



Master's degree thesis

LOG950 Logistics

A managerial decision model for order fulfillment process improvement in wholesale industry.

Darya Ramanava

Olga Sergeeva

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Preface

This master thesis is the final mandatory part of the Master of Science in Logistics program at Molde University College - Specialized University in Logistics.

We appreciate the opportunity to express our gratitude to our supervisor Associate Professor Berit Irene Helgheim for her guidance through the writing process, valuable advice and constructive recommendations.

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Molde, May 2013.

Olga Sergeeva and Darya Ramanava

Abstract

Under the pressure of strong competition and increasing customer requirements many companies in various industries struggle to gain competitive advantages by increasing customer satisfaction. Companies operating in wholesale of machinery, equipment and supplies industry are not an exception. More and more companies are adopting various approaches like business process improvement to raise customer satisfaction and improve company- and supply chain performance.

However a task of business process improvement is not an easy one as most of the approaches on process improvement are rather philosophies than a well-developed set of guidelines that provide assistance in process analysis and decision support in development- and implementation of improvement initiatives.

Therefore this paper is focused on development of managerial decision model that provides a set of guidelines for improvement of order fulfillment process, which has a direct influence on customer satisfaction in wholesale of machinery, equipment and supplies industry. Besides, this paper provides an example of a real case application of a model within single case study of TOOLS Molde AS which is considered to be a typical industrial distributor operating in a given industry.

Developed model is based on a holistic approach to business process improvement and covers four key business processes in a given industry: order fulfillment process (in the focus of improvement), and processes that used as analytical dimensions - customer relationship management, inventory management and supplier relationship management. Besides, model provides analytical instruments corresponding to each of the dimensions which are used to receive necessary input for improvement. Finally, model suggests a set of performance measures and modeling tools in order to evaluate success of developed improvement initiatives. In addition this thesis provides an example of a real case application of the model is demonstrated by means of a single case study of TOOLS Molde which demonstrates how the model can be applied by business practitioners.

Finally, this research has the following outcomes: managerial decision model for order fulfillment improvement and a real-life example of model implementation including a set of improvement initiatives and simulation model of order fulfillment process that allows to evaluate success of improvement. The paper discusses the possibility for developed model to be generalized for implementation by other industrial distributors and for improvement of other business processes besides order fulfillment.

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List of abbreviations

Abbreviation	Full Name
BP	Business Process
BPI	Business Process Improvement
BPM	Business Process Management
BPR	Business Process Reengineering
CLV	Customer Lifetime Value
CP	Customer Profitability
CRM	Customer Relationship Management
DIY	Do-It-Yourself products
IM	Inventory Management
MRO	Maintenance, Repair and Operations
OFP	Order Fulfillment Process
SKU	Stock Keeping Unit
SRM	Supplier Relationship Management
VMI	Vendor Managed Inventory
WME&S	Wholesale of Machinery, Equipment and Supplies

1. Introduction

Nowadays companies struggle to achieve competitive advantages on the market operating in a business environment characterized by highly competitive prices, growing demands for lower costs, high product commoditization and high automation of business. Main trends in the economy in the next decade such as growing importance of effective collaboration between corporate units, customers and suppliers; growing requests for product personalization or customization and growing importance of knowledge management will not make the situation easier (The_Economist_Intelligence_Unit 2006).

Therefore companies need to find new ways to excel among competitors. One of the most important and powerful approaches to improve performance and customer satisfaction is business process improvement (Forster 2006). Successful business process improvement has a significant impact on company or supply chain performance (Rohleder and Silver 1997).

Every company needs to make a decision which business processes should be improved first. This thesis is focused on order fulfillment process (OFP) improvement since it is one of the most important processes for each company that has direct influence on company performance and customer satisfaction (Croxtton 2003). This process links outbound and inbound logistics of the focal company and thus spreads across several functions of a company and across supply chain (Croxtton 2003). Customer is involved in OFP when it quotes for available offerings, places an order, receives the product or service and pays money for the offering. In its turn, supplier is involved in OFP when a focal company makes a quote, places an order, picks an order and dispatches an order.

Therefore, improvement and other redesign initiatives addressed towards OFP may influence customer satisfaction and thus company profitability and whole supply chain profitability which makes improvement of OFP an important issue. Croxtton (2003) states that OFP directly influences on delivery and sourcing costs by network optimization, total sales volume by managing the availability of products, order-to-cash cycle by streamlining the process and inventory level by reducing delivery time.

Even though there are a lot of valuable approaches to business performance improvement these approaches do not offer any specific guidelines on process improvement which makes business process improvement “a-state-of-art” business practice (Forster 2006).

Therefore main purpose of this research is to develop and demonstrate a real case application of a managerial decision model for strategic OFP improvement for industrial

distributor in wholesale of machinery, equipment and supplies (WME&S) industry. The model developed in this research embraces business improvement approaches and corresponding instruments and tools that can be used for strategic OFP improvement by managers or process teams.

The introduction will continue with the description of scientific context of the research.

1.1. Research in a Scientific Context

The research intends to develop a managerial decision model for strategic OFP improvement for industrial distributor in WME&S industry. While some aspects of this problem are well developed in scientific literature other aspects still require additional research.

From one side OFP is studied quite well, starting with fundamental ideas of Lambert, Cooper, and Pagh (1998) further developed by Croxton (2003). There are plenty of studies on order fulfillment process reengineering and improvement (Lin and Shaw 1998, Škrinjar and Trkman 2013). Some of them are supported by simulation (Zhang, Jiao, and Ma 2010, Roy 1998). Most of them deal with operational level of the process and are concentrated on implementation of IT (Cathy, Choy, and Chung 2011, Cort, Stith, and Lahoti 1997, Shepherd and Pope 2011) or evaluation of effects of information sharing and forecasting (César 2008, Forslund and Jonsson 2007). Quite recently scientists became interested in customization of order fulfillment process or its orientation towards customer needs (Škrinjar and Trkman 2013, Röglinger, Pöppelbuß, and Becker 2012, Das and Sengupta 2010).

From the other side relatively low attention is paid to specificity of wholesale of machinery, equipment and supplies industry. While very few studies concentrate on the industry from the wholesaler perspective, the majority of the studies described and analyzed product and information flow in the supply chain of the industry from the perspective of industrial customers (Ho, Chang, and Wang 2008, Bechtel and Patterson 1997, Webb and Lambe 2007, Sashi and Stern 1995). Some of studies deal with optimization and aggregation of purchasing or development of partnership with suppliers in order to optimize costs, other consider industrial wholesaling from marketing prospective.

Very few of articles use process-based approach to analyze wholesale of machinery, equipment and supplies industry. Only few examples were found: Pant, Sethi, and Bhandari (2003) suggest to apply e-supply chain principles for process that take place in industrial distribution and Cort, Stith, and Lahoti (1997) study general effects of IT implementation in

industrial distribution industry. No articles concerning problem of order fulfillment process improvement in industrial wholesaling were found.

Therefore the following research is considered to be relevant as it describes well developed ideas of business process improvement and adapts and applies them to the area of order fulfillment process improvement in the industry where no similar research was performed from industrial distributor perspective.

1.2. Research Questions

The main purpose of this research is to develop and demonstrate a real case application of a managerial decision model for strategic OFP improvement for industrial distributor in WME&S industry.

The first sub-problem of this research is to develop a managerial decision model for strategic OFP improvement.

The second sub-problem is to demonstrate a real case application of a managerial decision model for strategic OFP improvement.

First sub-problem

In order to explore the first sub-problem a set of corresponding research questions is explored in the present research.

First of all it is necessary to define the research environment. As far as the research problem is formulated for a specific industry, it is important to identify *what specific features of the industry are critical for OFP improvement*. This question is relevant due to a very little scientific research done for the WME&S industry as it was mentioned in the previous paragraph. Within current question this research describes typical supply chain of the industry, competitive advantages and core business processes of industrial distributor.

Second, it is necessary to define *what business improvement approach is appropriate for order fulfillment process improvement in this industry*. In order to answer this question the thesis describes a range of possible business process improvement approaches and then defines an appropriate business improvement approach for strategic OFP improvement with respect to the specificity of the process and the industry.

Third, the thesis defines *what dimensions of analysis and corresponding methods could be used for order fulfillment improvement*. Within this research question the thesis analyzes dimensions that influence on OFP and identifies the ones that can be used in strategic OFP improvement. Then a range of corresponding methods that can be used for a strategic OFP improvement is identified and discussed.

Fourth, the way *how to evaluate successfulness of strategic order fulfillment improvement* is explored in the study. Within this research question OFP performance metrics are defined. Besides, the thesis suggests and discusses the use of simulation as managerial decision support tool in order to evaluate successfulness of OFP improvement.

As a result managerial decision model for industrial distributor is formulated on the basis of selected dimensions of analysis and corresponding methods together with identified performance metrics and evaluation tools that are could be used for strategic order fulfillment improvement in the wholesale of machinery, equipment and supplies industry.

Second sub-problem

In order solve the second sub-problem the demonstration of a real case application of a managerial decision model a set of corresponding research tasks is performed in the present research.

First, this research describes a case company in order to provide understanding of current corporate structure, marketing strategy of a company, main customers, main competitors and the way internal business processes are organized in the company.

Then managerial decision model is applied to strategic order fulfillment in order to develop a range of improvement initiatives that can be initiated by a case company in order to increase company- and supply chain performance.

Finally, some of the improvement initiatives are tested with help of simulation model of OFP in order to evaluate whether developed improvement initiatives will significantly influence company's performance and make a conclusion whether it is reasonable to implement order fulfillment improvement initiatives in a real life.

1.3. Structure of the Paper

After Introduction, the second chapter of this paper provides description of WME&S industry in supply chain context. This chapter is aimed at answering the first research question formulated in the thesis: what specific features of the industry are critical for OFP improvement. The main goal of this chapter is to provide basis for the research and define the research area. Specific feature of machinery, equipment and supplies wholesaling industry are described in the first part of the chapter. This includes typical product description, market description and description of tendencies. Second part of the chapter provides specific characteristics of the supply chain in machinery, equipment and supplies wholesaling industry such as: network structure, key business processes and complexity parameters. First chapter provides a basis for identification of key business processes linked to order fulfillment in the

industry and main directions in which order fulfillment process should be improved. Chapter 2, besides, serves as a basis for chapter 3: “theoretical framework”, as the choice of appropriate business improvement approach is conditioned by the specific features of the industry.

