot of risks. Recognizing the critical steps is crucial because the developing of critical steps can be much more effective on process performance comparing to developing non-critical process steps. (Laamanen, 2005,

p. 168). Furthermore, critical steps must be identified as well because if process includes manual steps, usually employees tend to create their own ways to perform that specific task. These "own" ways can be recognized and improved to achieve efficient and coherent process description. (Hedge, 2007, p. 33).

3.3 Process Risk and Quality Assessment

Processes are an asset for companies, therefore process development and continuous improvement have a great impact for success of organizations (Guceglioglu & Demirors, 2011, p.112). In order to improve processes, the risks and bottlenecks of the process need to be identified. Managing and communicating the risks are valuable tasks in economy today. Risk management is crucial for process effectiveness and reliability specially on a long term.

Companies use multiple ways to identify risks. The means are for example surveys, workshops and risk factors. Furthermore, after risks are identified, each risk should be analyzed concerning potential consequence and probability of occurring. A risk heat map is utilized in the process of risk assessment. Risk heat map can be a very useful tool for supporting the communication of risks. (Mckay, 2016, p. 35-36). Mckay (2016) describes risk heat map as a tool for visualizing the big picture of risks. Heat map provides a holistic view of risks and takes into account likelihood and impact of the entity within organization. Moreover, risk heat map is two-dimensional representation of data, in which results are presented by colors. Colors can be coded to be visual traffic light variation from green to red for instance. (Mckay, 2016, p.37).

Heat map can be utilized in the visualization of large quantities of data in order to map out and to identify individual values in a data matrix. In addition, by using different colors by representation values in the heat map, different patterns are much easier to detect, which could otherwise be missed. (Dupin-Bryant et al., 2014). Heat maps can be used to provide an effective visual summary of possible risks, and it can be used the most effectively as a presentation tool as well. By using heat maps, large quantities can be communicated effectively and fast. Therefore, heat map is an effective tool to make sense of large number of columns of numbers. However, when utilizing heat map in risk assessment, it is vital to carefully design the claims / questions for survey, to be able to adapt the results for your company requirements and business terms. (Mckay, 2016, p.37).

Root caused analysis (RCA), is a relatively widely spread risk identifying method. Additionally, it is useful for understanding and solving a problem. The RCA is mainly used when companies are trying to solve and answer questions of why the problem occurred and what has caused the risk or problem. Furthermore, the RCA should be utilized to identify the origin of a problem and the primary cause of the problem by using the following three steps;

1. Determine what happened
2. Determine why it happened
3. Figure out what to do to reduce the likelihood that it will happen again

(Zwainy & Mezher, 2018).

To cover the background of quality management, the most known quality management philosophies are Deming's, Juran's and Crosby's philosophies. Focus of Deming's philosophy is to develop product or service quality by reducing uncertainty and variation in the planning and manufacturing processes. Moreover, in Deming's thinking the variation is the reason for poor quality. In order to reduce variation Deming presented a continuous process cycle which eventually leads to improved process quality. (Evans, J. & Lindsay, W., 1996, p. 59-61). Joseph Juran's philosophy focuses on three key points which are called a quality trilogy: quality planning, quality control and quality improvement. Quality planning is the process of identifying the quality goals. Quality control stage is the process of annexing the processes and quality objectives. Quality improvement stage is the process towards achieving the unforeseen performance. (Evans, J. & Lindsay, W., 1996, p. 83). Philip Crosby's philosophy is based on "absolutes of quality management" which stands for the following five key points:

1. Quality means conformance to requirements, not elegance.
2. There is no such thing as a quality problem.
3. There is no such thing as the economics of quality; doing the job right the first time is always cheaper.

4. The only performance measurement is the cost of quality, which is the expense of non-conformance.
5. The only performance standard is “Zero Defects”.

(Evans, J. & Lindsay, W., 1996, p. 85).

As said, there are multiple quality management theories, but the most commonly known probably is Deming’s wheel developed in 1950 by W. Edwards Deming’s. Based on Deming’s wheel, a further development was PDCA cycle (plan, do, check, act) evolved by Japanese executives in 1951. Furthermore, Deming introduced PDSA cycle (plan, do, study, act) in 1993, in which a checking step is changed to a study step, to be able to study what have been learned. Deming’s wheel studies quality management from product development point of view. The first step is to design the product, the second step is to test the product in production line or in the laboratory, and the third step is to put the product on a market. The fourth step is to conduct market research to test how the product works in practice. The fifth step is to re-design the product based on consumer feedback from step four and then continue around the cycle (Moen, R., 2010, p. 1-5).

The PDCA cycle includes four steps: plan, do, check and action. The first step, plan, consists of determining objectives and methods to reach the set goals. The second step, do, is about implementation of the work. The third step, check, focuses on checking the effects and results of implementation. The fourth and final step of the cycle is to take an appropriate action for previous findings. (Moen, R., 2010, p. 5). The PDSA cycle is a standardized model for improvement. The PDSA (plan, do, study, act) is seeking answers for the following questions:

1. What are we trying to accomplish?
2. How will we know that change is improvement?
3. What change can we make that will result in improvement?

(Moen, R., 2010, p. 8)

According to (Moen, R. 2010) in the PDSA cycle the first step, plan, consists of setting objective and hypothesis of results. It also includes planning to carry out the cycle. The second step, do, includes carrying out the plan, problem documentation and observing and start of analysis of data. The third step, study, focuses on completing data analysis started in the second step. The studying part also includes comparison of results for predictions gathered in the first step and most importantly it summarizes what was learned. The fourth step, act, is about conducting the required changes. (Moen, R., 2010, p. 8).

Guceglioglu & Demirors (2011) argue that the PDCA-cycle focuses on measuring process attributes during the process but conducts evaluation afterwards. The viewpoint of the PDCA is to measure time, cost and product quality. In order to analyze process quality Guceglioglu & Demirors (2011) have created a process quality measurement model, PQMM. The process quality attributes provide valuable insight for process improvement, due to the measurement which can be done before execution of the process. The PQMM is developed in-line between the process and software. The viewpoint of quality measurement on the PQMM is maintainability, reliability, functionality and usability. The PQMM should support its user to find strengths and weaknesses before deployment of software. (Guceglioglu & Demirors, 2011, p.112). In the figure below, there can be seen a process quality management model, in which the focus is on four process areas.

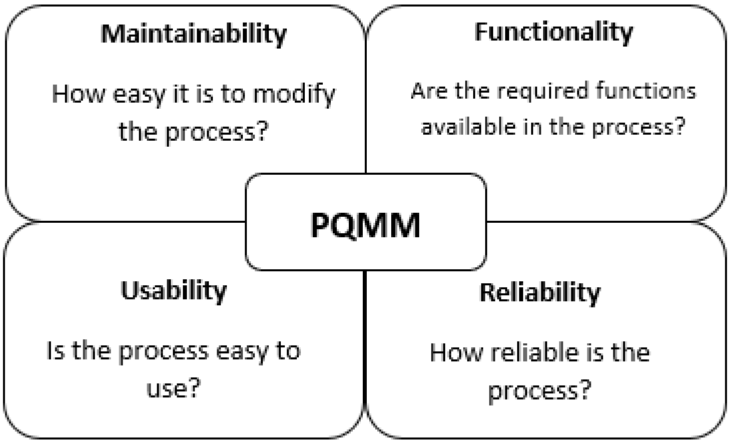

Figure 6. The PQMM model (Adapted from Guceglioglu & Demirors 2011, p. 114).

PQMM uses preventive approach for process improvement, by measuring quality attributes by using process definitions with their inputs, activities and outputs (Guceglioglu & Demirors 2011, p. 113). According to (Guceglioglu & Demirors 2011, p. 112) process quality defines the coherency of the process to the requirements and expectations set in the process definition. In other words, process quality can be called process performance. In order to assess quality of the process, general quality requirements need to be defined. Additionally, to evaluate process performance, the quality factors and metrics need to be defined. (Kedad & Loucopoulos, 2011, p. 1). According to Laamanen (2005, p. 169) in measuring process performance the focus should be directed to features which are critical for observed process. Kedad & Loucopoulos (2011) argue that the quality of business process needs to be considered already at the requirement engineering stage, when quality requirements are defined together with comparable quality factors that are used to evaluate them. Furthermore, dealing with quality requirements needs at first the identifying and redefining quality requirements, then defining a quality factors and metrics on the business process model and then the evaluating and analyzing is executed on the business process model (Kedad & Loucopoulos, 2011, p. 4).

Quality assessment of business processes is relatively widely researched topic. There are several conceptual models developed, to support process performance / quality assessment. Kedad & Loucopoulos (2011) developed a conceptual framework for business process quality evaluation. Framework differs from previous studies, because it seeks to unite two separate approaches into one. Kedad & Loucopoulos (2011) argue, that previous studies mainly concern either general principles or guidelines of quality, and information system related studies often concern the software quality, instead of focusing the quality of the actual process itself. Basically, the research seeks to bridge a gap between business viewpoint and technical viewpoint of business process quality. In the figure below, the gap is demonstrated between two different viewpoints for quality assessment.

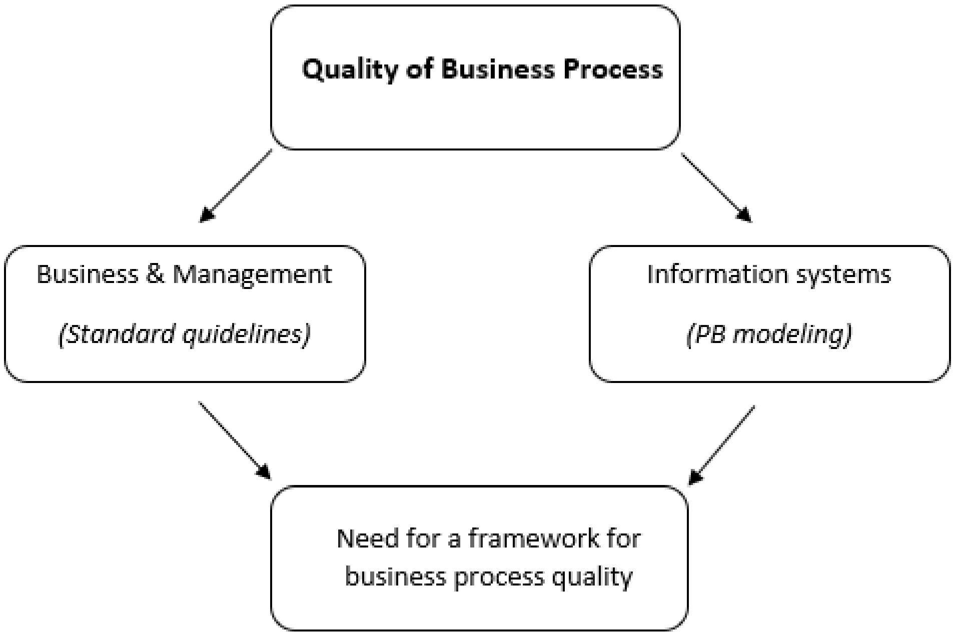

Figure 7. Two viewpoints for quality assessment (Adapted from Kedad & Loucopoulos, 2011, p. 3).

In the figure, it can be considered that the business & management viewpoint mainly focuses on general principles of quality. The information system viewpoint focuses on quality of model rather than business process itself (Kedad & Loucopoulos, 2011). Factors to be measured need to be carefully selected. Factors which have strategic influence should be under permanent measurement. (Laamanen, 2005, p.169). Kedad & Loucopoulos (2011) faced similar issues in assessing quality of business process efficiently:

- What are the quality factors and associated metrics relevant for business process?
- What are the quality services that allow the effective evaluation of these factors and metrics?
- Independently from a specific application, how to capture a quality information at metamodel level?
- Considering a specific application, what are the appropriate quality services allowing to achieve the quality requirements?

(Kedad & Loucopoulos, 2011, p. 3)

Strategic factors of the process can be, for instance, costs of the process or service level. Moreover, to be able to assess process performance reliably and coherently, it is vital to identify external factors as well. The external factors can be, for instance, a bankruptcy of the supplier or weather phenomenon. A common divisor of external factors is, that the process itself doesn't affect these factors at all. However, these factors affect directly to performance of the process. (Laamanen, 2005, p. 169). The figure below illustrates the process performance measurement.

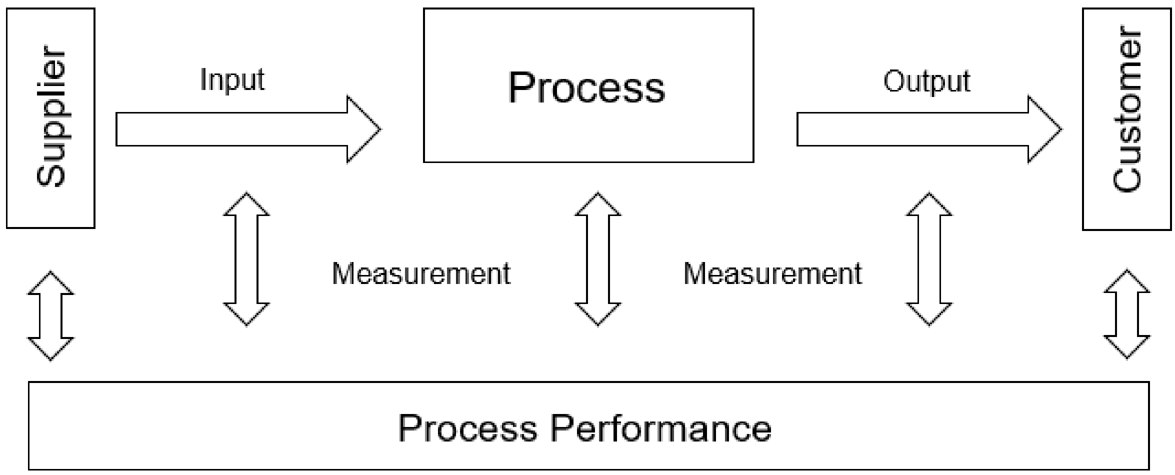

Figure 8. Process performance measurement. (Adapted from Laamanen, 2005, p. 169).

In the process performance figure, it can be seen that the measurement is required at all stages of the process. All stages consist of input and output and it should be measured with selected meters and models.

3.4 Developing a Process KPI Measurement

Key performance indicators (KPI) is a commonly exploited method or instrument for measuring results of conducted actions in processes. The objectives of KPIs are to help making beneficial decisions about direction of processes. Furthermore, KPIs can be exploited to detect upcoming changes in system performance to be able to create appropriate counter measures. (Stricker et al., 2017, p. 5537).