Chapter 3 provides description of business improvement approaches that are appropriate for OFP improvement in the industry and identifies business process improvement approach for this thesis. It aims at description of strategic order fulfillment improvement identified in the first part of the chapter. In the second part main dimensions of analysis and corresponding methods that could be used for order fulfillment improvement are described. In the third part, this chapter suggests performance metrics and modeling tools that can be used to evaluate successfulness of strategic order fulfillment improvement. Finally, on the basis of industry description, chosen BPI approach, described dimensions and corresponding methods and evaluation tools for OFP improvement this chapter provides the description of managerial decision model for strategic order fulfillment improvement in machinery, equipment and supplies industry.

Methodology of the empirical study is described in Chapter 4. This chapter explains the essence of case study, the model according to which case study was performed, research methodology, research methods and the way data for case study were collected, cleaned and analyzed.

Chapter 5 provides an example of managerial decision model implementation for a case company. This chapter provides general company description and description of key business processes within a company: order fulfillment, customer relationship management, inventory management and supplier relationship management processes. Further down the managerial decision model is applied and strategic order fulfillment initiatives are discussed on the basis of the obtained results. Then this chapter provides description of simulation model which was developed to evaluate successfulness of OFP improvement initiatives. Effect of some initiatives for strategic order fulfillment improvement that were formulated is tested with help of simulation model.

Chapter 6 contains discussion of managerial decision model. Strengths, weaknesses and limitations of the model are presented there.

Chapter 7 provides summary of the master thesis and recommendations for directions of further research.

1.4. Definitions and Delineations

Wholesale of machinery equipment and supplies industry

The choice of the industry in the thesis was determined by an operating area of a case company. It was identified that industry in which case company operates belongs to industry sector of wholesale trade according to North American Industry Classification System (NAICS). Among industry groups included in this sector the research is focused on the wholesale of machinery equipment and supplies. Since the range of products sold by a case company is spread among different specific industries of this group in the thesis a wholesale of machinery, equipment and supplies is considered to be the main industry of a case company.

This industry includes companies primarily engaged in the wholesale distribution of specialized machinery, equipment, and related parts and other industrial consumables generally used in manufacturing, oil well, and warehousing activities.

Further down a company working in wholesale of machinery, equipment and supplies is referred as industrial distributor or industrial wholesaler.

Strategic order fulfillment process

The research is focused mainly on the strategic order fulfillment improvement.

According to Croxton (2003) order fulfillment which deals with generating, filling, delivering and serving customer orders. It can be divided into operational and strategic processes.

Order fulfillment on operational level is focused on transactions while on strategic level it establishes the structure for managing the process at a focal company. As strategic order fulfillment forms the way operational process is executed on a day-to-day basis. Therefore critical improvements should be applied to strategic level of the process. According to Croxton (2003) “at strategic level management of a company can focus on making critical improvements to the process that influence financial performance of a company, its customers and its suppliers”.

2. Wholesale of Machinery, Equipment and Supplies Industry in Supply Chain Context

The aim of this chapter is to describe specific features of wholesale of machinery, equipment and supplies industry in order to identify features of the critical for order fulfillment improvement. First, this part describes main features of the industry and explores main market tendencies. Second, this part describes typical supply chain corresponding to WME&S industry in order to provide understanding of focal company in this research, critical supply chain members, key business processes and supply chain complexity in the industry.

2.1. Industry Description

Wholesale of machinery, equipment and supplies industry as well as its sub-industry industrial supplies wholesaling are experiencing a period of transformation (Tompkins_International (2013), DHL_Supply_Chain (2009), B&B_TOOLS (2012)). After the global financial crisis sales in the industry are getting back to before crisis level. However more and more industrial buyers and other customers of the industry are paying closer attention to their Maintenance, Repair and Operations supplies' efficiency and effectiveness (Tompkins_International (2013), DHL_Supply_Chain (2009), B&B_TOOLS (2012)). To understand the changes experienced by the industry and opportunities for building competitive advantage for industrial distributors this paragraph provides the insight into main industry characteristics and tendencies.

Product

Wholesale of machinery, equipment and supplies industry deals with supplies of maintenance, repair and operations materials (MRO) and supplies of other industrial consumables and components which can not be classified as MRO materials.

Its sub-industry Industrial Supplies Wholesaling, according to North American Industry Classification System “comprises establishments primarily engaged in the merchant wholesale distribution of supplies for machinery and equipment generally used in manufacturing, oil well, and warehousing activities” (NAICS 2013).

The sub-industry supplies industrial producers with industrial consumables and not customized industrial components such as: bearings, industrial containers, crowns and closures, printing ink, power transmission supplies, mechanical rubber goods, seals, shipping containers, industrial towels, abrasives, ropes, valves and welding supplies (NAICS 2012).

As referred above some of the products supplied by wholesale of machinery, equipment and supplies industry belong to maintenance, repair and operations or MRO goods

which are represented by a very vast range of diverse items that support internal operations and either do not become a part of end product or are not central to the company's output. This array of items consists of industrial consumables and components varying from safety gloves and office supplies to spare parts for industrial equipment and tools (DHL_Supply_Chain 2009).

MRO items are characterized by disproportional workload, extensive range of items and supplies, large amount of company-specific items (such as spare parts) and both low and irregular demand for items (Gelderman, Semeijn, and Lek 2008). According to Saggiaro, Martin, and Lara (2011) From the point of view of the buying company MRO goods are characterized by high cost of ownership compared to a price paid for materials (DHL_Supply_Chain 2009).

According to DHL_Supply_Chain (2009) expenses of industrial consumers on MRO represent up to 16 percent of the cost of goods – but 62 percent of total requisitions.

Characteristics of the product influence the way the supply chain of the industry is organized. Product characteristics explain the following features of supply chain of the industry:

- large amount of individual suppliers;
- necessity for intermediaries: industrial distributors;
- fluctuating demand;
- high supply chain complexity;

Market

Main customers of the industry are energy, oil & gas, nuclear, power generation, transportation, aerospace, industrial machinery, CPG, medical systems to name a few (QuEST 2013). Typically this industry is quite fragmented and is characterized by high competition from both local and global players (B&B_TOOLS 2012).

Customer preferences in the industry are: competitive prices, product breadth, availability, speed delivery and technical support (Tompkins_Inernational 2013).

On a global scale wholesale of machinery, equipment and supplies experienced a decline after the global financial crisis as many of its customers were affected by the crisis and had to cut expenses. Nowadays the industry is approaching its before crisis turnover level. The same applies to the Norwegian wholesale of machinery, equipment and supplier industry. Its example is used to show the development of industry market due to the fact that a case company operates on Norwegian market.

Norwegian wholesale of machinery, equipment and supplies industry experienced decline in sales between years 2008 and 2012 (see Figure 1) (SSB 2013). Growth index in 2012 compared to 2008 is 0,97% and growth rate is -0,03% respectively, however growth index in 2012 compared to 2009 is 113% and growth rate 13% respectively. It can be seen that even though in 2009 industry turnover declined by 13% compared to the year 2008 now the industry is approaching sales volume of that year. This might be explained by the negative influence of global crisis on the WME&S industry in Norway. Therefore the conclusion can be drawn that the industry is currently expanding in terms of sales volume and there are market opportunities for companies operating in the industry.

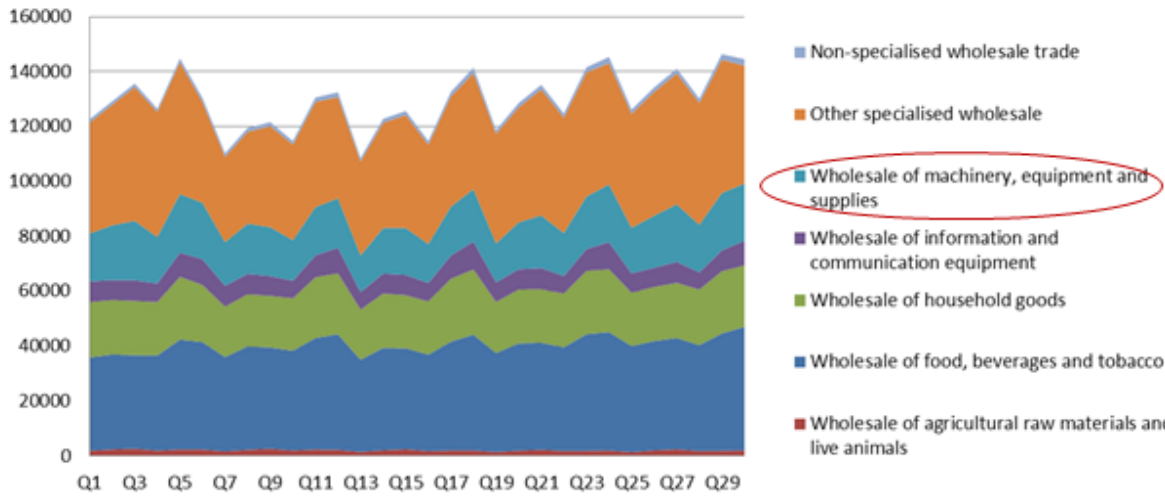


Figure 1. Turnover statistics of wholesale industry in Norway except wholesale on a fee or contract basis (by two months periods), MNOK.

As to the competition in the wholesale of machinery, equipment and supplies industry in 2010 and 2011 there were 3789 and 3786 enterprises respectively. Major companies in this industry are B&B TOOLS, Tess, Würth, Proffpartner and Albert E Olsen (B&B_TOOLS 2012).

Efficiency

Main activities that are performed by supply chains are transportation, storage and marketing of stock (NAICS 2012). All these activities are quite labor-intensive and, according to NAICS (2012) report, majority of ongoing capital expenditures on this market could reach 70%.

Profitability of the industry depends mostly on operational efficiency especially in inventory management area (First_Research 2013). Big distributors that have the major share of the market have a large distribution network of warehouses and outlets (First_Research

2013). This leads to a higher economic efficiency as long as a company has lower inventory/sales ratio.