In order to drive improvement for KPI's of any organization, it is required to determine organizations' core activities, selecting the meaningful indicators to measure performance in the core activities, and indicating the variation of selected indicators which are significant for the measured process. (Elliot, C. Mcullagh, C. Brydon, M. Zwi, K., 2018, p. 493). Furthermore, Laamanen (2005) divides KPIs development to four steps: 1. identifying what to measure, 2. selecting a method for presenting the measured KPIs, 3. agreeing objectives, communication and monitoring methods, 4. assessing the KPI's validity and improving. More comprehensively it is vital to go through the measurement plan to build the valid meters and specially to allocate the responsibilities. The below question list is to be answered as a measurement plan when creating KPIs.

1 Scope
   - What is the measured subject and what is the unit of measurement?
   - Which strategy, process or critical step the meter is related to?
   - Why the specific meter is used, what is the benefit from the measurement?
2 Data collection
   - What data is collected?
   - From where and how the data is collected?
   - When and how often the data is collected?
   - How the validity and reliability is ensured? (Sample, calibration, error reports)
3 Integrating data and reporting the results
   - How the data is integrated?
   - How the data is presented?
   - For who and how often the results are shared?
4 Responsibilities
   - Who collects, integrates, and reports the data?
   - Who analyses the results and does the conclusions and starts the change process?
   - Who sets the objectives and based on what?

(Laamanen, 2005, p. 353).

In order to narrow KPI subject towards the core subject of this thesis, this chapter aims to seek methods for determining what to measure to provide valid and informative KPI data. The main commonly stated challenge relating to KPI systems is about selecting the most relevant KPIs for the specific process. (Stricker, N. Echsler, M. Lanza, G., 2017, p. 5537). According to Piatt, J. (2012) there are five rules for selecting best KPIs to be able drive operational development:

1. Focus on critical few, instead of trivial many
2. Ensure that selected KPIs drive toward your strategic intent
3. Ensure that KPIs are relatable on all levels of the organisation

4. Ensure that data of KPIs are valid
5. Ensure that controllable KPIs are selected

By focusing on only critical few KPIs, a company avoids the situation when too many factors are measured and therefore no result is meaningful for process development. On the other words, number of KPIs should be as high as necessary but as low as possible. (Piatt, 2012, p. 2; Stricker et al., 2017, p. 5538). Figure below describes tradeoff between number of KPIs in consideration of simplicity to utilize the results and information received from the data.

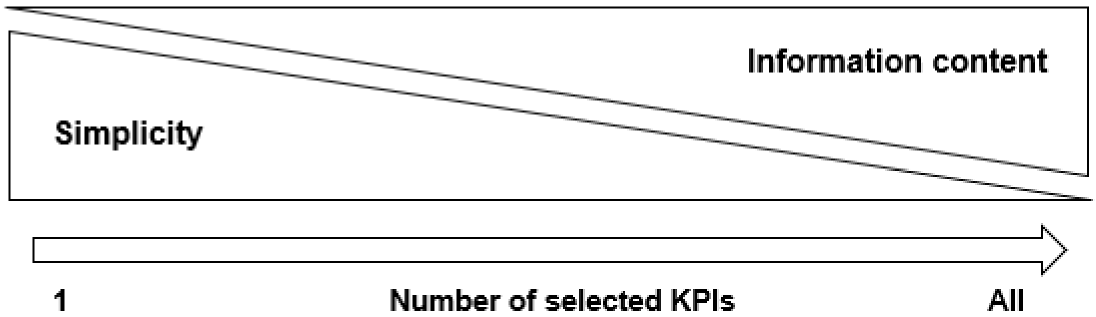

Figure 9. Tradeoff between information content and simplicity. (Adapted from Stricker et al., 2017, p. 5540).

KPIs should not only measure the performance itself. The focus should be on measuring performance only towards the strategic objectives of the company. It is important to ensure that information is relatable for all levels at the organization, because when metrics are easy to interpret and correctly presented for each level in organization, then improvements can be achieved. Data reliability is a key for results. Therefore, data needs to be validated continuously. The control of KPI analysis and development have to be under control. The specialist who is set to be responsible for KPIs has to be able to control all the data. (Piatt, 2012, p. 2).

4 Research Methodology and Data Collection

This chapter describes and determines the research methods which are used for this thesis and how the required data is gathered. In addition, reasons for selecting the specific methods are explained further. For instance, reasons for selecting a case study method and qualitative approach for this thesis are described.

4.1 Research Method

This research is a qualitative case study. Case study was a suitable method for this research because the topic of the research is to determine one specific process by exploiting more than one research method. Case study includes detailed information of a single case. Alternatively, a small group of cases which are related to each other can be studied intensively in a case study. Therefore, research material is required to be studied comprehensively but detailed (Hirsjärvi et al., 2005, p. 155.) Typically, as a target group of case study is a single person, group or even community. Moreover, the focus is on process effects, or how the process is affected by the target group. Case study can be studied in real and natural situations, where case is compared to its environment. In case study, data and research material are typically gathered by utilizing several different methods. Furthermore, methods can be observing, interviewing and researching different kinds of documents. In other words, objective of a case study can usually be to describe a certain phenomenon. (Hirsjärvi, et al., 2005, p. 125).

In addition, since I have been working in the case company, one key method for research and empirical data collection have been an action research. The primary objective of an action research is to solve a practical problem by researcher, and besides that, as a secondary objective, to gather information which has scientific value. Furthermore, action research can be determined as a self-reflective method in which participants exploit social interaction to comprehend and improve own methods. (Järvinen, P. Järvinen, A., 2012, p. 127). Susman & Evered describes the process of an action research in the figure below.

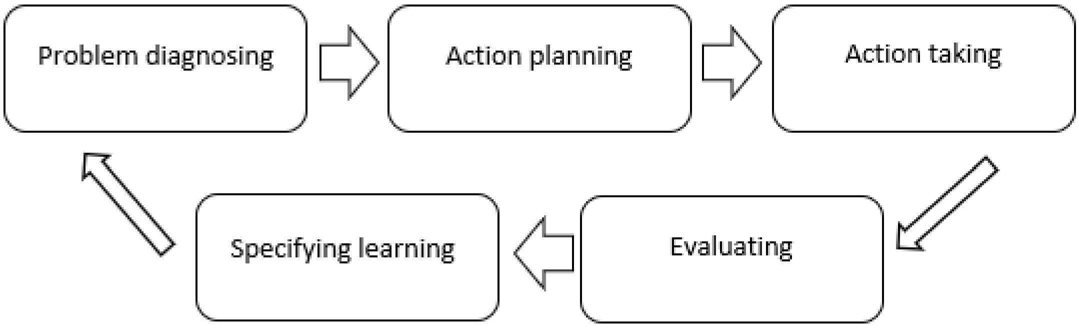

Figure 10. Process of action research. (Adapted from Susman & Evered, 1978. p. 588)

Figure describes an action research as a cyclic process which can be repeated multiple times during the research. The cycle starts from problem identification and continues through planning and execution to evaluating, and ends up in learning and further evaluation. The benefits of action research are looking into future and research objectives are determined in the basis of specific process. (Järvinen, P. Järvinen, A., 2012, p. 129). Furthermore, action research method is exploited in practice in researcher's daily work and broad information base for supply chain management and replenishment processes were conducted.

For this research qualitative method was chosen, for several reasons. The nature of data related to describing the user process is not suitable for quantitative analysis. Additionally, data collection was a continuous action research which is sub-method of qualitative research. Action research is determined comprehensively in the data collection chapter. A qualitative study seeks to describe a phenomenon of a real life, from multiple viewpoints. According to Hirsjärvi et al. (2005) typical elements of qualitative study are that the nature of the research is comprehensive, and data is gathered on real situation mainly from people related to research. Qualitative method relies on belief that human is adaptive enough to be able to trust its own observation in conversations between people interviewed. Instead of relying only in gathering information from interviews for instance. Interviews are recommended to use for collecting material, to be able to utilize the expertise of interviewed person. One objective of qualitative research is to reveal unexpected matters. Therefore, research material needs to be studied comprehensively and on a detailed level as well. What is expected from the study, cannot be the limiting aspect of qualitative method. Therefore, the main point is not only to test a hypothesis. (Hirsjärvi et al., 2005, p.155).

Considering the objective of the research, methodologically it is either mapping, explaining, describing or predicting. The mapping method is seeking a new view point and phenomena and it develops the hypothesis. The explaining method, instead, is seeking interpretation for problem or situation. The explaining method is more often related to quantitative research method when mapping requires more often qualitative research strategy. Describing refers to a detailed description of people or phenomena. The predicting method focuses on future and aims to predict actions as a consequence of certain phenomenon studied. (Hirsjärvi et al., 2005, p. 129). In this research, a mixture of previous methods is used. However, the main objective is to gather mapping and predicting research.

Scheduling the research is vital for successful project management, especially in this study where the timetable is basically set by case company and it's a project timetable. For aligning case company's project timetable with research timetable, a modified Gantt chart is used. Gantt chart is a common tool for individual or group progress in executing the set process steps. It supports the possibility to visualize work and expectations in perspective. The chart presents the most important features of the project which are to be completed in order to accomplish the set objective. Typically, the chart includes dates and responsible and milestones support illustration. (Lofurno, 2002, p.35). By aligning timetables, it was a lot easier to follow deadlines, but still keep thesis-research separated project from case company's original process implementation timetable. Hence, the months and years have been hidden from aligned charts due the case company's policy. Aligned charts are presented in the case company chapter.

4.2 Data Collection

Collected data is divided into primary and secondary data. Primary data for this thesis is specialist interviews. As a secondary data, the case company's internal materials are exploited and the academic literature sources as well, such as university international database and university library. In addition, webinars provided by service provider was exploited to study logics behind the user interface of the DC replenishment system. As said, the research was conducted alongside with researcher's daily work and therefore multiple meetings and informal discussions took place. The meetings were recorded, or notes were taken, to ensure the validity of the data. The records from meetings aren't transcribed because the meetings were unstructured.

As said, the primary source of information for empirical part of the thesis were the interviews. The interviews were conducted by semi-structural method, in which the researcher has the themes and questions to be covered, but these topics might vary from interview to interview depending on the situation. Additionally, the order of questions presented might vary depending on the flow of the conversation. Furthermore, the researcher might have to present additional questions to explore the research objectives in a specific nature. The nature of questions in semi-structural interviews requires audio recording or taking notes to be able to conduct the transcript afterwards. (Sounders, M. Lewis, P. Thornhill, A., 2009, p. 320). The steps of data collection and research process are described below in Figure 10. There are multiple data sources exploited for conducting this thesis.

Figure 11. Research process steps

Interviews were conducted in order to find out the problems related to old replenishment process to be able to point out how the current issues might present in the new replenishment process. Therefore, interviewees were selected to gain knowledge from all different product categories, to be able to follow up with the broader picture of all kind of issues related to replenishment process. Additionally, interviewees were selected from different levels of working experience in order to achieve as reliable results as possible. The replenisher interviews were one method to find out current problems from replenishment process in a detailed level.

Furthermore, an interview was conducted with service provider representatives as well. The interviewed persons from service provider were project managers from Denmark and Sweden offices. Interviewees were chosen because of their previous experiences with similar type of replenishment process development projects with other customer companies. The objective of interviews was to gain knowledge related to possible obstacles which needs to be tackled in the implementation process of replenishment system in general. Additionally, the possible recognized benefits from earlier projects were found out. Alongside whit semi-structural interviews with replenishers, a Heatmap-survey was conducted in which the focus was to critically present the most relevant stages or core activities of the replenishment process. The survey was divided into four themes which followed the new replenishment process structure in order to seek the major obstacles related to the process. The Heatmap survey and the results are analyzed comprehensively in chapter 6.

4.3 Data Analysis Methods

Risk assessment heat map is a tool used for data analysis. It was exploited, because it supports visual analysis for each risk to be developed. Formal semi-structured interviews were recorded and transliterated. Recording the interviews allowed to return the conversation afterwards which also supports reliability of analysis. The structure of the specialist interviews was set by risk heat map questionnaire, which was equal for every interviewee. Hence, the domestic and import suppliers are taken into notice in question layout. Hence, the questionnaire set the general structure of the interviews and answers were numbers for the heat map, the actual core results came from further explanations related to responses. Therefore, the interviews were transliterated to be able to analyze explanations for the different responses comprehensively. Most of the interviews were conducted in Finnish and therefore, responses were translated to English. Responses were summarized into questionnaire.

Due the structure of the risk heat map questionnaire the results were already divided into themes which helped analyzing process. Furthermore, in order to achieve valid results from heat maps for each theme, results from different interviews had to be combined. Combining was conducted by calculating mean from each theme from all interviews. The combining was reliable because the questionnaire was similar for every interviewee and the results were in a same scale. Calculating the mean is explained further in chapter 5.2.2. Data analysis mainly builds up for interviews in the case company and service provider. In addition, multiple informal meetings with case company representatives and project group have provided a lot of vital information, which have been analyzed by me personally or with colleagues in informal meetings.

4.4 Validity and Reliability

According to Sounders et al. (2009) reliability of research is about providing consistent findings throughout data collection techniques or analysis procedures. Moreover, validity refers to the findings of the research and to the question, are the findings such that they seemed to be. Threats for reliability can be a participant error. For instance, the results of the interviews can differ from each other because of the mood of the interviewee which can change during the week. In addition, as a threat is participant bias, which refers to situation where interviewee answers on behalf of management, which might lead to inaccuracy. (Sounders et al., 2009. p. 156). Furthermore, threats to validity varies a lot. For instance, if a study focuses in a specific interest group which have been affected by some major change in near history, it can affect to research validity as well. If research includes testing of a certain process for instance, and operator believes that tested process will have negative effect eventually. It could affect the results and decrease validity of testing. (Sounders et al., 2009. p. 157).

In this research, concerns related to validity and reliability of research are tried to be minimized in all stages of the project. Furthermore, interviewees for the research were carefully selected in order to be able to present valid results that take all varies into account relating to replenishment process. Interviews were first conducted to replenisher who was related to the project development earlier, to ensure that the questions presented in the survey were coherent and relevant with the upcoming process. When concerning the validity and reliability of the empirical study of this thesis, there are risks relating to adapting the results of interviews from the old process to the new process. The adapting has been made based on the researcher's personal knowledge about the new process and interview results from the old process.

Furthermore, one risk for research reliability is the researcher's relatively strong personal knowledge from the case company's processes which might lead to unilateral opinions or conclusion. Hence, the researcher's personal knowledge is no doubt beneficial for versatility of this research. The objective is to decrease the risk of unilateral thinking by gathering other opinions from interviews and other conversations.