Tendencies and key success factors

Main tendencies in the industry are formed with respect to five main customer preferences referred above: competitive price, product breadth, availability, speed of delivery and technical support. The buyer is in the focus of the supply chain and customer satisfaction is the main pillar of success in the industry.

More and more industrial buyers become focused on total price of ownership. “The ability to have total price transparency presents a clear expectation for price competitiveness” (Tompkins_International 2013). Both customers and distributors “lack comprehensive tracking systems that provide visibility into the total cost of ordering, warehousing, transporting, receiving, payment and other supply chain costs” (DHL_Supply_Chain 2009). Therefore distributors are expected to offer competitive prices by reducing total cost of ownership in the future and transparent pricing policies.

When it comes to product assortment more and more industrial buyers require wide, “full-line” product range (Tompkins_International 2013). Therefore there is a tendency for growth of product range offered by a wholesaler in the future (Tompkins_International 2013).

Availability is also very important for customers as they are more and more often looking for perfect order (Tompkins_International 2013). Order accuracy, shorter lead times and efficient information flow are the main areas customers, distributors and suppliers are going to collaborate on in the future (Tompkins_International 2013). Distributors need to collaborate closely with suppliers and manufacturers to prevent unnecessary rise of the stock and reduce non-moving stock (DHL_Supply_Chain 2009).

Speed of delivery is going to increase to same-day or next-day delivery even though now customers accept three- to four-days delivery (Tompkins_International 2013). Collaboration between distributors and suppliers or manufacturers becomes crucial to comply with customer requirements. Supply chain network, logistics and operations should be re-adjusted to meet the standard of same- or- next-day delivery (Tompkins_International 2013).

Technological support also becomes increasingly important on the market (Tompkins_International 2013). Consultancy services, help in searching for the best possible solution and ability to talk with an expert will become more important in the future customer requirements (Tompkins_International 2013). The companies that provide customers with specialized services (as delivery solutions, product expertise, product functionality

optimization), specific suppliers have a competitive advantage on the market (First_Research 2013, QuEST 2013). In the future this trend will become even more noticeable.

Another tendency in the industry is to move the stock from the manufacturer closer to the end user in terms of location (NAICS 2012). However, in terms of ownership the tendency is completely opposite: the stock is moved from the end user to the supplier or manufacturer (DHL_Supply_Chain 2009). Therefore there is a trend for on-site management of MRO procurement and inventory and consignment inventory (DHL_Supply_Chain 2009).

On the Norwegian market consolidation of distributors is going to be the main tendency when it comes to the market structure (B&B_TOOLS 2012). Currently Norwegian market is very fragmented. Taking into account that industrial buyers are trying to reduce the number of the suppliers of MRO materials, growth of mergers and acquisitions is expected.

In general, DHL_Supply_Chain (2009) has defined the following points of leverage in the industry of MRO supplies: lack of complete understanding and transparency of MRO costs, fragmented and inefficient supply chains, lack of visibility into MRO supply chain. Skilled workforce of customers spends too much time trying to find the right item on stock. Furthermore risk issues increased importance due to security aspects when multiple suppliers enter warehouse or on-site facilities. These areas are expected to be addressed in the future by customers, distributors and suppliers, (DHL_Supply_Chain 2009). Points of leverage, described above, indicate opportunities for the future development and competitive advantages.

To summarize, wholesale of machinery, equipment and supplies industry as well as its sub-industry of industrial supplies wholesaling are experiencing a period of transformation (Tompkins_International (2013), DHL_Supply_Chain (2009), B&B_TOOLS (2012)). Main products offered by the industry (MRO and other industrial supplies) are characterized by high demand volatility, in some cases low consumption levels and relatively low price per unit. At the same time they often are responsible for considerable amount of stock and customers' spending (DHL_Supply_Chain 2009). Norwegian market of MRO supplies is rising and main tendencies include: competitive prices, product breadth increase, higher level of availability, faster delivery speed and higher level of customer technical support.

2.2. Supply Chain Network Structure

The paragraph provides description of supply chain network structure and its characteristics. Three primary structural aspects defined within supply chain network structure

are: supply chain members, structural dimensions of the supply chain and main processes links that take place across the supply chain (Lambert, Cooper, and Pagh 1998).

The reason for identifying the most important supply chain members is to understand which members should have the greatest influence on OFP improvement by means of their requirements that should be taken into consideration when adjusting OFP. Only when the group of critical supply chain members is defined correctly can OFP improvement increase company- and supply chain performance. Structural dimensions of the supply chain provide understanding of supply chain complexity. Besides, description of supply chain network structure provides understanding of key business processes that are executed across the supply chain in order to understand which of these processes has the greatest influence on the OFP improvement.

Supply chain members

In order to provide better understanding of supply chain and supply chain network structure it is necessary to identify a focal point that suits in the best way to a research purpose. In this research a focal point is an industrial distributor or in other words an industrial wholesale company. Further down all the links from producer to end customer are considered from a focal company (industrial distributor) perspective.

From the structural point of view supply chain could be defines as “a network of business entities involved in the upstream and downstream flows of products and/or services, along with the related finances and information” (Serdarasan 2012, Lambert, Cooper, and Pagh 1998, Mentzer, Flint, and Hult 2001). In general “all companies/organizations with whom the focal company interacts directly or indirectly through its suppliers or customers, from point-of-origin to point-of-consumption” could be considered as supply chain members (Lambert, Cooper, and Pagh 1998). Upstream of the supply chain is presented by suppliers of the focal company and downstream members are customers of the focal company. Direct suppliers / customers are referred as tire one suppliers / customers. Other suppliers/customers are named according to the place in the supply chain and number of intermediates between focal company and particular supplier or customer.

In some cases supply chains are characterized by a very complex structure and may link huge amount of companies together. Managing every link and relationship in such supply chains require a lot of effort and resources. Therefore it is important to focus managerial activities on the most important members of supply chain. These members are referred as “primary” or “critical” supply chain members.

Lambert, Cooper, and Pagh (1998) define primary members of the supply chain as “those autonomous companies or strategic business units who actually perform operational and/or managerial activities in the business process designed to produce a specific output for a particular customer or market”. Supporting members are companies that provide primary members of the supply chain with resources, knowledge, assets or utilities. They do not participate directly in value-adding activities for the end-customers. There are no exact rules to distinguish primary and supporting members of the supply chain. The decision should be made taking into account special features of the industry in which focal company operates. Therefore in most of the cases managerial aspects help to define key supply chain members.

Wholesale of machinery, equipment and supplies industry is characterized by a relatively large amount of supply chain members. There are two main reasons for this:

- Industrial distributors need to achieve the economy of scale by attracting as much customers as possible. Due to the specificity of the industry product and customer behavior, customers usually place large amount of orders with relatively low value. Therefore for wholesaler to be profitable it is important to have enough orders from large amount of customers.
- Industrial distributors need to attract as many suppliers as necessary to satisfy demand of all customers. Industrial distributors often have to offer full-line range of products in order to satisfy customer requirement of high product variety. Therefore the number of supplier in the industry is relatively large compared to other industries.

It is obvious that due to the large amount of companies in supply chain industrial distributor needs to identify critical supply chain members. As long as there are no wide-spread and widely accepted methods to do so combination of the following factors could be used to identify critical members:

- Pareto rule for profit distribution;
- Reliability of customer or supplier;
- Length of relationships;
- Perspectives of business development.

Customers that continuously order large amount of products, have long relationships could be definitely defined as primary members. Reliable suppliers that provide wholesaler with high diversity or unique products could also be classified as primary members of supply

chain. Secondary members could be represented by customers that order sporadically insignificant amount of product in money terms or suppliers of second or third priority.

Structural dimensions of supply chain

Supply chain can be also described within following structural dimensions (Lambert, Cooper, and Pagh 1998):

Horizontal structure. Horizontal structure (or length) of the supply chain reflects amount of tiers in both upstream and downstream parts of the supply chain. The more tiers are in the supply chain the more complex horizontal structure is (or the longer supply chain is).

Vertical structure. Vertical structure is described by the amount of suppliers / customers in every tier. The more suppliers/customers are within same tier level, the more complex vertical structure is.

Place of the focal company in the supply chain. Any company in the supply chain can be referred as a focal company in dependence of managerial or research purpose. However the choice of a focal company changes supply chain structure perception. For example, office supplies companies may be viewed as non-critical supply chain member if focal company is an industrial manufacturer which supplies industrial customers. However if office supplies company is referred as a focal point then supply chain structure for that company may differ from the previous one if office supplies company does not supply customers of industrial manufacturer.

Typical characteristics of supply chain structural dimensions in wholesale of machinery, equipment and supplies industry are narrow horizontal and vast vertical structures. Narrow horizontal structure or shortness of supply chain is explained by the nature of products that are typical of the industry: industrial consumables and components are “consumed” during the production cycle therefore first tier customers represent consumers of the products or services offered by the industry. The product of the industry either supports the production process or is considered to be not central to the company’s output and therefore could be considered as “consumed” by first tier customers without any loss in precision.

Vast vertical structure or in other words thickness of supply chain is explained by a large amount of both upstream- and downstream 1st tier supply chain members.

Types of process links

The next important analytical dimension is process links that connect all the supply chain members. Types of these process links depend on the level of integration between the focal company and other supply chain members. There are following types of process links: managed, not-managed, monitored and non-member links (Lambert, Cooper, and Pagh 1998).

According to Lambert, Cooper, and Pagh (1998) if supply chain members (customers or suppliers) have integrated processes with focal company, they are connected with managed links. Process links in which the focal company cannot or does not necessary need to be involved are referred as not-managed links. Other important links that could not be managed directly but could be audited by the focal company are referred monitored links. And finally the links from other supply chains that have an influence on decisions of the focal company are considered to be non-member links.

As a rule focal company in wholesale machinery, equipment and supplies industry manages process links only with 1st tire suppliers and customers. However amount of managed links can be increased, if industrial distributor is integrated with other downstream- or upstream members of the supply chain.

Key business processes in Supply Chain

As referred above all the companies in the supply chain are connected via the process links. Supply chain processes serve as a basis for these process links. Successful supply chain management requires understanding of the supply chain network structure and all its dimensions and aims at “integrating activities into key supply chain business processes” (Thomas C Harrington 1991).

Business Process (BP) could be defined as “a structured and measured set of activities designed to produce a specific output for a particular customer or market” (Lambert, Cooper, and Pagh 1998, Davenport 1993). In dependence of the industry in which focal company operates number of business processes may vary considerably. There is a wide range of different business processes that are performed within a company and a supply chain. In general the number of main business processes varies from 10 to 20 in a big company (Davenport 1993, Lin and Shaw 1998). These business processes can be divided into intra-company business processes which take place only within one company and inter-company business processes which spread between several interconnected members of the supply chain.

It is also important to differentiate between core or key business processes and support business processes in the supply chain. According to Lin and Shaw (1998) and Trkman (2010) some of business processes deal with core competence of the supply chain. These core business processes are the ones that add (deliver) value to the end customer. Processes without direct influence on value for the customers are support process. Never the less support processes have an important strategic value for the company. There are eight main business processes in a supply chain (Lambert and Schwieterman 2012, Lambert, Cooper, and Pagh 1998, Silver, Pyke, and Peterson 1998):

- Customer relationship management processes (CRM);
- Customer service management process;
- Demand management process;
- Order fulfillment process (OFP);
- Manufacturing flow management process;
- Procurement process;
- Product development and commercialization process;
- Supplier relationship management (SRM).

Usually a set of key business processes vary from industry to industry. Core processes of the supply chain of the wholesale of machinery, equipment and supplies industry are quite similar to the general case of wholesaling. The primary aim of wholesale of machinery, equipment and supplies industry is to provide a product and information flow between customers and suppliers. Industrial distributors act as intermediaries that facilitate suppliers' access to the market and customers' access to necessary products. Main purpose of the supply chain is to deliver products from producer to consumer when needed. Therefore success of the supply chain is very much dependent on reliability of suppliers, on constant development of relationship with customers, on efficiency of inventory policies and organization of transportation.

Key business processes corresponding to the main industry purpose are CRM, Customer service management; Demand management; SRM; Inventory management (that could be considered as a part of manufacturing flow management process according to Croxton (2003)); Procurement management; OFP and Product development and commercialization process.

All of the following processes are important in the wholesale of machinery, equipment and supplies industry. However some of these processes have higher level of strategic

orientation than others. This research identifies the following most important key business processes in the WME&S industry: CRM, OFP, SRM and IM.

Customer relationship management processes (CRM) contains “all strategic processes that take place between an enterprise and its customers” both on operational and managerial levels (Keramati, Mehrabi, and Mojir 2010). CRM processes consist of both knowledge management processes and interaction management processes.

Order fulfillment process (OFP) starts when the customer identifies a need in some product and ends when the product is delivered to the customer (Lin and Shaw 1998). This process is cross-functional and inter-organizational in nature. Activities that fall into this process spread not only across different functional cells of the company but across different companies.

Inventory management process contains set of activities that coordinate inventory policies for every supply chain actor (such suppliers, manufacturers, distributors) for smooth material flow in order to minimize costs and meet customer demand (Giannoccaro and Pontrandolfo 2002). It is important to notice that due to the fact that industrial distributor in general case doesn't have any production process, inventory management (as a part of manufacturing flow management) is regarded as key business process.

Supplier relationship management (SRM) is a business process that includes activities responsible for development and maintenance of relationships with suppliers (Lambert and Schwieterman 2012).

Complexity

Another important aim of the supply chain management is to manage the complexity of the supply chain (Serdarasan 2012). Complexity management facilitates coordination of the flow of products, information and finances, cost reduction; improves customer satisfaction and allows to gain competitive advantage on the market.

Complexity of the supply chain influences the possibility to manage it efficiently and to achieve desirable results. According to Serdarasan (2012) there are three main factors that influence the complexity on the supply chain: static, dynamic and decision making:

- Static complexity. It is linked to the supply chain structure and its stability. More members are in the supply chain, the more complex it is considered to be and difficult it is to be managed.
- Dynamic complexity. It depends on how variable is the state of the system in time, or in other words it reflects uncertainty (randomness) of the process in

time. State of the system depends on the internal variables (for example demand predictability of uncertainty) or environmental factors.

- Decision making complexity. It combines both static and dynamic complexities and corresponds to the level of supply chain management complexity.

According to Serdarasan (2012) supply chain complexity could be driven by such factors as number/variety of suppliers and customers, number/variety of coordination and interaction processes, demand amplification, decision making procedures and actions, level of integration of IT systems.

In the wholesale of machinery, equipment and supplies there are factors that increase and decrease supply chain complexity. For example, high static complexity due to big amount of supply chain members is compensated by low number of tire levels. Dynamic complexity is increased because of high demand uncertainty, high variety of products and big stream of information and products flows. But this dynamic complexity could be compensated by relatively simplicity and standardization of processes.

To summarize present chapter provides the market and supply chain overview of the wholesale of machinery, equipment and supplies industry.

The following features of the industry and its supply chain were identified by the researchers:

- Product: MRO and other industrial consumables and components which are characterized by high variety, relatively low price and high volume of purchase (in most of the cases), fluctuating demand.
- Market: developing market with high competition between market players;
- Tendencies: customer preferences determine main tendencies in the industry which are competitive and transparent prices; high product variety; high product availability; speed of delivery; high level of technological support;
- Supply chain network:
 - Members: large amount of individual suppliers; necessity for intermediary between industrial manufacturers and suppliers; large amount of customers;
 - Narrow horizontal and vast vertical structure;
 - Relatively high amount of managed process links spread only to 1st tire suppliers/ customers;

- Main key business processes are: CRM, SRM, IM and OFP;
- High level of complexity.

Presented analysis allowed to identify key business processes in the industry and main points of leverage, which need to be taken into account when improving OFP. The results of this chapter serve as a basis for choice of business process improvement framework for order fulfillment improvement; identifying main drivers for order fulfillment improvement and developing managerial decision model.

3. Theoretical Framework and Literature Review

The chapter provides theoretical basis the following research objective of the thesis:

- Identify what business improvement approach is appropriate for OFP improvement in the industry;

The first part of the chapter provides literature review of business process improvement (BPI). It describes BPI in the context of business process management as well as existing BPI approaches or philosophies. The first part of the chapter serves as a basis for the development of managerial decision model: it determines the character of change, level of change, identifies the framework strategy for the decision model and determines which factors influence on the success of the decision model implementation.

The second part of the chapter provides literature overview of OFP: its place in the supply chain and interaction with other key business processes. It identifies the level of improvement; describes main dimensions for the OFP improvement and their influence on order fulfillment; describes main techniques that can be used to improve order fulfillment within main dimensions and suggests performance measures and simulation modeling tool that could be used to measure the result of improvement.

At the end of the following chapter managerial decision model of order fulfillment improvement is formulated. It is based on the review of industry's market and tendencies; business process improvement approaches; OFP interfaces with key business processes; main dimensions of the order fulfillment improvement in the industry and main techniques that can be used to improve OFP.

3.1. Business Process Improvement: Definition and Approaches

Management and improvement of business are considered as core tasks that organization should perform in order to achieve competitive advantage (Röglinger, Pöppelbuß, and Becker 2012, Škrinjar and Trkman 2013). Business process management was listed as a “number one priority” among top ten business priorities in 2009 (Zellner 2011).

Business Process Improvement is a systematic approach for business process optimization that is used by organizations to change significantly the way they do business and achieve efficiency (Forster 2006). Business process improvement is aimed at increase of customer satisfaction by complying with customer requirements in the best possible way and at elimination of waists and bureaucracy (Doss and Kamery 2006).The goal of BPI is to

“incite improvement through the streamlining of operations and production processes while retaining outputs of high quality” (Doss and Kamery 2006).

BPI is based on understanding of a company as a set of interconnected business processes (process-based approach). Within this approach business process is typically defined as “a structured, measured set of activities designed to produce a specific output for a particular customer or market” (Davenport 1993). The main characteristic of the process is a set and order of activities performed in the process and the way these activities interact.

Another approach to define business process is to focus on the result of a business process. For example another widely spread definition of business process is described by Harrington (1991):

Business process is a transformation of inputs into outputs; where inputs are resources or requirements, whilst the outputs are products or results. The outputs may or may not add value and could serve as input to another process.

Thus, business process can be seen as a complex of logically interconnected activities that use given resources in order to provide specific result that supports company’s goals (Sola and Baines 2005).

Process-based approach to the organization was developed in 1990’s. This approach considered business process management as a main driver for enhancing work in organizations. For the last two decades process approach was developed into a set of theoretical directions such as Business process Reengineering (Davenport 1993), Business Process Redesign (Reijers and Liman Mansar 2005), Core Process Redesign (Heygate 1993), Business Process Change (Harmon 2003), Business Restructuring (Talwar 1993), Continuous Improvement Process (Juran 1991, Singh and Singh 2013). All these approaches are relatively close to each other as they consider modification of processes in the organization as a tool for performance management. However from the other side they differ from each other by the following parameters: level of change, starting point for analysis, frequency of changes, time and scope.

With respect to the degree of improvements two main areas are developed within process-based approach: Business Process Reengineering (BPR) and Business Process Improvement (BPI).

While Business Process Reengineering deals with radical improvement of processes, Business Process Improvement is focused on incremental improvement (Zellner 2011). Both Business Process Reengineering and Business Process Improvement are subsets of Business Process Redesign that is a subset of Business Process Management (Zellner 2011). Business

Process Improvement is considered to be a structured, analytical, cross-functional, continuous improvement process which focused on incremental changes at all levels of business processes (Zellner 2011, Škrinjar and Trkman 2013).