5 Empirical Analysis

Empirical analysis provides an introduction to the case company's business in general. Secondly, this chapter presents the old replenishment process shortly to provide further insight about researched process. The stakeholder interviews are analyzed, and based on the analysis results the core processes of DC replenishment process are determined. After determining the core processes, the structure of the user process is outlined. The monitoring of the quality factors of replenishment process is analyzed. Lastly in the empirical analysis chapter the findings of this research are summarized.

5.1 Case Company

This chapter presents the principles of business environment of the case company. Additionally, case work background in the case company will be described. Key objective of this thesis is to create a user process for new replenishment process. Therefore, it is relevant to describe the background of the project. After the case company presentation, larger scale project as a whole is described. Secondly, the actual case work project is described further, in order to determine schedule, methods, objectives and expectations of the new DC replenishment operation.

5.1.1 Case Company Background

Case company of the thesis is a large Finnish retailer which holds a strong market position. Store network is widely spread and have a strong geographical customer coverage. Case company's customer base covers all social classes and age groups. Considering the supply chain management of the case company, sourcing of inventory is conducted globally, hence, a large part of suppliers are domestic companies as well. Therefore, an effective supply chain management is a prerequisite. Generally, overall sales are distributed throughout the whole year, but in the retail market the seasonal peeks are evitable. For instance, Christmas and other national holidays create massive peeks to the sales. Product range is considerable widespread and consists of multiple different product category types which all have different kind of demand variations. Additionally, considering the weather, seasonal variations create obvious challenges to supply chain management and demand forecasting. Considering the business environment and requirements in which the case company is operating in, it is evitable that continuously improving is essential for profitable growth. As discussed in chapter 2.1, companies can exploit several different replenishment strategies. MRP is a key determinant in case company replenishment, hence internal DC to DC replenishment re-order point is exploited as well. Some seasonal products are stored in addition to DC which is a temporary location before goods are delivered in DC from where the goods are distributed to stores. The replenishment from supplier to temporary DC is based on MRP, but replenishment from temporary DC to actual DC is conducted based on ROP.

As mentioned in the introduction chapter, there is ongoing large-scale information system renovation in the case company. The objective of the renovation is to be able to annex multiple different information systems to less amount of separately functioning systems. The goal of the project is to improve efficiency of the all processes which are related to renovation. In order to give insight about the scale of the process, the timeframe for the project as a whole is several years. (Case company’s internal project material, 2018). One part of the whole project is to implement new DC replenishment system. It is described in the next chapter.

5.1.2 Project Background

As stated in this chapter earlier it is clear that in the case company’s business environment the requirements for the demand forecasting and supply chain management are on a very high level. To keep up the continuous improvement, the new DC replenishment system has to be developed. Considering the current DC replenishment operation, it requires a relatively lot of manual work and repeating actions. Shortly described the objective of the new system is to automate the manual work partly and redirect the surplus working hours to forecast validation and process development functions. (Case company’s internal material, 2018).

The project of implementing the new replenishment system is partly linked to the larger information system renovation in the case company. Therefore, the implementation is divided into three development stages. This thesis focuses on the pilot stage in which the new replenishment system is launched for DC replenishment operation. Hence, the user process describes the process as it will be in the final stage, due the process does not change scientifically from the user point of view after implementation. In the first stage, the old replenishment process is only partly replaced with the new system. The old process builds on ERP-system which is utilized with manual planning methods. The first stage of implementation of the new replenishment system replaces the manual planning tool, hence, the old ERP-system is still utilized in collaboration with the new system. At the second stage, new ERP-system will be launched which then replaces the old ERP. Furthermore, the last stage of implementation enables involving the real-time store sales data to the whole product category. At the last stage, the forecasting and ordering process should be as accurate as it can possibly be at these days. (Interviews 1 & 5, 2018). The figure below outlines the stages of the replenishment process implementation. The focus of this thesis is outlined in the first and second stage of the figure.

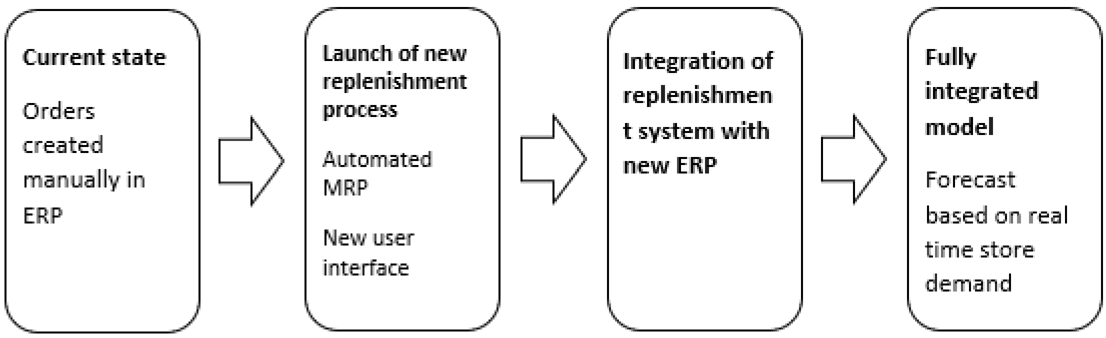

Figure 12. Schedule towards integrated replenishment model. (Adapted from the case company's internal material, 2018).

When considering the first stage of the implementation project schedule more precisely, at first, the deployment of the new interface will increase the requirement of resources, because the new process requires development, and specialists must be trained. However, after the process is launched and possible deployment challenges have been overcome, the need for additional resources will decrease. (Interview 6, 2018). During the thesis research, there are a lot of testing and integration actions conducted together with the case company and service provider, for instance, system integration testing (SIT) and user acceptance testing (UAT). Testing is enforced in a test environment by utilizing data copied from production. Testing is highly relevant for the success in implementation. Furthermore, UAT is enforced later in the project development, partly simultaneously with the end user trainings. (Case company's internal workshop, 2018). User acceptance testing cannot properly start before the end user training, due the actual users are conducting the acceptance testing. In the figure below, there is the scheme of implementation of new DC replenishment system. The project tasks are aligned with the thesis tasks, in order to give insight about the scale of the project.

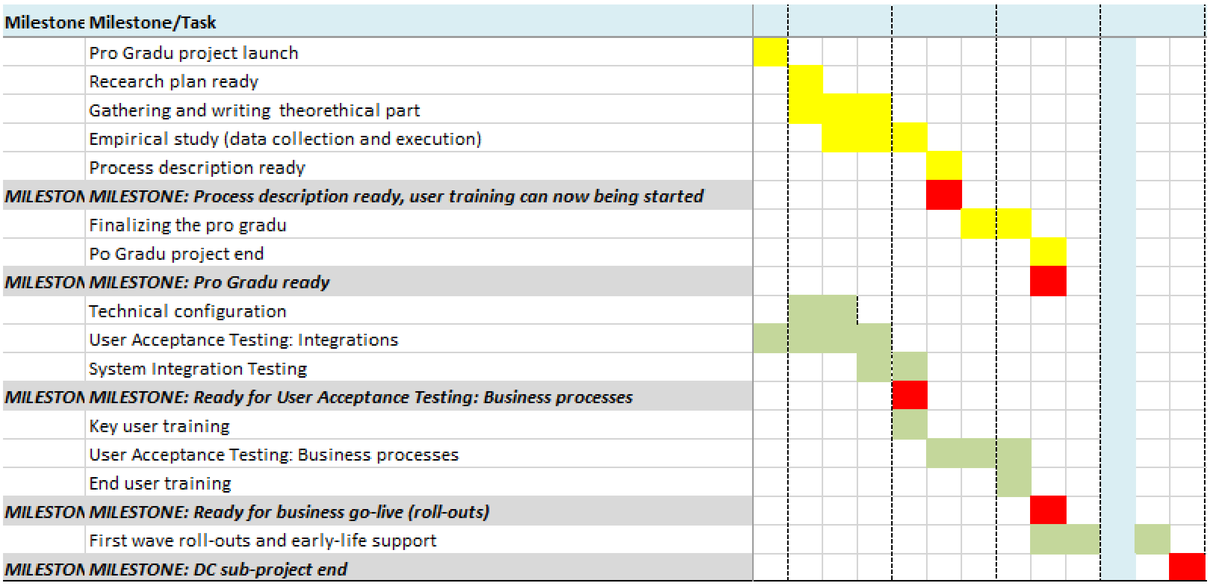

Figure 13. Thesis and case company project steps, aligned on Gantt chart. (Adapted from case company's' internal material, 2018).

Focusing on the first stage of implementation, as said objectives are to minimize the amount of manual work in DC replenishment process and to redirect working hours to the validating results of automated process. Additionally, automatization is expected to free up time for process development (Case company's internal material, 2018). Service provider of the new replenishment process outlines the quantitative forecasting methods which enable automatization of analyzing the ordering dates and quantities. The old replenishment process requires qualitative analyzing of each product individually from the replenisher. Moreover, the new system calculates by using qualitative methods and set limitations the optimal order. (Webinar of service provider, Demand forecasting basics, 2018). In other words, the new replenishment system increases weight of quantitative forecasting in comparison to the old process. It is consistent with the arguments of Shao & Lizhong (2010) in chapter 2.3. The role of the replenisher is to validate the proposed order created by the new system and either accept, decline or adjust the proposal. The key for efficiency comes from the possibility to rely on the order proposals for most of the products.

The system allows to set alarm limitations to outline the products which require further qualitative analyzing before accepting the order proposal. For instance, products which are new for the category should be analyzed precisely, because the actual sales history is not available to support the forecast yet. (Case company's internal material, 2018). Basically, the products will be analyzed mainly by using only the set limitations for identifying the special products which need to be analyzed more precisely. The products of which demand are easy to forecast, will be ordered most automatically in the new system. However, the forecasting and order proposal calculating logics are highly dependent on correctly maintained masterdata. Masterdata maintaining and especially validation will be a in major role in comparison to the old replenishment process. (Case company's internal material, 2018).

Considering the upcoming change from the replenisher's point of view, the biggest changes will probably be learning the whole new operating interface with different functions and dashboards. Furthermore, the replenisher needs to assimilate a whole new mind set for the replenishment process, since the focus is on validating the defected forecasts and masterdata instead of going through all the products when planning replenishment orders. It requires a lot of trust and adaptability from the replenisher's. (Interview 1, 2018). Additionally, the implementation of the whole new interface and process creates certainly many risks. The next chapter will consider the identified risks and core steps of the process.

5.2 Determining the Core Processes of DC Replenishment Operation

In accordance with Figure 4 in chapter 3.2, in order to create a user process, the core processes and critical success factors must be defined. To study success factors of the user process, it is decided to start with the replenisher interviews to conduct a general overview of the problems related to current replenishment process. By analyzing the concerns gathered from interviews, a risk assessment survey for replenishers is conducted. The objective of the survey was to figure out the most relevant concerns from current replenishment process and to be able to point out core processes and critical success factors regarding the new replenishment process. By researching the problems from the current process, it allows to react and to modify the user interface proactively during the user acceptance testing before the actual launch of the new replenishment process. However, at first the basis of current replenishment process in general is described, and the future objectives of new replenishment process as well.

5.2.1 Replenishment Process

This chapter describes briefly the simplified main aspects of current replenishment process. In order to describe the replenishment process distinctly the process is divided into four themes; forecasting, ordering process, masterdata and assortment periods. In the current process, the forecasting is based only for analyzing the historical sales data. The sales data is gathered from sales from DC to stores. Historical sales data is presented from the last three weeks and in addition, the next three months' sales from a year ago is presented for the replenisher to support supply planning for a longer period. From the historical data, the estimated stock level in days is calculated, and the replenishers use their professional knowledge to analyze how much is the most efficient quantity to order.

The current order creation process is relatively manual and all products are analyzed separately, hence the analyzing process can be conducted usually in a short time, because of the routine nature of the process. Number of products and suppliers have been growing during the last years, and therefore, the required time for order planning process has been increased. Purchase orders are outlined into manual planning tool by products and suppliers. From the planning tool, the product codes and order quantities are manually copied to the ERP-system, in which the actual purchase order is created for supplier. Creating the orders is a repeating routine process, especially for domestic suppliers when replenishment orders are created almost every day with short lead times.

Managing masterdata is a highly important theme for replenishment process, hence, the actual masterdata maintaining is conducted by a different team and department. masterdata in the replenishment process refers mainly to product information management. For instance, masterdata determines assortment which needs to be replenished. In addition, it determines how many stores are selling each product. Also, for instance, supplier contact information is a part of masterdata. In other words, masterdata comes from external processes but it plays a major role in DC replenishment process. Space management, Category management and Sourcing -teams collaborate and determine what needs to be purchased and for what period. Then the information is provided to the masterdata team, which maintains changes to ERP-systems. With masterdata information maintained in ERP, the replenishment process can be conducted.

In the case company, assortment management is based on a period rotation, in which for every product category there are determined category periods. The category periods take into account consumer habits and seasonal changes. Quantity and length of category periods are different depending on product category. Assortment planning is conducted strictly inside of determined periods. The assortment planning cycle is also variable and partly dependent on suppliers' schedules. From the replenishment process' point of view, the category periods are significantly important, in order to be aware of product assortment that need to be replenished. The category information for replenishers comes from the masterdata. All product changes are informed, for instance, new products, ending products and products which are going to be replaced with a similar new product.

Future Objectives

When comparing the old replenishment process to the new process to be implemented, there are few general objectives which are expected from the new process. For forecasting, the new process provides a lot of new tools for improving forecasting accuracy by time-series analysis. In the old process the focus is on historical data, but in the new process focus is on validating the forecasts for future. Considering the ordering process, the objective of the new replenishment process is to automatize the order proposals. The focus of the replenisher should be only in validating the exceptions and inaccurate forecasts, and the repeating routine orders should be approved without checking all order proposals by product. In the figure below there are compared steps of order creation processes in the old and new model. As it can be seen in the new process, the order proposals are created automatically, and only critical proposals are validated by the replenisher.