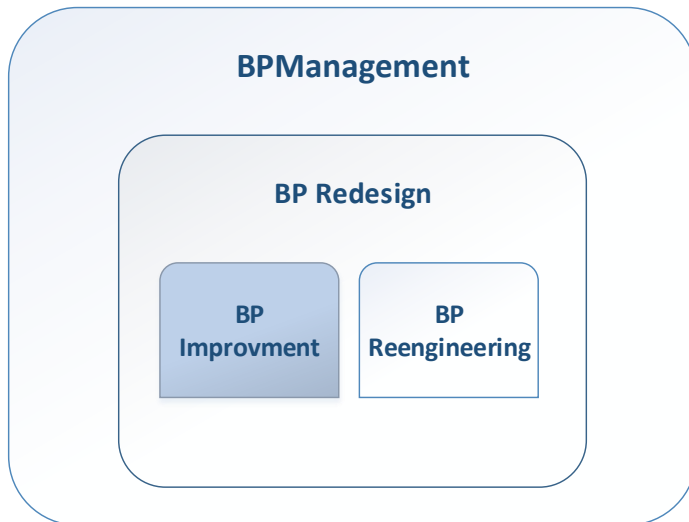


Figure 2. Focus of the research. Adopted from (Forster 2006).

It is important to notice that in some scientific literature BPR is considered to be a methodology that is used within BPI. For example this idea is supported by (Harrington 1991, Lee and Chuah 2001), but in the majority of the research articles, as well as in the present research BPI and BPR are considered as subsets of more general approach of Business Process Redesign (Doss and Kamery 2006).

There are a lot of methodologies and practices that are realized within business process improvement, but there is no generally accepted method that supports the act of improvement (Zellner 2011). According to Forster (2006) and Florian (2006) existing business improvement approaches are rather business philosophies than a well-developed business frameworks that are able to guide through- and support managerial decision-making process. Most of the business improvement approaches suggest the way how a manager or improvement team should think. However in most of cases they do not provide any specific guidelines and tools for process improvement. Mainly these philosophies describe standard set of stages which may include the following: standardize process, measure operation or process, analyze, innovate control the result, etc. Quite rarely these stages in a particular BPI approach suggest specific tools of analysis, measures, evaluation or control tools that can be used by a company in a real-life business environment. Therefore many companies try to develop and implement their own tools within chosen business process improvement approach in order to receive a concrete set of improvement initiatives. However it is important

to have a strategic and philosophical framework for decision-making within BPI. Some examples of the most wide-spread business improvement approaches are described below.

One of the most popular methodologies in BPI is implementation of Six Sigma method (Zellner 2011, Rummler and Brache 2013). It is a statistically-oriented process improvement method realized within five-phases. These phases are known as DMAIC-cycle which stands for Define, Measure, Analyze, Improve and Control.

Define. This step is focused on definition of Critical To Quality (STQ) parameters that mainly relate output of the existing process to actual needs of customers and definition of the current state of processes under consideration (state As-Is).

Measure. Within As-Is process critical input-output parameters should be defined. Initial process characteristics and capabilities should be calculated.

Analyze. In the analysis part it is necessary to define outcomes that add value to the final product and corresponding objectives of the organization, define desirable state of the process (To-Be) and find the way to achieve these results.

Improve. On this stage complex of initiatives within the BPI methods should be performed in order to meet new objectives.

Control. This step deals with updating of Control Plan and verification of improvements.

The phase “Improve” contains the act of business process improvement itself. The set of defined activities should lead to desired outcome (to the state To-Be). These activities can be performed according to the following logic. First, a set of possible solutions should be defined, then every possibility should be evaluated and final set of solutions should be chosen with corresponding measures of implementation. Pilot programs can be started after all these steps (Zellner 2011). An initial set of outputs could be provided with any possible technique, for example, brainstorming, 5S or poka yoke.

Another approach for Business Process Improvement is Harrington’s “breakthrough strategy for total quality, productivity, and competitiveness” (1991). Harrington proposes 12 cornerstone tools for improvement of processes and creation of positive change in effectiveness, efficiency and adaptability. These tools (as for example “bureaucracy elimination”, “simplification”, “duplication elimination”) should be implemented in a certain order with a final goal of evaluation and minimization of delays, paper work, reviews and approvals (Zellner 2011).

Benchmarking as a methodology of BPI is considered to be a process of systematic and continuous measuring of business process performance and comparing it against

comparable processes in leading organizations in order to define key factors that will help to improve performance of existing business processes (Siha and Saad 2008). In order to define difference between two organizations one or multidimensional “gap analysis” tool is recommended to use. From one side benchmarking is limited to the idea of “best industry” that could be quite disputable. From other side benchmarking was considered as a successful methodology that allows an effective transfer of best practices (Siha and Saad 2008).

Process innovation approach developed by Rohleder and Silver (1997) is aimed at modification of As-Is business process towards an “ideal” process. Authors do not specify a procedure model for process improvements but present “techniques” that will help to achieve this “ideal” state of the process. According to Rohleder and Silver (1997) brainstorming, simulation, what-if analysis could support the business process improvement within process innovation methodology.

A weakness determination and analysis model for business process improvement (WABPI) was proposed by Coskun, Basligil, and Baracli (2008). This methodology is aimed at analysis of weak points in an organization and development of activities that reduce the degree of weakness.

SUPER approach for BPI proposed by Lee and Chuah (2001) embraces three other methodologies: Continuous Processes Improvement, Business Process Reengineering and Business Process Benchmarking. According to this approach BPI is also a phase process with an actual improvement forth phase “execute the process improvement” (Lee and Chuah 2001)

According to holistic approach to BPI, improvement initiatives should be focused on key business processes in the company or a set of key business processes. According to Hammer and Stanton (1999) processes within the organization overlap and include common functions and therefore can not be regarded separate “islands”. Numerous researches in business process improvement area prove that separate functional process improvement initiatives do not reach required levels of company’s performance improvement, moreover often “local process improvements have degraded performance in other areas of the organization” (Jones 1994). Jones (1994) argues that organization is able to achieve the highest possible performance level if its management and improvement initiatives are concentrated on key business processes that are cross-functional in nature. Croxton (2003) describes the way each of the key business processes interacts with other seven key business processes within a company. Besides Croxton (2003) describes the input that can be used from each of the key business processes in order to re-adjust and improve key business process under consideration.

Among other BPI methodologies one can find Knowledge-intensive business process improvement methodology; k; MIPI methodology; BPI concept focused on learning organization concepts; Specify, Analyze and Monitor (SAM) framework to name a few.

In most of the cases original description of considered methodologies is not supported by explicit set of activities that should be completed in order to achieve planned result (with exception to Six Sigma). Strategies described above have different perspective on BPI which provides a researcher with a possibility to choose critical issues to be addressed during BPI process (Zellner 2011).

To summarize the present part provides understanding of BPI and allows to identify suitable for the research purpose level of changes and the methodology (approach) of BPI. The present research embraces approaches developed by Rohleder and Silver (1997) and approach developed by (Croxtan 2003). The present research embraces several approaches referred above such as approach developed by Rohleder and Silver (1997) and Croxtan (2003) in order to define dimensions of analysis and corresponding methods that could be used for order fulfillment improvement. According to these methodologies OFP should be improved towards an “ideal” process taking into consideration its interconnection with other key business processes in a focal company.

3.2. Strategic Order Fulfillment Process Improvement in Supply Chain Context

The following paragraph provides detailed description of theoretical framework for OFP improvement based on the framework of key business process interfaces developed by Croxtan (2003). The following paragraph provides basis for the following research objectives:

- Identify what dimensions of analysis and corresponding methods that could be used for OFP improvement;
- Identify the way how to evaluate successfulness of strategic OFP improvement;

This paragraph describes interaction of strategic OFP with other key business processes typical of the wholesale of machinery, equipment and supplies industry. These key business processes are chosen as dimensions of analysis for strategic order fulfillment improvement. A detailed description of techniques and methods that could be used to improve OFP is provided further down in this paragraph.

Holistic approach to strategic order fulfillment improvement

As referred above this research is focused on strategic OFP improvement even though Croxton (2003) divides OFP into strategic and operational segments.

Croxton (2003) divides strategic order fulfillment into five sub-processes among them review marketing strategy, supply chain structure and customer service goals; define requirement for order fulfillment; evaluate logistics network; define plan for order fulfillment; develop framework of metrics.

Croxton (2003) states that OFP can not be managed exclusively within the logistic function, although many managers believe so. OFP as any key business process is cross-functional in nature and requires inputs from other functions as well as from other seven key business processes. Croxton (2003) developed a framework that shows process interfaces or interactions between sub-processes of both strategic and operational OFP with other key business processes defined by Global Supply Chain Forum. Figure 3 depicts the sub-processes and process interfaces for OFP.

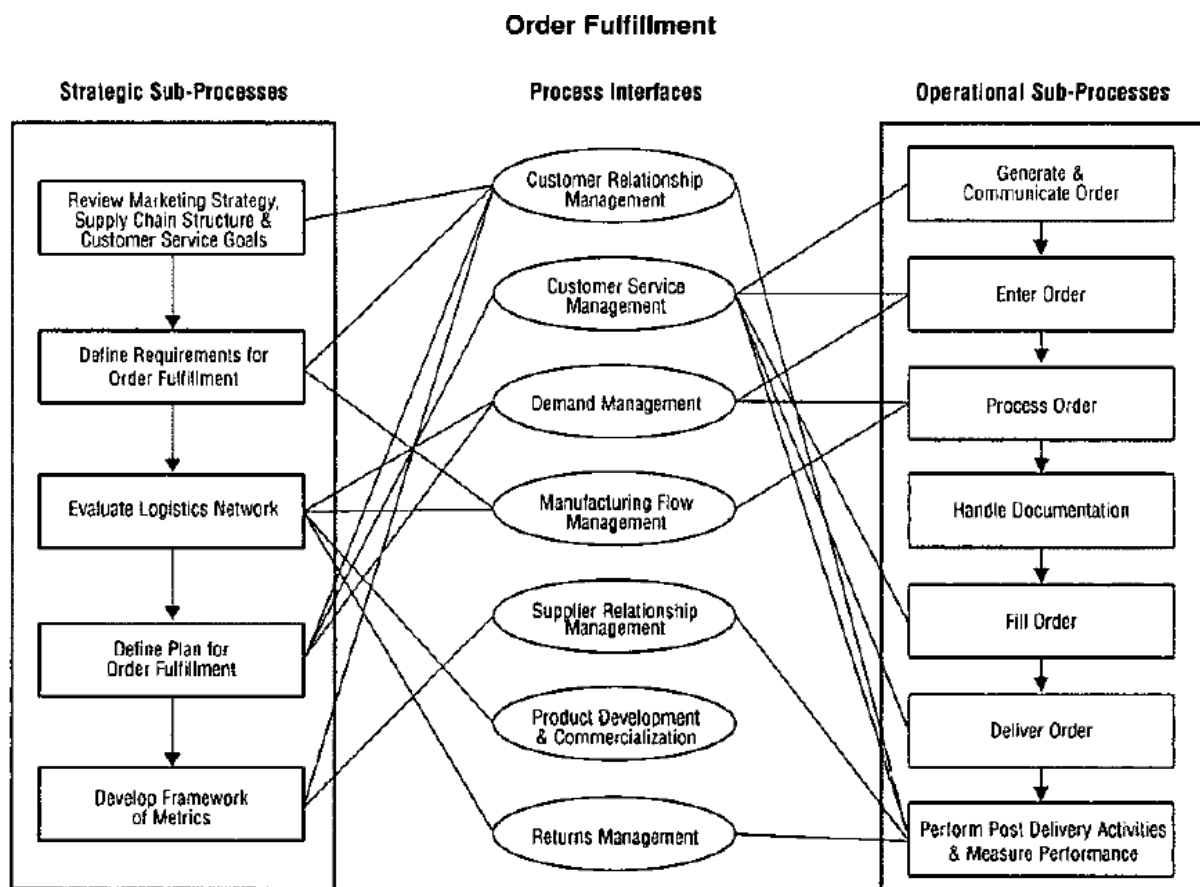


Figure 3. Sub-processes and interfaces for strategic and operational OFP (Croxton 2003).

On its first stage: “review marketing strategy, supply chain structure and customer service goals”, strategic OFP receives input information and support from customer relationship management process. The first sub-process results in revision and possible adjustment of marketing strategy, supply chain structure and service goals (Croxtan 2003). Needless to say that in business process redesign a customer should always come first. On this stage two business processes OFP and CRM interact in order to determine needs and requirements of a customer. However all readjustments if needed should be made within corporate marketing strategy and budget. When redesigning OFP one should take into account trade-offs between customer and supplier benefits and costs (Croxtan 2003).

On the next stage: “define requirements for OFP”, it is necessary to review the order-to-cash cycle, supply chain capabilities and define the lead time and customer service requirements and core competences within order fulfillment (Croxtan 2003). Assistance is provided by CRM and manufacturing flow processes. On this stage customer differences must be taken into consideration to develop specific customer offerings. “In this case the team would develop multiple sets of requirements and assure that the fulfillment process can meet all the variations” (Croxtan 2003). a company must define differentiating aspects, or competitive advantages, of current OFP (Croxtan 2003).

The third sub-process: “evaluate logistic network”, is necessary to balance capabilities of the supply chain and customer requirements and if necessary re-adjust existing process. Croxtan (2003) states that company should primarily concentrate on a network design which is viewed as complex of facility location problems. In this research it is also network structure design is considered to be used to determine optimal number of members in supply chain. Therefore on this stage company might also review the number of customers and suppliers. “Particularly important input to this sub-process comes from the demand management, manufacturing flow, product development and commercialization, and returns management process” (Croxtan 2003).

“Define plan for the order fulfillment” sub-process determines how orders from various customer segments will be taken and filled (Croxtan 2003). Decisions about payment terms, allowable order sizes, picking, packing and outsourcing part of the process must be made (Croxtan 2003). All this decisions should be based on customer requirements developed in cooperation with CRM team. It is also necessary to understand the nature of the demand and develop some guidelines if the demand can not be met. The examples may include prioritization or “sell what you have policy” (Croxtan 2003). Therefor demand management process provides an important input to this sub-process of OFP. It is equally important to

determine the flow of information and appropriate information technologies to facilitate and optimize the OFP (Croxtan 2003).

The last sub-process should be focused on the development of framework of metrics to measure and monitor performance of the process (Croxtan 2003). According to Croxtan (2003) the most popular metrics include order-to-cash cycle time, order fill rate, order completeness and perfect order.

Even though Croxtan (2003) describes an extensive approach to business process interaction in supply chain which can serve as a basis for order fulfillment improvement his work does not proved any specific and detailed business framework on how to re-adjust strategic OFP based on the input from other key business process. The following research is focused on three dimensions that provide input for strategic order fulfillment improvement and are the most important for wholesale of machinery, equipment and supplies industry: customer relationship management, supplier relationship management and inventory management.

Customer relationship management serves as a basis to review existing OFP from the customers' perspective. Customer relationship management helps to identify customer requirements and evaluate whether OFP is efficient and effective enough to fulfill those requirements. In case OFP does not answer customer needs it is necessary to re-adjust the process. The re-adjustment is again based on the information about customer requirements.

Supplier relationship management provides information to the OFP when it comes to the development of metrics to assess efficiency of OFP. Suppliers are directly responsible for procurement costs, logistics efficiency, flexibility and responsiveness of the supply chain (Choy, Lee, and Lo 2004).

Both CRM and SRM are responsible for identification of key customers and suppliers. These key business partners require some special product/service agreements and may be possible candidates for inter-organizational process integration. Besides, CRM and SRM are responsible for supply chain network optimization. CRM and SRM initiatives may identify some customers or suppliers that do not contribute to the company profitability and might be unwanted as a business partners.

Usually manufacturing flow management process is regarded as key business process that influences order fulfillment. However this research substitute manufacturing flow management process with inventory management and control process within an organization as due to the specificity of the industry there are no production activities and thus inventory management process becomes key business process for industrial distributors unless they

offer private label products. Inventory management provides input information for one of the sub-processes of order fulfillment as it helps to decide on how the orders from customers will be filled, determine products that are to be on stock according to customer requirements and products that can be backordered.

To summarize OFP is one of the key business processes in the industry of wholesale of machinery, equipment and supplies along with customer relationship management, supplier relationship management and inventory management. All these processes interact between each other and inputs from CRM, SRM and inventory management can be used in order to improve strategic OFP.

Further down each of the identified dimensions for strategic order fulfillment is going to be described together with corresponding methods that can be used for strategic order fulfillment improvement.

3.2.1. Customer Relationship Management

This paragraph provides a detailed description of customer relationship management process in order to understand the way it contributes to strategic order fulfillment improvement. Besides, it provides a detailed description of the techniques that represent input of CRM to OFP and can be used to improve OFP on a strategic level.

Customer relationship management provides instruments that allow to tailor a specific OFP in dependence of the customer group. CRM also helps to define critical customers that may require specific solutions within OFP or further extension of OFP that results in closer integration with internal customer processes.

Lambert (2010) states that customer relationship management is one of the critical business processes. It becomes increasingly important among other eight macro business processes identified by Global Supply Chain Forum as it has a critical impact on supply chain profitability and robustness (Lambert 2010). CRM “provides the structure for how relationships with customers are developed and maintained” (Lambert 2010). CRM helps to understand existing customers, differentiate them according to their profitability, service requirements, buying patterns or other distinctive trait and communicate to the customers more effectively addressing them with tailor-made offerings. This has a direct impact on the way OFP is organized on both strategic and operation and levels. This in turn affects firm’s profitability by increasing lifetime customer value and customer retention rate as according to Lambert (2010) there is an evidence that profit growth, customer loyalty, customer satisfaction and the value of goods delivered to customer are strongly related.

One of the most important sub-processes of customer relationship management is customer segmentation and identification of critical customers (Lambert 2010). According to Handfield and Nichols (2002) “to develop customer relationships, firms must begin by understanding and classifying their customers”.

According to Sharma and Lambert (1994) segmentation is an instrument that helps to identify distinctive groups among the firm’s customers and adjust firm’s offerings to those customers groups according to their needs or expectations.

Customer segmentation is important for identifying order fulfillment improvement initiatives as According to Sharma and Lambert (1994) it allows to tailor individual approach and individual offering to a specific group of customers. Segmentation places the customer first and allows to adjust OFP according to the demand side of the market (Sharma and Lambert 1994). In other words “segmentation reveals several demand schedules, where only one was recognized before” (Sharma and Lambert 1994).

One of the ideas behind customer segmentation is that “all customers do not contribute equally to the firm’s success” and a firm must distinguish between profitable and unprofitable customers or critical and not critical (Lambert 2010). Another idea is that not all the customers have the same needs and expectations when it comes to firm’s offerings. The purpose of segmentation is to establish which value the customer wants and which solution the seller should provide under restriction of seller’s ability to adapt resources, activities and actors which will determine seller’s ability to fulfill customer needs (Clarke and Freytag 2008).

“Different purposes of segmentation raise different questions and result in different answers and decisions” (Clarke and Freytag 2008). Segmentation can be developed based on identifiable/accessible characteristics and needs/benefits characteristics (Sharma and Lambert 1994). Sharma and Lambert (1994) state that identifiable/accessible characteristics, usually demographic, lack this “actionability” and argue in favor of two-stage segmentation.

Sharma and Lambert (1994) as well as Clarke and Freytag (2008) state that segmentation should preferably have two dimensions. On the first level segmentation should identify which customers to serve and on the second level it aims at planning and developing operational schemes for reaching target segments with an effectively adjusted offering and monitoring the performance (Clarke and Freytag 2008).

Sharma and Lambert (1994) propose descriptive dimension as the first segmentation level and purpose dimension as a second level.

Handfield and Nichols (2002) define the following possible criteria for descriptive customer segmentation:

- Demographic segmentation;
- Product end-use;
- Buying situation (bargain hunters, one-time transactions, repeat customer...);
- Customer benefits obtained from a firm;
- Customer buying behavior;
- Customer decision making style

Sharma and Lambert (1994) consider customer profitability (CP) as one of the descriptive characteristics along with customer size, customer branch or total volume of spending on a specific group of products. Although in this research it is suggested to implement several descriptive criteria due to the fact that such descriptive criteria as size of the company or length of relationship are fairly easy to implement this part of the work is concentrated on the CP segmentation which requires more sophisticated approach.