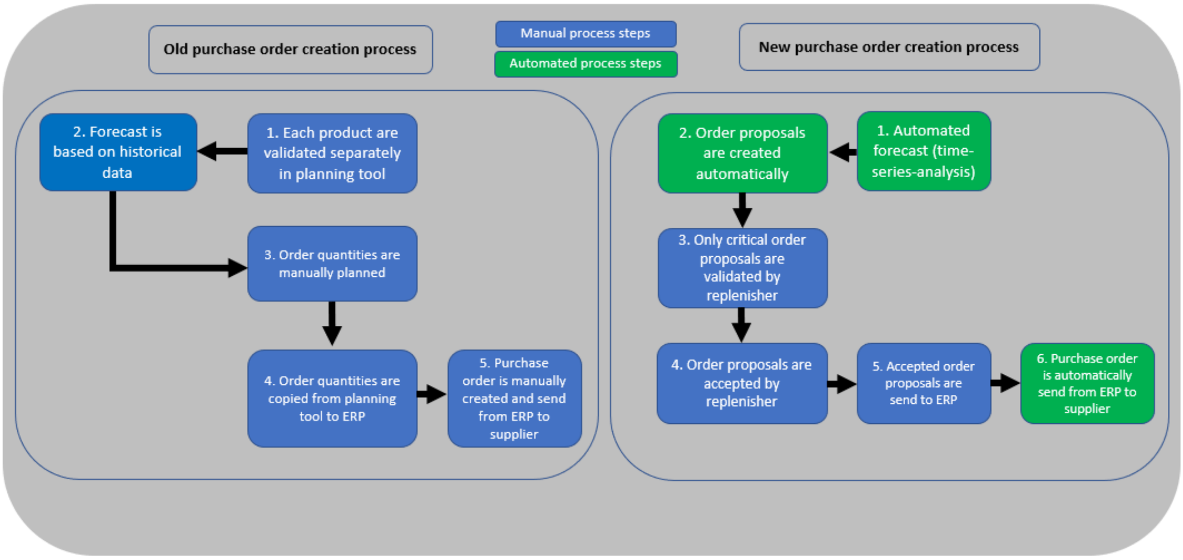

Figure 14. Order creation process comparison: old versus new process.

Since some tasks are automated in the new process, it generates more time for other tasks than order creation. In the figure below, there are roughly described the time management of current replenishment process and objectives for the new replenishment process.

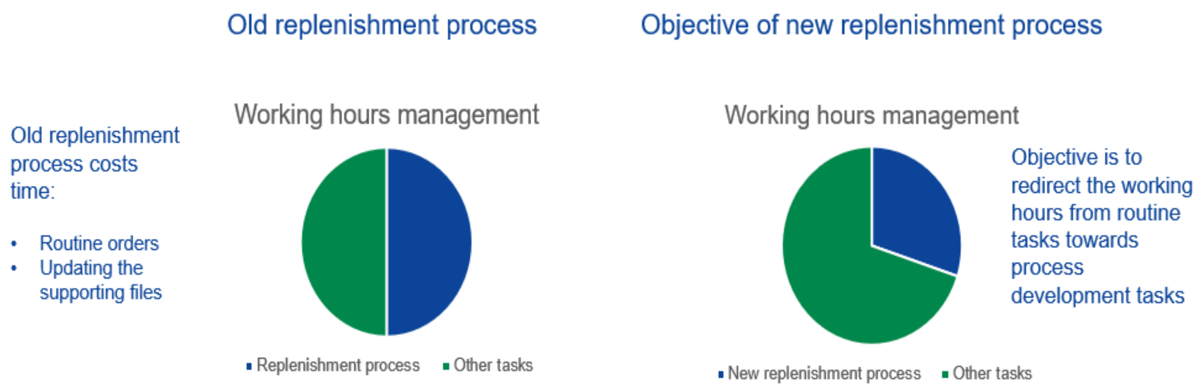

Figure 15. Replenishment process time management objectives

In the figure, it can be seen that in the new process, the time spent to order creation should be reduced significantly due to the automatization. One key objective of the new process is to at least maintain the service level for stores or to improve it, compared to the current process. (Case company's internal material, 2018).

5.2.2 Process Risk Assessment

As mentioned earlier, to be able to determine the core processes of the new replenishment process, the replenisher interviews and risk assessment surveys were conducted. The objective of the risk assessment survey was to point out the risks and critical steps of the current process in order to determine the most relevant tasks from the new process. In this chapter the results of risk assessment are analyzed. The risk assessment was conducted by heat map method. In accordance with the heat map theory in chapter 3.3, risk heat map is useful for supporting the communicating the risks. The heat map survey was divided into four themes in line with the process; Forecasting, Ordering process, masterdata and Category periods. The survey was conducted with four replenishers who are all responsible for different types of products. The surveys included 39 questions or risks in total which are represented in appendix part of this thesis. The results of all questionnaires were gathered by calculating mean from all answers in order to represent the general impact of the risk for the process.

The method for risk assessment is adapted from the research conducted by Jukka Hallikas et. al. (Riskienhallinta yhteistyöverkostossa, 2001). Even though the risk assessment is in a major role in this research, it is not included in the research questions. This decision is made because the risk assessment is used as a tool for risk identification towards quality management. For each question, respondents were required to answer with two numbers on a scale of 1-4. The first number indicates an impact for the process and the second indicates a probability of occurrence. By multiplying both answers together, the total impact for the process is determined. The scale is limited to 1-4 instead of the original 1-5, because this scale is the most suitable for analyzing the case company's processes. Furthermore, number 5 in scale 1-5, refers to a catastrophic consequence which is not a case in the case company's replenishment process. Therefore, the scale is limited to 1-4. The results are presented in a heat map, where red color refers to higher risks and green color refers to low risks. Below the figures of answer options and scales of interpretations are presented.

Consequence	Interpretation
1 No effect	Insignificant considering DC replenishment process as a whole.
2. Minor effect	Possibility for short OOS situation in DC, or possibility for minor overstock.
3 Moderate effect	Definent OOS situation in DC, possibility for OOS in stores (impact to end customers as well). Or major overstock, risk for scrapping.
4 Major effect	Long OOS situation in DC and stores (Product is not available for end customers). Or major overstock and need for scrapping.

Table 1. Interpretations of consequence for the process.

Interpretations of consequences are adjusted to be in line of possible impacts for the replenishment process' point of view. By answering "1 No effect", the question doesn't create anything significant impact for the replenishment process. However, by answering "4 Major effect", the interpretation is long out of stock situation in distribution center and also in stores, which affects the end customers, or in addition it can refer to a huge overstock situation when scrapping the products is required. In the figure below, there are presented interpretations of probability answers of survey. Basically, by answering "1 Very small", the incident is very rare. However, by answering "4 Major", the incident might occur frequently.

Probability	Interpretation
1 Very small	Very rare incident
2 Minor	Rare incident
3 Moderate	Occasional incident
4 Major	Frequent incident

Table 2. Interpretations of probability for the process.

Forecasting

Questions of the first theme Forecasting were divided into two categories; the forecasting of products from import supplier and from domestic suppliers. Import and domestic were separated, because of the different natures of processes. Most of the import suppliers have long lead times and slow order rotation cycle. However, domestic supplier usually has short lead times and orders are placed more often, hence in both domestic and import suppliers there are exceptions. The objective of forecasting related questions, was to find out differences between domestic and import forecasting, but most importantly, to find out which are the hardest aspects of forecasting. Below there is a heatmap of results from import forecasting theme.

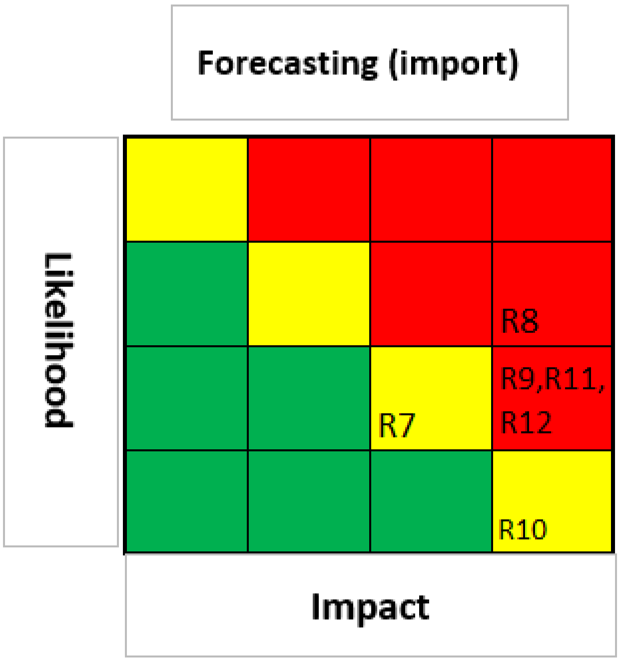

Figure 16. Forecasting (import) results.

At first, it can be seen that all risks have high impact for the process, hence, the likelihood is not that high in most of the risks. However, before further analysis, it can be argued that forecasting of products from import suppliers is very demanding and consists of many risks for the process. Therefore, forecasting should be emphasized in the user process as well. Risk 7 refers to out of stock (OOS) situation because of replenisher's mistake, when expected sales have been forecasted to be lower than occurred. Moreover, risk 8 refers to OOS situation which is caused by the suppliers' delivery issues. It can be argued that, suppliers' delivery accuracy is a higher risk in comparison with the forecasting itself. Even though, forecasting risk itself is also relatively high in the scale of heatmap, and should be emphasized as well. Supplier delivery problems is a big risk for the forecasting, because usually the problems occur without the warning and the consequences can be critical for the process. (Interview 2, 2018).

Risk 9 refers to scrapping the overstock because of the best before dates. It proved to be a high risk especially regarding to products with short best before dates and especially when combined with long lead times. In addition, one reason for scrapping from forecasting's point of view can be too high period forecast. Period forecast is provided by a category manager, and it is used especially for forecasting of new products of import suppliers. Because there are not available sales data yet, and due to the long lead times, the first purchases must be created "blind". (Interview 2 & 4, 2018).

Risks 10,11,12 are related to different types of factors that influence forecasting. Risk 10 refers to the forecasting difficulties because of trend. Trend can be caused, for instance by food blog receipt or food recommendation in popular newspaper etc. Trend appeared to be a highly effective factor and almost impossible to forecast and react when lead time is long. In addition, usually suppliers are not prepared for a sudden high demand. Finally, when a supplier reaches the required production speed, the trend itself might be decreasing, which might cause scrapping the products. However, trend in a big scale do not occur too often, according to all respondents' comments. Trends occur approximately once in a year.

Furthermore, risk 11 refers to the forecasting of seasonal changes, for instance Christmas season etc. Seasonal changes are expected and occur same time yearly. However, the responses refer to a high risk. The problem is the variation of different factors between the seasons. For instance, presentation in the stores or packaging of the products can be changed from last season. In addition, the store coverage can be different. These are the factors which cannot always be compared to previous years. Additionally, the volumes for instance for Christmas can be many times higher than normally, and therefore, to achieve the results hoped for, the forecast must be precise. (Interview 4, 2018). Risk 12 instead, indicates untypical weather during the season, for instance especially warm summer or cold winter. According to the respondents, it is very difficult to forecast, and the consequences can be critical for the process. However, usually the problems are also with a supplier's delivery capacity when demand is higher than expected. The results of forecasting of domestic products are set below.

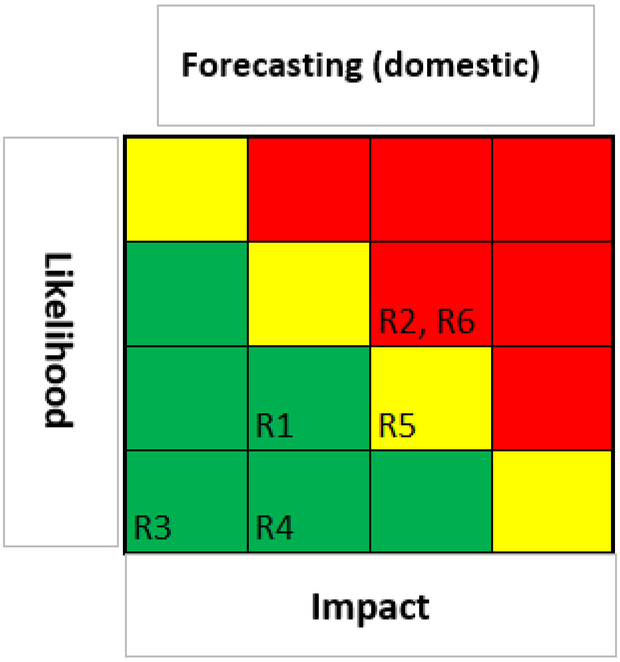

Figure 17. Forecasting (domestic) results.

It can be seen that risks are not that significant in domestic forecasting. Risks are smaller mainly because of shorter lead times. There are only two risks on red sector of the heatmap risk 2 and 6. Risk 2 refers to supplier's delivery difficulties, which appears to be problem sometimes with domestic suppliers because of generally high sales volumes. Furthermore, risk 6 indicates an unpredicted weather seasons, which also might cause delivery difficulties for suppliers because of high demand. Moreover, the problem within domestic process is not in forecasting itself. Due to the high volumes and product quantities the challenge is timing. How to conduct the replenishments without burden the distribution centers' capacity too much. Replenishers are required to keep stock levels at the lowest possible level without compromising the service level. Therefore, because the buffer stocks are low, even small changes to demand can cause a short OOS situations. (Interview 3, 2018).

To summarize the results of the first theme of forecasting, generally the challenges related to forecasting are in import ordering process. When lead times are long, all mistakes in forecasting multiplies into process and leveling the process takes time. The highest risks are related to suppliers' capacity and forecasting the changes between the seasonal sales. In addition, the short best before dates create challenges for the forecasting. There is a lot to be developed to achieve the accurate forecasts in the future. In the domestic process, the problems are not in the forecasting itself, but the challenge is to manage a large quantity of products and volumes with a low buffer stock. Especially in seasonal sale peaks the volumes must be divided equally, in order to not to burden the DC capacity too much.

Ordering Process

The second risk assessment theme is order process, which refers to a process of creating the actual replenishment order for the supplier. Also, in this theme the import process is separated from domestic process, not only because of the different natures but also because the processes differ from each other in some parts. Import ordering process requires more manual updating of stock levels and order details in comparison to the domestic process. A heatmap of the results of import order process is set below, and further analysis is gathered below the figure.

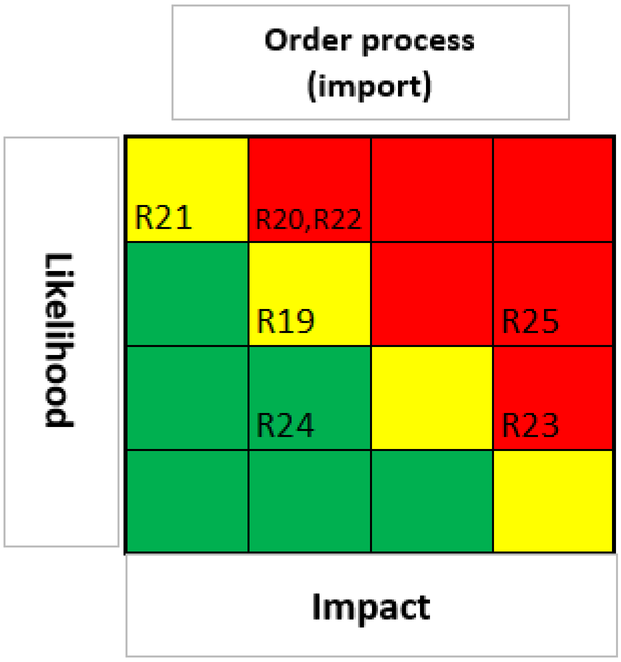

Figure 18. Order process (import) results.