Main idea of customer segmentation according to profitability is the allocation of revenues and costs to customer segments or individual customers (van Raaij, Vernooij, and Sander van 2003). According to Pfeifer, Haskins, and Conroy (2005) customer profitability is an important characteristic of customer profile as “each dollar of revenue does not contribute equally to the income”. Measure of customer profitability takes into account costs incurred by the focal company in order to serve each customer. Pfeifer, Haskins, and Conroy (2005) define customer profitability as “difference between the revenues earned from and the costs associated with the customer relationship during a specified period”. Customer profitability analysis also helps to identify critical customers which require higher level of attention from management and for which OFP should be readjusted in the first place van Raaij, Vernooij, and Sander van (2003) state that in order to build profitable relationships with customers a focal company should know how current customers are distributed in terms of profitability and what potential and opportunities offer customer segments in in terms of future profitable relationships.

There are several ways to implement customer profitability in order to group customers. Some companies base segmentation directly on customer profitability. “There are two basic approaches to do this: to base the grouping on relative profitability (relative to the total customer base) or to group customers based on their absolute profitability” (Storbacka 1997). The most used example of customer segmentation by relative profitability is ABC

analysis which is based on the Pareto principle (Storbacka 1997). Pareto principle is recognized as a “universal” method and is often used in management practice. (Craft and Leake 2002) According to Pareto principle 20% or fewer number of customers generate 80% of sales (Sabath and Whipple 2004).

It is accepted to group customers in three categories: group A - 20% of customers that are responsible for 80% of company's profitability, group B - 30% of customers that are responsible for 15% of company's profitability and group C – 50% of customers that are responsible for 5% of profitability (Giltner and Ciolli 2000) or four groups: group A - 20% of the most profitable customers, group B – next 30%, group C – next 30%, and group D – 20% of the most unprofitable customers ((Storbacka 1997), (Sabath and Whipple 2004)). Many researchers state that group A of customers is usually even smaller than 20% ((van Raaij, Vernooij, and Sander van 2003), (Sabath and Whipple 2004)). As these customers are significantly important to the company's well-being each customer should be considered as an individual market segment and receive perfect service and customized offerings (Sabath and Whipple 2004). According to Sabath and Whipple (2004) customers consisted in group B should also receive a great deal of attention as their contribution to firm's profitability is still high although each individual customer contributes less to overall profitability than A-customer. Therefore this customers should be managed as segments that differ by service requirements (delivery requirements, additional-services requirement, etc.) and specific offering should be made to each customer segment (Sabath and Whipple 2004). Group C consists of customers that contribute slightly to overall profitability and each customer is marginally profitable (Sabath and Whipple 2004). These customers might borrow resources that should have been allocated to A- and B-customers and to prevent this should be a major concern of a focal firm (Sabath and Whipple 2004). C-customers should be provided a standard offer with limited amount of service options (Sabath and Whipple 2004). Customers in group D are unprofitable and must be managed on a transactional basis: each transaction should be analyzed in terms of profitability and in case it is not profitable rejected (Sabath and Whipple 2004). One of the ways to serve these customers is to rise prices (to reduce the amount of these customers in the customer base) or use an intermediary to manage customer orders (Sabath and Whipple 2004). B-, C- and D-customers should be examined as potential candidates to be included into higher level groups A, B or C (Sabath and Whipple 2004).

An important issue in customer profitability analysis is the way costs are allocated to a particular customer (van Raaij, Vernooij, and Sander van 2003). Pfeifer, Haskins, and Conroy (2005) state that one of the extremes to compute CP is to include only one category of

costs: the cost of goods sold. In this special case CP becomes a synonym of gross margin (Pfeifer, Haskins, and Conroy 2005). Without a doubt this approach to CP is limited and the easiest one that a company may implement. van Raaij, Vernooij, and Sander van (2003) state that to make CP segmentation useful costs should be calculated based on the principles of activity based costing and describes a specific approach to be implemented.

Besides van Raaij, Vernooij, and Sander van (2003) state that company might use Stobachoff curve to analyze distribution of profitability (Figure 4).

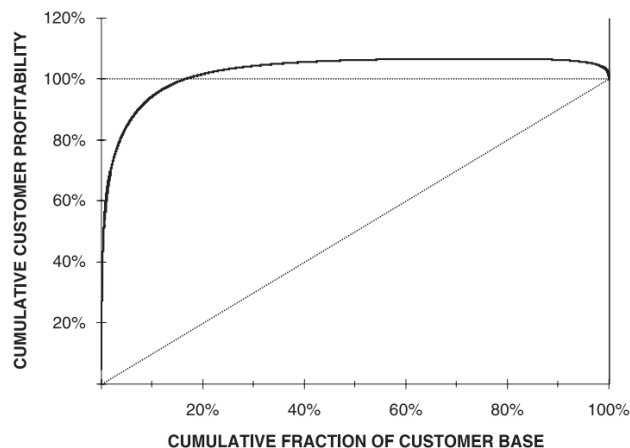


Figure 4. An example of Stobachoff curve of a firm (van Raaij, Vernooij, and Sander van 2003).

The shape of the curve provides information about vulnerability of the customer base, where the area under the curve shows the degree of subsidizing in the customer base (van Raaij, Vernooij, and Sander van 2003). “A large area means that some customers with very high profits subsidize other customers with negative profits” (van Raaij, Vernooij, and Sander van 2003). “When combined with a measure of dependence (the proportion of profitable customers), the vulnerability of customer base can be determined” (van Raaij, Vernooij, and Sander van 2003).

Figure 5 show possible examples of Stobachoff curves for different levels of subsidizing and dependence.

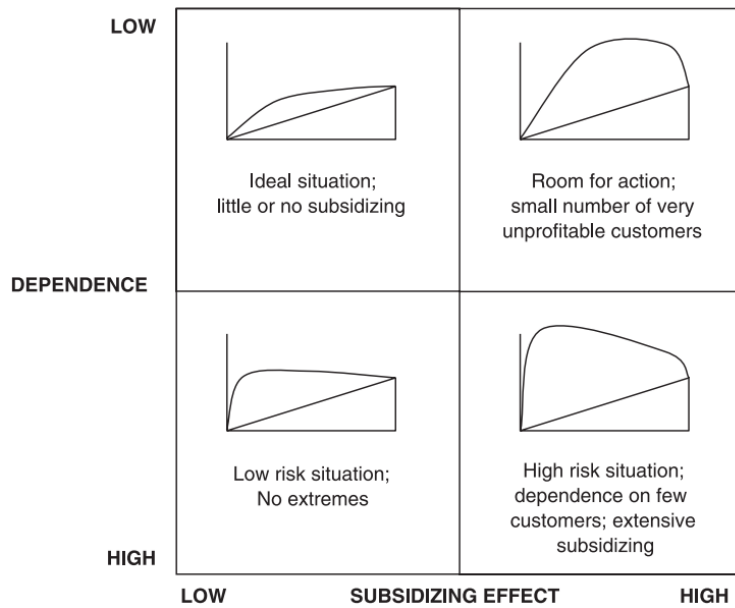


Figure 5. Stobachoff curves for varying levels of subsidizing and dependence (van Raaij, Vernooij, and Sander van 2003).

Customer profitability may serve as a basis for other segmentation or portfolio models (Storbacka 1997). Customers may be grouped based on relationship volume and relationship profitability: model 1 on Figure 6 (Storbacka 1997) or based on the gross margin and length of tenure: model 2 on Figure 6 (Ang and Taylor 2005).

Model 1 (Storbacka)	Low volume	High volume
High CP	Group II	Group IV
Low CP	Group I	Group III
Model 2 (Ang and Taylor)	Low tenure	High tenure
High margin	Supernova	Star
Low margin	Eclipse	Blackhole

Figure 6. Customer groups according to portfolio models 1 and 2. Based on (Ang and Taylor 2005) and (Storbacka 1997).

Nevertheless segmentation of customers according to profitability is often criticized in the literature ((Ang and Taylor 2005), (Giltner and Ciolli 2000)). It is argued that CP should not be considered as a function of a customer as customers are not intrinsically unprofitable rather a focal firm have chosen to serve them in an unsuitable way and has not understood their requirements (Giltner and Ciolli 2000). “By basing CRM efforts around “A”, “B” or “C” profit segmentation of customers, bankers are attempting to select profitable customers as a way to increase performance with existing bank processes” (Giltner and Ciolli 2000). This statement can be generalized and applied to other types of industries. Giltner and Ciolli (2000) state that to create profitable customers companies should adjust their processes based on customer requirements, or companies should change themselves rather than trying to change their customers.

Therefore customer profitability should not be used as the only criterion to determine customer groups. As it has been stated earlier research papers on customer segmentation argue in favor of two level segmentation ((Giltner and Ciolli 2000), (Lambert 2010), (Sharma and Lambert 1994), (Clarke and Freytag 2008)). Sharma and Lambert (1994) suggest the use of customer service level as a second-level criteria for segmentation. Emerson and Grimm (1998) define two element of customer service: logistics, or criteria that contribute to time, place and/or form utility, and marketing, or those services that ensure possession utility. Examples of logistics variables are: percentage of order filled, order cycle-time consistency, accuracy of orders shipped, order status information, etc. (Emerson and Grimm 1998). Examples of marketing service variables are: term of sale (price, the length of time allowed for invoice payment, advertising solutions, trade solutions), competence of customer service representatives, overall product quality (customer perception of value received for the price paid), action on complaints, etc. (Emerson and Grimm 1998).

Sharma and Lambert (1994) in the methodology developed for customer segmentation based on customer service suggest that elements of customer service used for customer segmentation should be built on criteria that customers use to evaluate suppliers. The steps of methodology are as follows: on the first step the elements of customer service used by buyers in selecting and evaluating suppliers can be obtained based on earlier research and specified according to the industry requirements; on the second step buyers of the product are surveyed to define the importance of chosen metrics in their supplier evaluation practices; the dimensions of customer service need to be extracted from the received data (possibly by using the factor analysis); customers with similar need are grouped on the fourth step and on the final stage customer segments are identified taking into consideration descriptive characteristics of each customer (Sharma and Lambert 1994).