The results of import ordering process are divided into two categories. Most of the result answers refer to risks which occur often but the negative impact for the process is low. However, there are two risks which are relatively likely to occur, and negative impact is significant. Risk 23 refers to a situation where an order is sent to supplier from our ERP, but for some reason the supplier hasn't received the actual purchase order. Likelihood is not that high. According to the interviewees this situation might occur few times in a year. Especially in import orders where lead times are longer in comparison to domestic orders, if the supplier hasn't received the order and the replenisher assumes that the supplier will deliver order normally, it always causes significant impact for the process. Further orders are planned for the future and if one order is suddenly missing, the planning is immediately incorrect. Negative effect multiplies to other orders and most likely consequence is OOS-situation in distribution center and possible in stores as well. (Interview 4 & 5, 2018).

Risk 25 refers to a situation where the amount of operative work is too high, and less time is available for further analysis of relevant data regarding the ordering process. According to all interviewees, they have too high operative work load which might lead to a situation where some relevant information is not noted. Risks 20 and 22 refer to the required changes to the orders afterwards. Quite often suppliers are not able to deliver exactly what is ordered, and therefore purchase orders need to be amended. According to the interviewees, it occurs on a daily basis, and the impact is not that significant for the process. However, it causes a lot of work to maintain dozens or hundreds of orders up to date all the time.

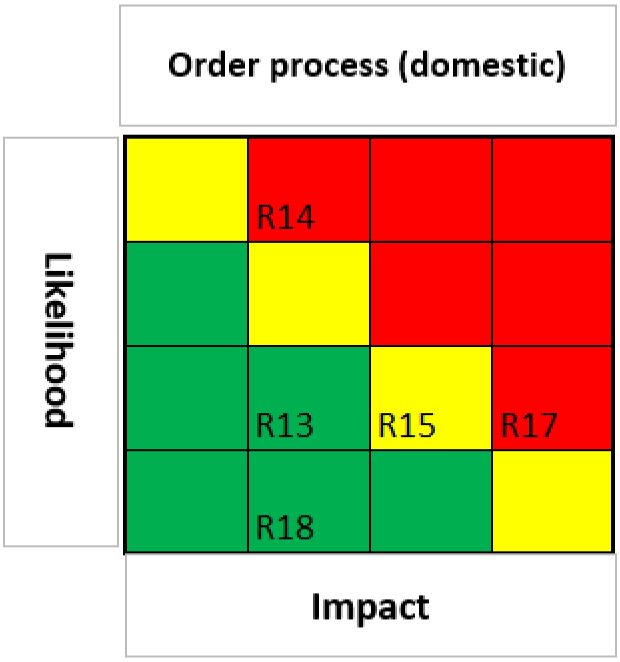

Figure 19. Order process (domestic) results.

The results of domestic ordering process are not that negative in comparison to import process. However, there are two risks on red risk level in the heat map. Risk 14 is equivalent to risk 20, in which there are required amendments for the orders afterwards. Correspondingly risk 17 is equivalent to risk 24, which refers to a high workload. Arguments to responses were similar to the ones in the import process. The quantity of order lines to be evaluated is very high, which causes rush to the managing of the process. Moreover, also in the domestic process, if the supplier hasn't received the order, the consequences are significant, and problems cumulate further in the process. (Interview 3, 2018). Hence, the lead times are smaller in domestic orders, also the buffer stocks are lower as well. Therefore, in a case of missing order, the out of stock situation might occur relatively quickly.

To summarize the results of ordering process, the results are quite alarming, especially considering the high work load of individual replenishers. When a new replenishment interface is launched, the surplus time for learning is a prerequisite to be able to assimilate all the new information in short period of time. In the old process, there is not additional time for learning, and it might cause problems later. However, many risks are likely to occur but don’t affect negatively to the process when process is working as it should be. For instance, risk 21 refers to a need for doing changes by manual order planning tool, in which interview responses are clear. Changes are made on a daily basis and it works well as long as the changes are possible to follow up in the planning tool. Risk actually seems to be in the new process, in which updating the order planning tool are left out from the process. Order changes are evitable, and these risks are definitely required to be investigated.

Masterdata

The third theme is masterdata, which is an important feature of the replenishment process. As mentioned in chapter 5.2.1, masterdata comes from external process and all purchasing information relies on reliable masterdata. Therefore, masterdata has to be precisely correct to avoid mistakes when placing the replenishment orders. Results of the masterdata theme are quite widely spread. Moreover, there are three risks on red color, which is quite alarming.

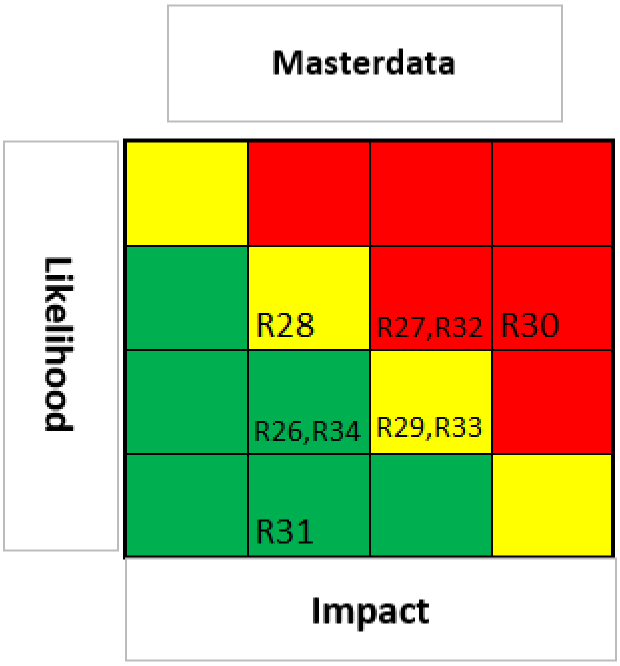

Figure 20. Masterdata results.

Risks 27, 30, 32 are all on red color which is a sign for required actions to prevent negative consequences to occur in the process. Risk 27 refers to a wrong supplier item code in the case company's internal system. Especially in the import order it can create difficulties when supplier isn't aware of what product is tried to be ordered. However, according the interviewees' comments, risk 27 is very frustrating when it occurs, it slows all processes and takes time to investigate and fix. Risk 32 is similar to risk 27, and it refers to any situation when replenishment process is slowed or prevented due to any incorrect masterdata. Because of the general nature of the risk, it was rendered to occur often.

Risk 30 refers to a situation when any information to product status changes is provided too late to masterdata team and further to the replenisher. It can cause significant problems into the process. For instance, if the category manager has decided to cancel the product from assortment, and lead time of supplier's products are long, and if the information from this cancellation is provided too late for the replenisher, it might lead to a high over stock situation. Because there might be several orders on the way simultaneously for one product, and if the cancellation comes too early, there will be over stock left after the cancellation date. (Interview 4, 2018). This type of situation creates costs due to the value of inventory and risk of scrapping the products.

Risk 30 refers to a situation where sourcing manager has negotiated for instance minimum order quantity, to achieve lower purchase price, and information hasn't been provided to the replenisher. Positively, all the interviewees had the same opinion that this kind of lack of communication is not a problem. In interview 3, masterdata appeared to be a bigger concern than in the other interviews. Interviewee 3 has only domestic suppliers and therefore, the quantity of products is higher. It can be argued that, when product quantity increases, the problems of managing the masterdata issues might increase. Basically, all the masterdata risks are caused by other departments, hence the negative consequences might not appear until the replenishment process. Moreover, risk 30 refers to the lack of communication between stakeholders. It was generally stated as a relatively concerning issue in all interviews. Therefore, all risks are extremely important to communicate to the other stakeholders to achieve improvements for the process.

Category Periods

As stated in chapter 5.2.1, the assortment management in the case company is based on period rotation, and thus, category periods are determined for every product category. Information of changes in category are maintained in masterdata. The results of the fourth theme are quite interesting, due to the high impact but low level of probability of occurrence of risks. For instance, risk 35 refers to a situation where the replenisher hasn't recognized the launch of new products, and the order isn't placed. All interviewees agree that the impact for the process would be catastrophic if ordering the new product would be forgotten. Luckily, it is clear that most likely this situation doesn't occur at all in the current process. Therefore, it is important to keep the situation as it is, also in the new replenishment process.

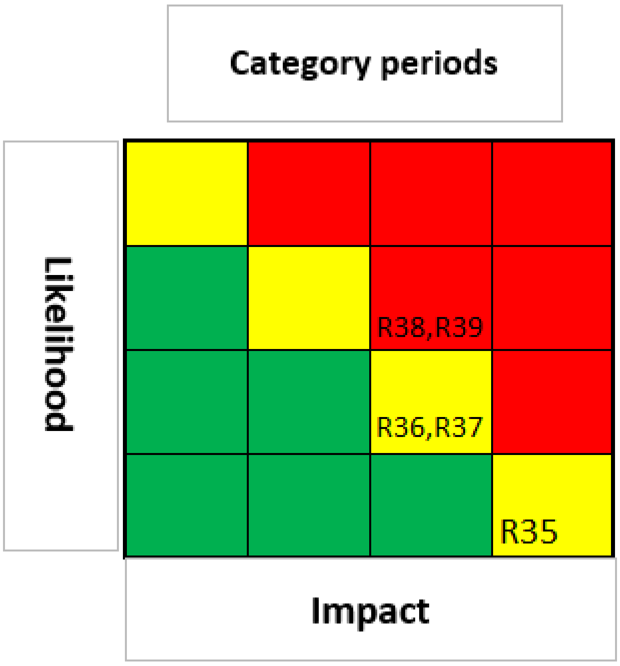

Figure 21. Category period results

Risk 36 refers to a situation where the replenisher mistakenly orders a product which is going to be deleted from the category. The situation might occur if the replenisher is busy and for some reason doesn't recognize the changes in product information in the masterdata. However, it is not that typical and the situation doesn't occur too often. (Interview 3, 2018). Risk 37 and 38 are related to each other. Risk 37 refers to a situation when a new replacing product is ordered too big or low quantity at the start of the category period. Risk 38 refers to a similar situation with a totally new product. First orders are easier to forecast with a new replacing product, because historical sales data is available from replaced products' masterdata. The first orders of a new product are slightly more difficult to forecast, because lack of sales data. (Interview 2,3,5, 2018). Risk 39 refers to a situation where there is stock left after category period with deleted product. According to all respondents, this is a typical case, which is caused mainly by providing the replenisher with the necessary information to slow down the ordering too late. In addition, usually the products which are going to be cancelled from the category are slowly rotating (Interview 3, 2018).

Heat Map Summary

The risk assessment by heat map is proved to be a very beneficial tool to figure out the most critical aspects in the current replenishment process. If all the questionnaire themes are compared to the average total impact ratio for the replenishment process, the most alarming theme is the import-forecasting with average total impact of 7,6. Another alarming theme is the import ordering process with average total impact of 7,14. The third alarming theme is category periods with average total impact of 6,44. The fourth one is masterdata with average total impact of 6,14. Both domestic themes forecasting and ordering process are less alarming with the average total impact of 5 and 5,6. The impact ratio is calculated by multiplying answer for consequence and probability of each risk, which results in total impact for the process. Furthermore, the mean is calculated from all the answers inside of a theme which creates total impact for each theme. The lowest possible result is 1 and the highest is 16, due to the response range of 1-4 for consequence and probability.

In order to visually point out how the risks appear in supply chain, in the figure below the seven most critical risks from old replenishment process into the new replenishment process steps are mapped. Risks are in red color.

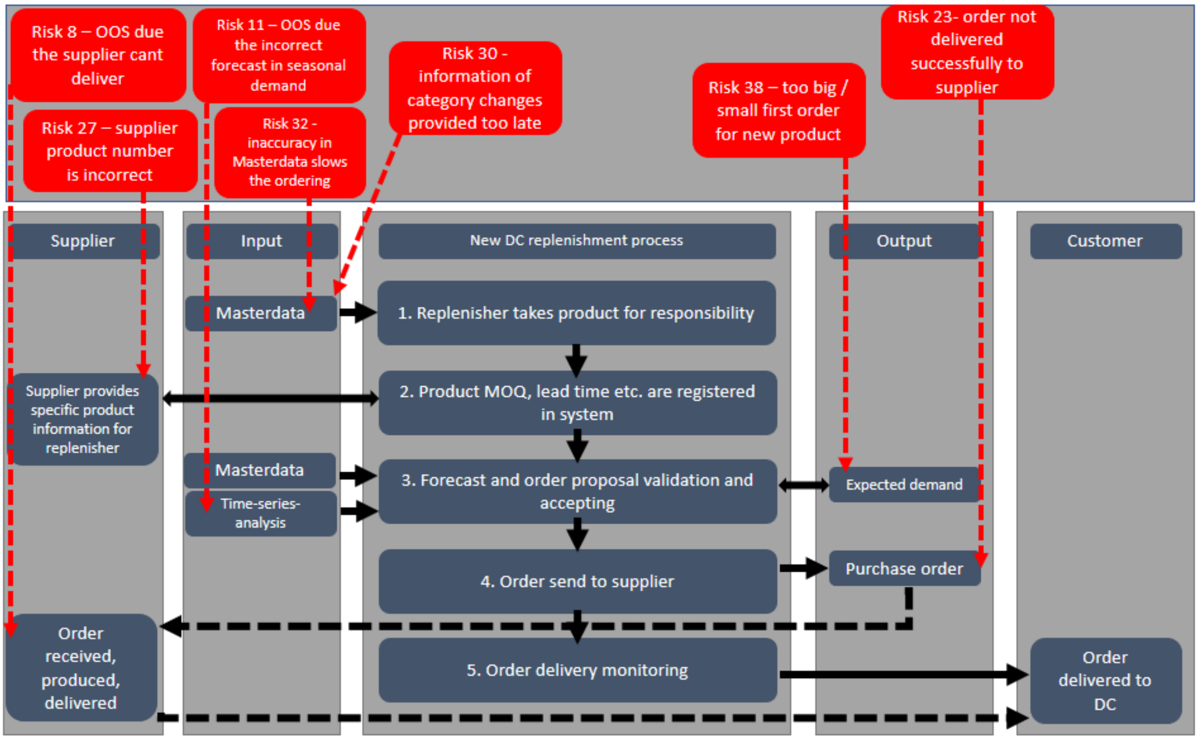

Figure 22. Risks of old process mapped in new process steps.

Process steps are conducted in the basis of Figure 8 in chapter 3.3. The process steps are described more comprehensively in chapter 5.3. However, from the risk point of view it can be seen that some risks are caused by supplier, but some risks appear in masterdata management or in forecasting. However, all risks have high impact for success in replenishment process and therefore, focus should be on minimizing these risks.

5.2.3 Core Processes of the New Replenishment System

Based on the interviews conducted with the replenishers, the general expectations from the new replenishment process and interface to be used are quite hopeful and anticipatory. Products with following features should be the most suitable for the new process. Products with short order-to-delivery time, products with steady demand and products with long sales history. Generally, it is expected that domestic short lead time products are most suitable and easily launchable in the new replenishment system. Moreover, the most critical expectations are related to products of global suppliers with long lead times and short best before dates. It is clear that long lead time and short sales time, create challenges for order-to-delivery process and inventory management. However, when combining qualitative and quantitative forecasting methods, there is a lot of development opportunities ahead. (Replenisher interviews, 2018).

Risk heat map questionnaire was conducted for the old replenishment process, because of the new process is not defined yet. Therefore, when the user process is conducted, results of the risk heat map questionnaire should be analyzed from the new process perspective. For instance, it should be assessed whether the risk 20 is relevant for the new process or whether it should be emphasized in the process description. Based on the results from the risk heat map questionnaire, the following core processes of the replenishment process are determined: Forecasting, ordering process, category periods and masterdata. The core processes are used as headlines in process description as well. In this chapter, recognized risks of the core processes are analyzed from a new process perspective.

Forecasting

Import forecasting is proved to be the most potential risk for the process when total risk impact is considered. However, also the domestic forecasting is challenging. In addition, considering the new process, focus will be on looking forward instead of ordering based on historical data. Therefore, forecasting is clearly relevant core process in the new replenishment interface and should be emphasized in the user process as well. There are few alarming risks when analyzing forecasting risks from the new process perspective. Seasons are very demanding to forecast accuracy, because of the high volume increasements and quick changes. In addition, products with short sales time, are quite potential to be scrapped because of inaccurate forecast, especially in import products. These are risks and topics which should be highlighted in the user process.

Ordering Process

Ordering process is proved to be challenging in the old replenishment process. However, many of the risks were high on probability of occurrence, hence low on impact. Especially risks 19-21 seemed to occur on a daily basis, but the negative impact for the process are low. These risks refer to required changes for the orders afterwards. Low level of negative impact for the process is explained with supportive order planning tool, which is used for calculating full container shipments for instance. Order planning tool have been used for a long time for import ordering, and it is useful especially in order amendments and planning the orders for a long period. When orders are placed and updated in order planning tool, process goes through easily. However, if there is not a possibility to plan and try different ordering scenarios the impact for the process will be negative. (Interview 4, 2018). As mentioned in risk assessment chapter, in the new replenishment process, order planning tool is left out from the process. Changes for the import orders are conducted in a new user interface, in which there are not possibility for real time updating and testing the different scenarios for the orders. In order to ensure the process safety, this concern needs to be mentioned in the user process. Also, in testing stage, order updating will be emphasized to ensure properly working process after the deployment.

Masterdata

Risks results in masterdata where relatively widely spread. There are few alarming risks and risks which should not lead to negative consequences. Moreover, considering the risks related to masterdata in the new process, one relevant aspect is, how to recognize all necessary information and especially changes (Interview 1, 2018). According to all interviewees, in the old process, masterdata changes will be recognized for sure, because replenishment specialists are used to work with current process. Therefore, in user process and in user trainings, the process of recognizing the required changes should be emphasized. On the other hand, considering the results of the questionnaire, development steps should be taken also in internal collaboration with different stakeholders of the process. For instance, many of masterdata problems could be avoided if suppliers are informed precisely in the first place by sourcing department. (Interview 3, 2018).

Category Periods

Category periods is definitely one of the core processes, because basically all working in the case company is directed around the category periods. Furthermore, if some product is cancelled from category, and there is stock left after the period, it might have to be scrapped or stores are forced take all of the remaining stock and sell it with discount. For instance, space management in stores is planned around the category periods, and there is not such space for products which are not planned to be in the category. Because of the size of the case company, the processes are quite rigid and last-minute changes are not usually possible. Therefore, the process must be precisely described, to avoid any unnecessary risks. From the new process' perspective, the biggest concern in category periods, is the recognizing all of the relevant data during the process. In addition, at start of the category period, there were many potential risks in launching of new products. The first steps of the ordering process and placing the first orders to a new product must be highlighted in user process.

5.3 Structuring the User Process

Since the core processes have been defined, in accordance with chapter 3.2 the next step is to utilize the standardized model for process description, which refers to the user process as indicated in chapter 3. Below there are applied the parts of standardized model for process description, in order to support structuring the actual user process. The actual user process is not presented in this thesis, due to the sensitive information regarding the case company's processes. The model includes researching answers to few themes, and because of sensitive information, themes are concerned on a general level.

Limits of application

When the limitations of the process are considered, this particular process focuses only on the end users process. For instance, key user's responsibilities are left out of this process description. In addition, the focus only on process steps in the new interface and all other ERP-systems related to process is generally left out of the process description.

The end users process starts from taking a new product for replenishment responsibility. Process end can be considered from two ways. Firstly, the replenishment process ends when goods are successfully delivered to distribution-center. Secondly, the replenishment process ends when a product is deleted from category and stock is sold out.

Process development will be key user's responsibility, and therefore it is not part of user process document. Currently before the process deployment, process is constantly developed and planned in project teams, to achieve the best possible outcome when process is actually deployed. The process efficiency is measured by selected meters, which are more comprehensively examined in quality assessment chapter 5.4.

Customers and stakeholders of the process

DC replenishment process is business to business process, and therefore, when customers and stakeholders of the process are considered, the main customer is DC and all of the stores nationwide. The replenishers are in the middle of supply chain and therefore process includes many stakeholders. If stakeholders are divided into internal and external, then the external stakeholders are suppliers, custom clearance and forwarders. The internal stakeholder can be for instance, sourcing department, DC-management, masterdata specialists, category department, store replenishment team or analytics team. When customers process is considered, objective is to distribute all of the ordered goods to stores. Furthermore, stores require the best possible availability for goods ordered from DC.

Process objectives

The process objective or function is described by the case company's management to provide the best possible service level for stores ordering goods from DC. Hence, inventory turnover and overall supply chain cost-efficiency is considered as well. In order to accomplish the set objectives, critical steps can be shortly described as follows. At first, masterdata must be correct. Information provided in the new interface must be interpret correctly by the end users. Forecasts must be accurate. It supports scheduling orders and determining quantities. Succeeding in process will be analyzed by monitoring set KPI's, for instance service level compared to average inventory days of selected product or product category. The key users of the new interface and management are responsible for monitoring the process success. However, process performance affects even more to the replenishers and their personal work and actions.

Inputs and outputs

Process inputs and outputs are described more comprehensively in the actual user process. However, in a general level inputs and outputs for the end user's replenishment process can be determined followingly. Inputs for replenisher to react are order proposals which are updated every day. Information from external masterdata for new products, category changes, ending products, replaced products or other noticeable information. Furthermore, in the interface there can be set different types of alert notifications for the replenishers, informing a situation relating to, for example, high stock level, low stock level, high forecast or low forecast. Outputs from the replenishment process are accurate forecasts and most importantly purchase orders to suppliers. In addition, any kind of information can be easily reported to other stakeholders of the process.

Process steps

In the actual user process, the process steps are determined slightly more comprehensively especially from the different viewpoints and situations. In accordance with chapter 3.3 Figure 8, I have structured simplified replenisher process steps in the new replenishment process. The figure below points out a whole supply chain from the supplier to customer and the most important inputs and outputs for the replenishment process are pointed out. In the case company, there are already existing detailed process charts and process maps from subprocesses which are technically detailed. However, the key objective of this user process is to provide an overall insight of new process for end users. In the figure below, the process steps are divided into five tasks which are presented in the center of the figure.

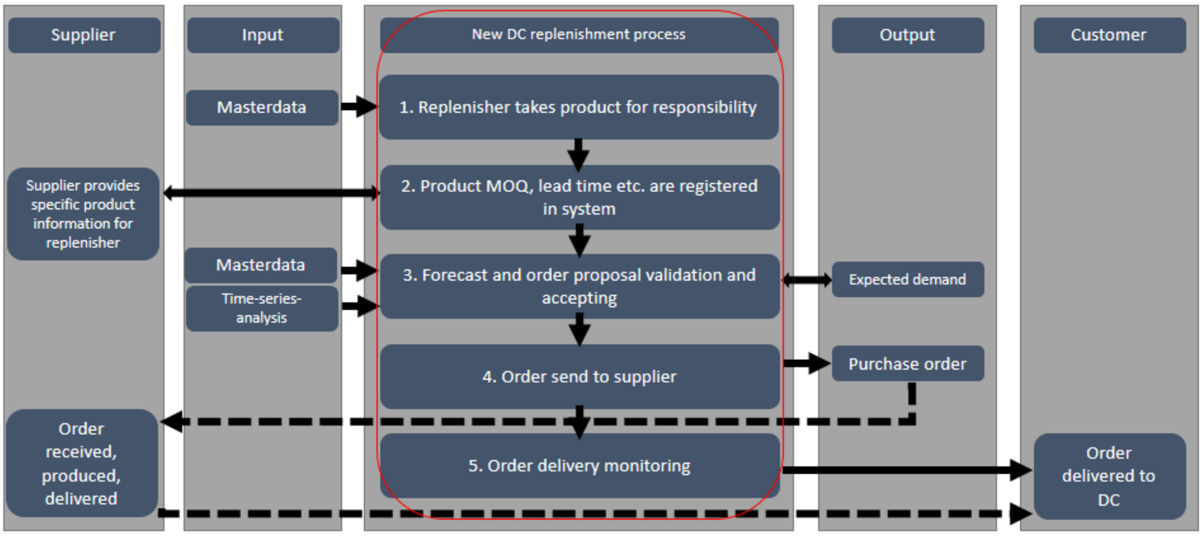

Figure 23. Replenishment process steps.

Input for the first task, taking product for replenishment responsibility, comes from masterdata. The second task is to register product details and lead times and other critical information into new interface. This information can be enquired from supplier. The third step is the most critical for the new process, forecast is based on information from masterdata and automated calculations conducted by exploiting time-series-analysis. Output of third task is validated forecast which is expected demand. In the fourth step the order is send from new interface to ERP from which the order is automatically send to supplier. The fifth step is delivery monitoring, to ensure that the goods are successfully delivered to the distribution center.

5.4 Assessing the Quality of Replenishment Process

In this chapter, the focus is on quality factors of replenishment process and how the quality can be improved. Firstly, the quality in the case company's replenishment process is determined. Secondly, the current methods and future objectives for replenishment process quality assessment are described. However, focus of this chapter is to determine methods for process quality improvement to the new replenishment process. Quality in DC replenishment process can be called process performance. Moreover, process performance determines, how well does the output of the process meet the requirements set for the process. It can be said that quality in the case company's process is in coherence with theory in chapter 3.3 process risk- and quality assessment.

Currently in the case company, quality of replenishment process is analyzed mainly by relying on service level monitoring. In addition, other inputs for process quality come from stakeholders of the process. For instance, the distribution center is one of the key partners of the process and collaboration is very close between DC management and supply chain management team. If something doesn't go like planned at warehouse and it is caused by inconsistent replenishment, distribution center's management provides instant feedback. In other words, on a daily basis feedback is received from stakeholders if replenishment process performance is impaired. Hence, general quality measurement is currently conducted from service level monitoring. In the case company's replenishment process, service level refers to a successfully delivered order from distribution center to stores nationwide. Without a doubt, the service level is a relevant indicator for quality measurement, because it gives good insight how well the replenisher have fulfilled his tasks. (Case company's internal material, 2018).

In order to truly improve quality and process performance assessment in case company and especially in the new process, PDSA (plan, do, study, act) method should be appropriate tool / check list during the improvement process. In accordance with chapter 3.3 (Moen, R., 2010), the following three questions should be answered from the new replenishment process point of view. It can be stated, that PDSA method provides a beneficial check list for quality measurement improvements.

What are we trying to accomplish?

The objective of the new replenishment process from quality perspective is to improve forecasts and stock levels management. Generally, the objective is to improve material flow management. With new replenishment process, efficiency of ordering process should be improved significantly in comparison to the old replenishment process. By improved ordering process efficiency, time for development tasks will be free up, which should be supportive for further process development in the future. Most importantly, when DC replenishment process quality is improved, it will affect end customers' complacency by improved store availability of goods.

What change can we make that will result in improvement?

In order to be sure that a change made is improving quality, the process should be measured and compared to old process before any changes. One issue is that the old process is not monitored or measured that comprehensively, which creates blind area to development monitoring. However, in addition, it is vital to collect feedback from stakeholders, for example from distribution centers. Basically, the key for validating the actual improvements is to be active with other parties, who might have recognized some changes in the process.

What change can we make that will result in improvement?

With the new replenishment interface there come multiple new possibilities to monitor and report different kind of process performance factors. Therefore, it is important to make sure that the process deployment is conducted properly at first place and there are enough resources at deployment and training stages. In addition, well conducted user process supports the end user learning process and helps to achieve improvement objectives. The actual tools for KPI measurement must be carefully build, to achieve the hoped results. The change we can make is to deploy the new replenishment interface and to keep developing it continuously to match the case company's constantly developing requirements.

PQMM

It is beneficial for future process development to proceed process quality management framework in accordance with chapter 3.3 Figure 5. In the figure, process quality is in centrum of four features: maintainability, functionality, usability and reliability. When themes are developed, and the potential of the process exploited, the best possible process quality can be achieved. Hence, the case company's process deployment is yet to be conducted and evaluating the actual process is difficult since the process is not complete at this moment. However, by researching answers to PQMM model questions at this stage of the project, it will support deployment of the process and actual development later, after the deployment. Therefore, based on the action research I have conducted, and on all interviews, below there are set answers to the PQMM model questionnaire, in order to support deployment and testing processes and future development.

Maintainability - How easy it is to modify the process?

The objective of service provider is to build an individually adjusted user interface for requirements of each customer. However, they use the best recognized practices to mitigate process customization. New user interface is meant to be continuously developed after deployment. Basic modifying is supposed to be conducted by key users in the case company, which includes changing and developing parametric optimizations for instance. By modifying the optimizations, output of the process can be developed. In addition, key users can do changes and build new functions inside the interface. However, because of the determinative logics there are some limitations for modifying the user interface. In general, the new replenishment process should be relatively easy to modify and develop, hence certain results will be seen after deployment.

Functionality - Are the required functions available in the process?

At the planning stage, all business rules requirements are determined precisely. During the thesis project, a system configuration is conducted and at same time all earlier determined requirements are checked to ensure that all functions are available in the new process. Moreover, as said, many end user tasks are partly automatized in comparison to the old process. For instance, order proposals are evaluated only by checking the critical items and steady standard orders are created automatically. However, some of the steps of the new process might be slightly more complicated in comparison to the old process. For instance, amending the already existing import orders could be more challenging than in the old process, because of the lack of order planning tool.

Usability - Is the process easy to use?

Considering the researcher's previous personal experiences with the similar system of the same service provider, the interface is relatively easy to use. In addition, considering the few testings that we have conducted already for new interface it seems that new interface is even more user friendly compared to the researcher's previous experiences. New interface requires less window changes while using. It is possible by dashboards, which include multiple different windows and functions. However, considering the change management's view point, there might be some difficulties with training the new process for end users. End users have used the old process for a long time and upcoming change to the new process might be quite challenging. Therefore, a lot of effort should be put into end user trainings before actual deployment. Furthermore, user process is very helpful tool for helping the end users to understand the new process as a whole.

Reliability - How reliable is the process?

Process reliability is one of the key requirements of the case company, to ensure process performance. Process reliability in the new replenishment process can be considered from a few different views. Is the data transferred to interface valid? Is the interface able to proceed massive amounts of data? Is the relevant information presented easily for users in interface? Validating the data which is transferred from other systems to interface, will be monitored daily by end users. The objective of monitoring is to ensure the validity of calculated order proposals for the next days and to ensure process reliability in case of error in data transfers. To ensure interface's ability to proceed all of the data, demo runs with full data are made in the testing stage to ensure go through efficiency. In user testing the actual uploading times in the interface will be tested comprehensively. In order to ensure that the information is easy to interpret for the end user, the experiences from the case company's similar processes and service providers' best practices have been used to achieve the most usable interface as possible. Moreover, the objective of all planning and configurating is to build easily usable interface which includes all business requirements. For instance, in the project team there are end users of old process to provide insight of the process requirements in practice. Further, after deployment of the new replenishment process, key users will continuously develop the interface more usable, based on end users' feedback.

Process quality management model is a supportive method to gather all relevant features from the process including the working aspects and also downsides of the process. Hence, actual development steps for the new process can be conducted not before process deployment. Furthermore, as said, the process quality refers to process performance, which is often analyzed by measuring output of the process. Therefore, the next chapter focuses on KPI development.

KPI Questionnaire

As said in the beginning of this chapter 5.3., there is only one monitored key performance indicator in the old replenishment process which is service level percentage. The service level measures successfully delivered orders from DC to stores. The service level is a relevant meter to measure replenisher's success, however, as its own, the service level is not sufficient for monitoring the quality of replenishment process. Therefore, it was decided to conduct a questionnaire considering KPI-development. The questionnaire was conducted alongside with risk assessment interviews. The questions asked are presented below.

- Is service level as its own a sufficient meter for KPI monitoring?

- Should inventory turnover be considered as a part of KPI monitoring, in applicable product categories?
- Should value of inventory be considered as a part of KPI monitoring, in applicable product categories?
- Would more versatile KPI monitoring support developing a personal professional know-how?
- What would be proper method for measuring the replenishment process KPI?

Questions were presented for four replenishers, and quite surprisingly the results were highly coherent to each other. For instance, everyone agreed that the service level on its own is not sufficient meter for KPI monitoring, hence, the general comment was that service level is a relevant meter. For the second question, everyone agreed that inventory turnover should be considered as a part of KPI monitoring. However, inventory days is a clearer indicator than inventory turnover, which could be misleading and difficult to interpret. (Interview 3, 2018). Value of inventory as a part of KPI monitoring was dividing respondent's thoughts. In interview 2, the value of inventory was considered irrelevant for succeeding in replenishments. However, in interview 3, the value of inventory was considered crucial and very relevant information for replenishments and inventory management.

The difference in these answers might be explained by different nature of products which are replenished. Interviewee 2 is responsible mainly for import products which have short sales time. Short sales time and long lead time create enough challenges for replenishment process, therefore, inventory value is not considered relevant for these products. However, interviewee 3, is responsible mainly for domestic volume products and for instance cigarette replenishments. For example, cigarettes are considerably valuable products to be stored in a warehouse. Therefore, inventory value management is a key aspect for effective replenishment process in valuable products.

All interviewees agreed that more versatile KPI monitoring would support personal know-how development. Hence, interviewee 2, commented that currently he is so burden by work that he doesn't have time for analyze additional indicators. The last question was about proper methods for KPI monitoring. Inventory days in DC should be presented alongside with service level, in order to provide information about balance between service level and warehouse fill level. In addition, stores shelf availability would be a great tool for analyzing consequences of different kind of replenishments. (Interview 3, 2018). Store shelf availability will also support the recognizing of the effect of DC service level to actual store shelf availability and it refers to success in supply chain management as a whole (Interview 2 & 5, 2018). Also, information of DC reception times and volumes, would support managing of seasonal volume peeks (Interview 3, 2018).

KPI questionnaire provided good insight about current situation of process quality measurement and the replenisher's expectations and recommendations of development steps to be taken. According to interview 5, it is important to focus only on a few relevant KPI's instead of using all possible meters for measuring process quality. That is in accordance with chapter 3.4 Figure 8., tradeoff between number of selected KPI's. It is not beneficial to provide all information, because then there is a risk to miss relevant parts. Moreover, for measuring process performance, KPI's are a good tool. In the old replenishment process KPI's are not monitored comprehensively enough. Luckily in the new replenishment process interface provides multiple new tools and possibilities for KPI monitoring. For instance, DC receptions and upcoming volumes are possible to follow up in new user interface. In addition, new interface provides functions for managing material flow for instance in seasonal peeks and in daily basis as well. These factors and future recommendations are presented more comprehensively in findings chapter.

5.5 Findings

5.5.1 The User Process

Key finding of this thesis was the end user process for case company's new DC replenishment process. User process was also key output from this thesis for the case company. User process is utilized in the case company for multiple functions. At first, it is used in system configuration to provide insight about user's requirements in each dashboard inside the interface. Furthermore, user process will be used in end user trainings as a key material for learning the overall process. In addition, it will be used as a supportive data package in interface and process development. Actual user process could not be presented in this thesis, because of sensitive information described in document. However, in the appendix there is a table from content of actual user process, to provide further insight about content in the document. Also, the steps of gathering all required information for the process description are described.

Process of creating user process was relatively multilateral and required information gathering from different sources. As said in the methodology chapter, a big part of information for this research is gathered by action research method. The most of base information for interface usability is learned from different department in case company where the researcher was working before current position. However, the most of technical information for new user interface are discussed in process configuration meetings / workshops, which have been kept twice a week. The meetings are kept with the project team, which consists of service providers team and the case company's project manager, IT-specialists, supply chain analysts and replenishers. These meetings have been highly beneficial for developing the user process because logics and functions inside the user interface have been discussed comprehensively.

Before creating the user process, there were determined core processes of the new process. Core processes were studied by conducting a risk assessment interviews and questionnaires and as results of interviews was risk heat maps. Heat maps indicated which part of the old replenishment process included the most risk potential. From that information, it is relatively straight forwarded to lead risk potential to new process ruling factors. Therefore, the core processes were determined to be forecasting, ordering process, masterdata and category periods. Forecasting and ordering processes were clearly holding most of the risk potential and therefore these processes are emphasized in the actual user process. In addition, some of the perceptions which came up in the replenisher interviews, are pointed out in specific chapter of "recognized challenges". The objective of that chapter is to enhance consciousness of possible challenges which appears because of new process. Furthermore, the most critical risks were pointed out into a process map in chapter 5.2.2 in Figure 24, to visually emphasize possible reason for each risk.

After determining the core processes, the structure of user process was sketched by utilizing the model for standardizing a process description which is presented in literature chapter 3.2. Hence, some parts of the model weren't necessary in this process. Most importantly, major help for creating the user process was meetings with project manager. Project manager is responsible for deployment of the new replenishment process and he is the thesis instructor for the researcher. There were seven meetings in total which involved user process development. In the first meetings, the requirements of case company were set. After that, the meetings were about going through the processes step by step. Usually, the researcher provided a latest version of user process before the meeting to be commented, and in the meeting, comments were covered. It can be argued, that the project manager meetings were the most instructive in developing the user process. Moreover, the user process will be supportive and helpful document for end users learning towards the new process. The user process will be kept updated during the process development in case company.

5.5.2 Optimal Meters for KPI Monitoring

It has come clear that service level as its own is not sufficient meter for measuring the replenishment process performance. Inventory level must be considered as well, because if the focus is only on purchasing as much goods as possible to ensure 100% service level, the outcome for sure is a dramatic overstock which cannot be handled in supply chain. Therefore, the level of inventory must be monitored alongside with the service level. It is important not to measure KPI itself without any development objective in foresight. This is in accordance with chapter 3.4 (Piatt, 2012). By comparing the development of service and inventory level together there can be seen the direction for which the replenisher should develop its own purchasing. The replenisher should not be feeling that KPI's are monitored to supervise the work and to seek the made mistakes. When KPI supports the replenisher's development in work, it truly develops the case company's strategic objectives.

Based on the interviews and further action research there have been gathered theoretically optimal meters for process performance monitoring for the new replenishment process. In addition, the researcher has planned how these meters should be presented in the new interface and how often and how the information should be interpreted. In the new interface, there should be developed one specific dashboard view for all relevant KPIs. Dashboard provides clearly right away a few key figures which show the general trend performance for each replenisher. For instance, there can be provided a service level for all products in last week and in the same graph inventory turnover.

This dashboard is monitored daily, at least to see a general trend. When the replenisher logs in to the interface, the dashboard should show as a default only the products of which the replenisher is responsible. In addition, the outlook could be widened to show other products as well if needed. Furthermore, a key thing is the possibility to customize the dashboard view for each replenishers needs and product categories. This dashboard view will truly support the development of reaching replenisher and the case company's objectives for developed supply chain management. For usability of monitoring KPI's all meters should be gathered in one dashboard.

Based on the research made, optimal meters for monitoring and developing the replenishment process performance are service level, inventory turnover and forecasted inventory days. The service level will remain as a key metric in the future as well, but it should be used with inventory turnover and easily interpretable forecasted inventory days. Furthermore, as a supportive meter new interface provides possibility to monitor upcoming deliveries to DC which helps recognizing the peaks. Being able to recognize volume peaks in advance, it allows users to redirect and level the material flow peaks in product category or supplier level.

Upcoming deliveries to DC as a functionality can be utilized for seasonal peak leveling. Hence, it can be utilized to level weakly peaks for each supplier for instance. Further KPI development should focus to increase exploiting the store data. For instance, in the replenishers' interviews a common request for new KPI was to have the ability to store shelf availability data to follow succeeding in a whole supply chain. The store shelf availability data can be exploited and developed with store replenishment team in the future. However, in accordance with chapter 3.4, it is important to remember to focus on critical few KPIs instead of trivial many. Therefore, key KPIs should be: service level, inventory turnover and forecasted inventory days.

6 Discussion and Conclusions

This chapter summarizes this research and provides future foresight as well. Risk assessment has been proved to be a functional method for outlining the key factors of processes. In addition, risk assessment found out to be a beneficial from process quality management's perspective. It can be stated that this research answers all the research questions successfully.

The main research question: *How to create an end user process for the new operating system to distribution-center replenishment operation?*
In order to create user process for new operation, the core processes needed to be identified. To identify the core processes from the new process it was decided to find out bottlenecks and major risks from old replenishment process. Risk assessment by exploiting heat map questionnaire method is proved to be beneficial in researching the core processes. After the core processes were determined, a new user process was structured by exploiting standardized model for process description. The model supported recognizing the key features and inputs and outputs of the new process. In addition, the process steps were mapped. After the user process was structured, the actual user process was conducted. Hence, the actual user process is not presented in this thesis due to the detailed information. Feedback about actual user process from the case company's management have been very positive and according to the project manager, the user process will be used in many purposes and it will support the objectives of the case company. Therefore, it can be stated that this research was successful.

First sub-question: *How the quality of distribution-center replenishment process should be measured?*
At first the case company's process objectives were studied to determine term quality in the case company. As a result, the service level was proved to be a key metric for measuring process quality. To determine quality objectives more comprehensively the PDSA check list questions were answered. Furthermore, PQMM questionnaire was answered to study how adjustable the new interface actually is. As a result of PDSA and PQMM questionnaires the key objective is to improve SCM management and

provide better forecasts and service level. Furthermore, an answer for actual research question was found out by conducting KPI questionnaire to replenishers. It was found out that current service level metric is not sufficient as its own. Inventory turnover, inventory days and inventory value should be monitored as well to provide further feedback for replenishers. Additionally, stores shelf availability was recognized to be beneficial information in the future. Based on PQMM results, the new process interface should be capable to provide requested metrics in some point. Despite new metrics the service level will remain as a key metric in the future as well and new metrics will be supportive.

Second sub-question: *What are the main processes of distribution-center replenishment operation, from replenisher's point of view, to ensure effective inventory management?*
The main processes are forecasting, ordering process, masterdata and category periods. This question was answered at the basis of risk assessment heat map questionnaire. The results of heat map helped to point out the core processes for the replenishment process. These defined processes were used to designate the actual user process.

Third sub-question: *What actions are required from replenisher to different inputs in replenishment system, to achieve set objectives?*
All actions required from the replenisher are determined in actual user process on required level of details. Due to the details, these required actions haven't been described in detail in this thesis. Hence, in chapter 5.3 the general process steps are described to provide insight about inputs and outputs of the process. Replenisher's key steps in the replenishment system are: 1. Replenisher takes product for responsibility. 2. Product MOQ, lead time etc. are registered into interface. 3. Forecast and order proposal validation and accepting. 4. Order send to supplier. 5. Order delivery monitoring.

Fourth sub-research question: *What kind of added value does the new process create?*
At this point, before the actual process deployment, question can be answered only on a theoretical level. Added value from the new process in comparison to the old

process, is expected to come from improved working efficiency and increased forecast accuracy. Working efficiency is expected to increase due the half-automated replenishments. In the new replenishment process, only critical order proposals are evaluated by the replenisher and other order proposals are accepted without monitoring. Half-automated ordering process is expected to free up time for process development, which should improve efficiency even further in the long term. Moreover, forecast accuracy is expected to be improved by the new process interface, because of advanced time-series analysis in collaboration with replenisher's professional expertise.

This research was limited to grocery DC replenishment operation and the key focus was in conducting the user process. Due to the limitation of this study, it leaves an opportunity for further research. The user process was created on the basis of user interface which is still under development. Because all process steps haven't yet been tested, some steps had to be described partly based on assumptions. Therefore, natural continuum of research will be further testing of the actual replenishment process in the user interface. Alongside with testing a process, the user process should be updated with the latest changes, so it remains reliable and it can be exploited as much as possible. After the implementation of the new replenishment process the research should focus on continuous development of the process in detail. It is obvious that after implementation of the new process, user interface has to be developed from all process parts. Hence, some parts might need more development than others.

In addition, one point of view for further research could be to change management of implementation of the new process. It was already recognized that implementation of the new process will require a lot of effort from all the replenishers and other responsible working with the new process. Therefore, resource determination and allocation will be vital for successful implementation. Furthermore, the training programs should be planned and scheduled as well.

References

Agrawal, N. & Smith, S. A. 2009. Retail Supply Chain Management: Quantitative Models and Empirical Studies. Boston, MA: Springer US.

Al-Fedaghi, S. Haya, Alahmad. 2017. Process Description, Behavior, and Control.

Al-Zwainy, F. 2018. Diagnose the Causes of Cost Deviation in Highway Construction Projects by Using Root Cause Analysis Techniques. Arabian Journal for Science and Engineering, 43(4), pp. 2001-2012.

Arrow, K. J. 1951. Optimal Inventory Policy. Econometrica, 19(3), pp. 250-272.

Baecke, P. De Baets, S. Vanderheyden, K. 2017. Investigating the added value of integrating human judgement into statistical demand forecasting systems. INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 191.

Caniato, F. Kalchschmidt, M. Ronchi, S. 2010. Integrating quantitative and qualitative forecasting approaches: Organizational learning in an action research case. Journal of the Operational Research Society, 62(3), p. 413.

Chen, S. 2011. A membership function approach to lot size re-order point inventory problems in fuzzy environments. International Journal of Production Research, 49(13), pp. 3855-3871.

Chikán, A. 2007. The new role of inventories in business: Real world changes and research consequences. *International Journal of Production Economics, 108*(1), pp. 54-62.

Choi, T. & Chiu, C. 2012. Risk Analysis in Stochastic Supply Chains: A Mean-Risk Approach. New York, NY: Springer New York: Imprint: Springer.

Davenport, T. H. 1994. Reengineering: Business Change of Mythic Proportions? MIS Quarterly, 18(2), pp. 121-127.

Dupin-Bryant, P., & Olsen, D. H. 2014. Business intelligence, analytics and data visualization: A heat map project tutorial. International Journal of Management & Information Systems (Online), 18(3), 185.

Ehrenthal, Jcf. Honhon, D. Woensel, Tvan. 2014. Demand seasonality in retail inventory management. European Journal of Operational Research, 238(2), pp. 527-539.

Elliot, C. Mcullagh, C. Brydon, M. Zwi, K. 2018. Developing key performance indicators for a tertiary children's hospital network. Australian health review: a publication of the Australian Hospital Association, 42(5).

Evans, J. Lindsay, W. 1996. The Management and Control of Quality. Third edition. West publishing company. ISBN 0-314-06215-7. 767 pages.

Fernie, John. Sparks, Leigh. Mckinnon, Alan C. 2010. Retail logistics in the UK: Past, present and future. International Journal of Retail & Distribution Management, 38(11/12), pp. 894-914.

Fildes, R. Goodwin, P. Lawrence, M. 2006. The design features of forecasting support systems and their effectiveness. Decision Support Systems, 42(1), pp. 351-361.

Finne, S. Kokkonen, T. 2005. Asiakaslähtöinen kaupan arvoketju. Kilpailukykyä ECR-yhteistyöllä. WSOY. Juva. ISBN 951-0-31262-2. 460 pages.

Friend, S. Walker, H. 2001. Welcome to the new world of merchandising. Harvard Business Review, 79(10), pp. 133-141.

Guceglioglu, A. S. & Demirors, O. 2011. The Application of a New Process Quality Measurement Model for Software Process Improvement Initiatives. Quality Software (QSIC), 2011 11th International Conference on, pp. 112-120.

Gîrbea, A. 2010. Design, implementation and monitoring of a screw order handling process using business process management tools. Proceedings of the International Conference on Optimisation of Electrical and Electronic Equipment, OPTIM, pp. 760-767.

Haile, N. 2016. Value creation in software service platforms. Future Generation Computer Systems, 55(C), pp. 495-509.

Hallikas, J. Karvonen, I. Lehtinen, E. Ojala, M. Pulkkinen, U. Tuominen, M. Uusi-Rauva, E. Virolainen, V.M. 2001. Riskienhallinta yhteistyöverkostossa. Helsinki: Metalliteollisuuden kustannus. ISBN 951-817-762-7. 93 pages.

Hedge, A. 2007. Developing a Business Process Model. AIIM E - Doc Magazine, 21(2), pp. 31-33.

Hirsjärvi, S., Remes, P. & Sajavaara P. 2005. Tutki ja kirjoita. 11. Uudistettu painos. Jyväskylä. Gummerrus Kirjapaino Oy. ISBN 951-26-5113-0. 436 pages.

Hübner, Alexander H. Kuhn, Heinrich. Sternbeck, Michael G. 2013. Demand and supply chain planning in grocery retail: An operations planning framework. International Journal of Retail & Distribution Management, 41(7), pp. 512-530.

Janssen, M., Voort, H., Wahyudi, A. 2017. Factors influencing big data decision-making quality. Journal of Business Research, 70, p. 338.

Ju, B., Gluck, M. 2005. User-process model approach to improve user interface usability. Journal of the American Society for Information Science and Technology, 56(10), p. 1098.

Järvinen, P. Järvinen, A. 2012. Tutkimustyön metodeista. Tampere. Opinpajan kirja. ISBN 978-952-99233-4-2. 212 pages.

Kedad, Z., Loucopoulos, P. 2011. Considering quality factors for business processes during requirement engineering. Research Challenges in Information Science (RCIS), 2011 Fifth International Conference on, pp. 1-9.

Klein Haneveld, W. K. Teunter, Ruud H. 1998. Effects of discounting and demand rate variability on the EOQ. International Journal of Production Economics, 54(2), pp. 173-192.

Laamanen, K. 2005. Johda suorituskykyä tiedon avulla – ilmiöstä tulkintaan. Helsinki, Suomen Laatukeskus Oy. ISBN 952-5136-27-2. 433 pages.

Lecompte, M. D. 2000. Analyzing Qualitative Data. Theory Into Practice, 39(3), pp. 146-154.

Lepmets, M. 2014. The Evaluation of the IT Service Quality Measurement Framework in Industry. Global Journal of Flexible Systems Management, 15(1), p. 39.

Li, X. t. & Xu, X. t. 2017. Proceedings of the Fourth International Forum on Decision Sciences. Singapore: Springer Singapore

Lofurno, M. 2002. The Gantt chart. Compoundings, 52(6), p. 35.

Mckay, S. 2016. CGMA TOOLS: How to communicate risks using a heat map. *Journal of Accountancy, 221*(6), pp. 35-40.

Metsämuuronen, J. 2006. Laadullisen tutkimuksen käsikirja. Jyväskylä, Gummerrus Kirjapaino Oy. ISBN-10: 952-5372-19-7. 750 pages.

Moen, R. 2010. Foundation and History of the PDSA Cycle. Associates in Process Improvement-Detroit (USA). pp.1-9.

Ould, Martyn A. 2005. Business Process Management: a Rigourous Approach. XII. Swindon: BCS Learning & Development Limited

Piatt, J. 2012. 5 RULES for Selecting the Best KPIs to Drive Operational Improvement. Industry Week, 261(11), p. 30.

Quiescenti, M. Bruccoleri, M. La Commare, U. Noto La Diega, S. Perrone, G. 2006. Business process-oriented design of Enterprise Resource Planning (ERP) systems for small and medium enterprises. International Journal of Production Research, 44(18-19), pp. 3797-3811.

Sakki, J. 2009. Tilaus-toimitusketjun hallinta. B2B vähemmällä enemmän. Hakapaino Oy. Helsinki. 7th edition. ISBN 978-951-97668-4-3. 221 pages.

Shao, C. Wang, Lizhong. 2010. Quantitative and Qualitative Forecasting Applied to Supply-Chain Inventory. Multimedia and Information Technology (MMIT), 2010 Second International Conference on, 2, pp. 184-187.

Scholz-Reiter, B. Heger, J. Meinecke, C. Bergman, J. 2012. Integration of demand forecasts in ABC-XYZ analysis: Practical investigation at an industrial company. International Journal of Productivity and Performance Management, 61(4), pp. 445-451.

Sounders, M. Lewis, P. Thornhill, A. 2009. Research methods for business students. 5th ed. Harlow: Pearson Education. ISBN: 978-0-273-71686-0. 613 pages.

Stricker, N. Echsler, M. Lanza, G. 2017. Selecting key performance indicators for production with a linear programming approach. International Journal of Production Research, 55(19), pp. 5537-5549.

Susman, G. I. Evered, Roger. D. 1978. An Assessment of the Scientific Merits of Action Research. Administrative Science Quarterly, 23(4), pp. 582-603.

Suwanruji, F. Enns, S. 2006. Evaluating the effects of capacity constraints and demand patterns on supply chain replenishment strategies. International Journal of Production Research, 44(21), p. 4607-4629.

Tersine, R. 1994. Principles of inventory and materials management. 4th ed. The University of Oklahoma: Prentice-Hall. Inc. 591 pages.

Trkman, P. 2010. The critical success factors of business process management. International Journal of Information Management, 30(2), pp. 125-134.

Östring, P. 2004. Profit-focused supplier management. American Management Association. New York. ISBN 0-8144-7178-0. 238 pages.

Electronic references

Business Dictionary (2018) Value creation [Online document]. [Accessed 08.11.2018]. Available at http://www.businessdictionary.com/definition/value-creation.html

Internal references

Interview 1. 15.11.2018. Replenishment specialist, case company.
Interview 2. 22.11.2018. Replenishment specialist, case company.
Interview 3. 29.11.2018. Replenishment specialist, case company.
Interview 4. 13.12.2018. Replenishment specialist, case company.
Interview 5. 12.12.2018. Replenishment specialist, case company.
Interview 6. 14.12.2018. Project managers, service provider.
Service provider Webinars, 2018.

Appendices

Appendix 1. Risk Heatmap questionnaire

	Forecasting related problems
	Domestic orders
R1	Short lead time product from domestic supplier is out of stock due the too small order created by replenisher
R2	Short lead time product from domestic supplier is out of stock due the supplier cant deliver requested quantities
R3	Product is scrapped due the excess stock which is caused by too high demand forecast
R4	Product is out of stock due the too small order / forecast, when demand is increased because of new food trend
R5	Product is out of stock due the too small order / forecast, when demand is increased because of seasonal sales for instance, chistmas, midsummer day etc
R6	Product is out of stock due the too small order / forecast, when demand is increased because of seasonal changes for instance particularly rainy or hot summer

	Forecasting related problems
	Import orders
R7	Long lead time product from international supplier is out of stock due the too small order / forecast created by replenisher
R8	Long lead time product from international supplier is out of stock due the supplier cant deliver requested quantity
R9	Product is scrapped due the excess stock which is caused by too high demand forecast
R10	Product is out of stock due the too small order / forecast, when demand is increased because of new food trend
R11	Product is out of stock due the too small order / forecast, when demand is increased because of seasonal sales for instance, chistmas, midsummer day etc
R12	Product is out of stock due the too small order / forecast, when demand is increased because of seasonal changes for instance particularly rainy or hot summer

	Ordering process
	Domestic orders
R13	You have to do amendments to the non-coordinated order afterwards based on changes informated by supplier
R14	You have to do amendments to the coordinated order afterwards based on changes informated by supplier
R15	Purchase order havent been succesfully sent to supplier from ERP-system, and fault is noticed not until date of delivery
R17	Due the high work load there is not enough time for order planning and management which increases the risk of missing something relevant information
R18	Agreed minimum order quantities are too large for efficient inventory management

	Ordering process
	Import orders
R19	You have to do amendments to the non-coordinated order afterwards based on changes informated by supplier
R20	You have to do amendments to the coordinated order afterwards based on changes informated by supplier
R21	When doing amendments to the order afterwards, you also make same amendments to the order planning tool to be able to follow up with supply planning
R22	You are using your own markings for instance comments or color codes in order planning tool to be able to follow up with changes
R23	Purchase order havent been succesfully sent to supplier from ERP-system, and fault is noticed not until date of delivery
R24	Agreed minimum order quantities are too large for efficient inventory management
R25	Due the high work load there is not enough time for order planning and management which increases the risk of missing something relevant information

	Masterdata
R26	Product price is missing
R27	Supplier product code is missing
R28	Pallet quantity information is incorrect or missing
R29	Category information for new or replacing new product are missing
R30	Information of category changes is provided too late for replenisher
R31	Sourcing department have negotiated minimum order quantity for product / order, but haven't informed replenisher from agreement
R32	Incorrect information in masterdata prevents or slows down the order creation process
R33	Some relevant information haven't reach replenisher, due the incomplete stakeholder communication
R34	Supplier hasn't provided information for changed tray size

	Category periods
R35	Replenisher hasn't recognized a new product, and as a result product is not available on launch date
R36	Replenisher mistakenly orders delisted product
R37	First order of replacing new product is too small or big compared to demand
R38	First order of new product is too small or big compared to demand
R39	There are excess stock left after category period for delisted product

Appendix 2. Specialist interviews: Key performance indicator questions.

Is service level as its own a sufficient meter for KPI monitoring?
Should inventory turnover be considered as a part of KPI monitoring, in applicable product categories?
Should value of inventory be considered as a part of KPI monitoring, in applicable product categories?
Would more versatile KPI monitoring support developing a personal professional know-how?
What would be proper method for measuring the replenishment process KPI?

Appendix 3. Table of content of End user process for DC replenishment operation.