To summarize in this research it is suggested to use segmentation as a main tool of customer relationship management to provide necessary input information for strategic order fulfillment improvement. It is suggested to use several descriptive criteria for segmentation (size of the customer, length of relationships, profitability and volume of purchase) to determine groups of customers on a strategic level and understand customer base. Then it is suggested to use customer segmentation according to customer service requirements as an operational level of segmentation that will provide the necessary degree of actionability to segmentation and allow to develop specific offering to each customer segment according to their requirements. Example of segmentation and its results can be found in the case study chapter.

3.2.2. Supplier Relationship Management

This paragraph provides a detailed description of supplier relationship management process in order to understand the way it contributes to strategic order fulfillment improvement. Besides, it provides a detailed description of the techniques that represent input of SRM to OFP and can be used to improve OFP on a strategic level.

Croxton et al. (2001) defines supplier relationship management as a process which decides how company interacts with its suppliers. Choy, Lee, and Lo (2004) adopted the following definition of SRM: “a process involved in managing preferred suppliers and finding new ones whilst reducing costs, making procurement predictable and repeatable, pooling buyer experience and extracting the benefits of supplier partnerships”. Another supplier relationship management definition is provided by Moeller, Fassnacht, and Klose (2006): “Supplier Relationship Management (SRM) is the process of engaging in activities of setting up, developing, stabilizing and dissolving relationships with in-suppliers as well as the observation of out-suppliers to create and enhance value within relationships”. There are no significant differences between these three definitions of supplier relationship management. Although definition provided by Croxton et al. (2001) is very simplified and doesn't highlight that supplier relationship management is used not only for handling relationships with existing suppliers but also is aimed at establishing and developing relationships with new suppliers.

The main goal of SRM is to facilitate and optimize supplier selection process in the company. Both Choy, Lee, and Lo (2004) and Croxton et al. (2001) state that SRM is a mirror reflection of CRM. Supplier relationship management recognizes that suppliers are different and are not equally important for a company. Principal difference between CRM and SRM is that the goal of the CRM process is to maximize the amount of the profitable customers and goal of the SRM process is to optimize the amount of the suppliers (Moeller, Fassnacht, and Klose 2006). However both CRM and SRM are based on the statement that neither customers nor suppliers can be treated in a “one-size-fits-all” manner and a distinction should be made between strategic (key) and transactional partnerships (Miocevic and Crnjak-Karanovic 2012). Miocevic and Crnjak-Karanovic (2012) therefore identify such process as key supplier relationship management which focuses on the management of strategic relationships and is based on the assumption that suppliers have different level of importance to the company.

Choy, Lee, and Lo (2004) state that SRM increases competitive advantages of the company in the following way: reduces procurement costs, increases logistics efficiency of a company, increases flexibility and responsiveness of company's supply chain and therefore

increases order fulfillment performance and customer satisfaction (Choy, Lee, and Lo 2004).

According to Moeller, Fassnacht, and Klose (2006) there are three main elements in supplier relationship management: out-supplier management, in-supplier management and in-supplier dissolution management. The goal of out-supplier management is to continually evaluate suppliers that do not have any relationships to the company in order to attract new effective and efficient suppliers and enhance value creation (Moeller, Fassnacht, and Klose 2006). In-supplier management is aimed at optimization of the existing supplier (Moeller, Fassnacht, and Klose 2006). In-supplier dissolution management aims at facilitation of dissolution process between company and unwanted suppliers (Moeller, Fassnacht, and Klose 2006). Among these three elements of supplier relationship management defined by Moeller, Fassnacht, and Klose (2006) only in-supplier management element provides input information for strategic order fulfillment improvement. Therefore our research takes into account only that element of SRM.

Supplier segmentation plays a central role in SRM. The main goal of supplier segmentation is to identify key suppliers and supplier segments (Croxtton et al. 2001). Each key supplier as well as each supplier segment require the development of specific PSA (Croxtton et al. 2001). Segmentation serves as a basis for supply chain reduction process as in the end relationships with some suppliers may be found unwanted either for financial, quality or other reasons.

There are numerous approaches to supplier segmentation (Imanipour, Rahimi, and Akhondi 2012). Imanipour, Rahimi, and Akhondi (2012) in their work provide a list of Portfolio Models based on the structure of buyer-supplier relationships (Figure 7).

Model	Factors	<i>1=Low</i> <i>2=Low</i>	<i>1=High</i> <i>2=Low</i>	<i>1=Low</i> <i>2=High</i>	<i>1=High</i> <i>2=High</i>
Kraljic (1983)	1. Supply Risk 2. Profit Impact	Non Critical	Bottleneck	Leverage	Strategic
Krapfel (1991)	1. Interest commonality 2. Relationship value	Acquaintance	Friend	Rival	Partner
Olsen and Ellram (1997)	1. Strategic Importance of Purchase 2. Difficulty of Managing the Purchase Situation	Non Critical	Leverage	Bottleneck	Strategic
Trend and Monczka (1998)	1. Supply Risk 2. Profit Contribution	Low Value	Supply Assurance	Profit Contribution	Competitive Advantage
Bensaou (1999)	1. Supplier's Investment 2. Buyer's Investment	Market Exchange	Captive Supplier	Captive Buyer	Strategic Partnership
Kaufman et al. (2000)	1. Collaboration 2. Technology	Commodity Supplier	Collaboration Specialist	Technology Specialist	Problem-Solving Suppliers
Svensson (2004)	1. Supplier's Commitment 2. Commodity's Importance	Transactional	Friendly	Business Partner	Family

Figure 7. Portfolio Models and Related Factors (Imanipour, Rahimi, and Akhondi 2012).

Besides relationships structure Croxton et al. (2001) provides the following criteria that may serve as a basis for supplier segmentation: supplier's profitability, growth and stability; the critical or required service level of the components purchased; the sophistication and compatibility of the supplier's process implementation; the supplier's technological capabilities and compatibility; the volume purchased from the supplier; the capacity available from supplier; the culture of innovation at the supplier; and, the supplier's anticipated quality levels.

Salam (2011) suggests Teng and Jarmillo's Model for supplier evaluation. This model has a two-level structure. Suppliers are evaluated based on several criteria: quality, delivery, reliability, flexibility and cost (Salam 2011). These are the clusters that the cluster weights are assigned to by process team or functional departments of a company (Salam 2011). Every cluster has several sub-criteria. For example Salam (2011) describe that delivery cluster has such sub-criteria as geographic location, freight terms, trade restrictions, total order lead time. Each of these sub-criteria also receives a weight which identifies its importance for a company from process team or functional departments. Total score for each supplier is composed out of cluster indexes:

$$\text{Total Score} = \text{Delivery Index} + \text{Reliability Index} + \text{Quality Index} + \text{Flexibility Index} - \text{Cost Index}$$

Proposed decision matrix for supplier selection

Cluster	Weight	Factors	Weight	DVG	DV	Supplier A	Supplier B
Delivery	C _D	Geographic location	K _{gl}				
		Freight terms	K _{ft}				
		Trade restrictions	K _{tr}				
		Total order lead time	K _t				
Delivery index = CD[(Kgl *Vgl)+(Kft *Vft)-(Ktr *Vtr)+(Kt *Vt)]							
Flexibility	C _F	Capacity	K _c				
		Inventory availability	K _{iv}				
		Information sharing	K _{is}				
		Negotiability	K _n				
		Customization	K _{cu}				
		Product Variety	K _{pv}				
Flexibility index = CF[(Kc *Vc)+(Kiv *Viv)+(Kis *Vis)+(Kn *Vn)+(Kcu *Vcu)+(Kpv *Vpv)]							
Cost	C _C	Supplier's selling price	K _{sp}				
		Internal cost	K _{ic}				
		Ordering and Invoicing	K _{oi}				
Cost index = CC[(Ksp *Vsp)+(Kic *Vic)-(Koi *Voi)]							
Quality	C _Q	Continuous improv. Programs	K _{ip}				
		Certifications	K _{cs}				
		Customer service	K _{ct}				
		Percent of on-time shipments	K _{ot}				
		Product quality	K _{pq}				
Quality index = CQ[(Kip *Vip)+(Kcs *Vcs)+(Kct *Vct)+(Kot *Vot)+(Kpq *Vpq)]							
Reliability	C _R	Feeling of trust	K _t				
		Country's political situation	K _{ps}				
		Currentcy exchange situation	K _{ce}				
		Warranty policies	K _{wp}				
Reliability index = CR[(Kt *Vt)+(Kps *Vps)+(Kce *Vce)+(Kwp *Vwp)]							
Total score		delivery + flexibility score + quality score + reliability score -cost score					
Notes : DV = desired value							

Figure 8. Decision matrix for supplier selection (Salam 2011).

Batson (2011) describes in his work the following approaches to supplier evaluation: total cost of ownership approach, supplier suggestion systems, supplier improvement partnerships, supplier rating systems. Narasimhan, Talluri, and Mendez (2001) suggest data envelopment analysis or DEA as a supplier evaluation/monitoring tool and argue that traditional supplier evaluation approaches such as weighted method, clustering or ranking lead to subjective decisions. Other methods described in the literature include weighted linear model approaches, linear programming models, mixed integer programming, clustering methods on performance factors and supplier's technical capabilities, analytical hierarchy process, matrix method, multi-objective programming, total cost of ownership, human judgment models, principal component analysis, interpretive structural modeling, statistical analysis, discrete choice analysis experiments, and neural networks (Narasimhan, Talluri, and Mendez 2001).

Based on segmentation results company might opt to use one of the three main approaches to supplier base reduction: systematic elimination; standardization and tiering (Ogden and Carter 2008). According to the first approach company simply deletes those

suppliers from the database that have not been used for a long period of time (Ogden and Carter 2008). Strategic approach to systemic elimination suggests that all suppliers should be examined in detail and then those suppliers that are unable to deliver certain level of requirements are deleted from the database (Ogden and Carter 2008). Standardization approach involves standardization of component parts, simplification of the product or service design which allows supplier base reduction (Ogden and Carter 2008). Tiering approach reduces the number of suppliers that the organization deals with directly, however the number of suppliers not necessarily goes down (Ogden and Carter 2008). In other words first-tier supplier may act as intermediaries in the buying process.

Supplier segmentation serves as a basis for supplier selection which is considered to be a key strategic consideration in supplier relationship management (Kilic 2013, Chen, Lin, and Huang 2006). The main difficulty in supplier selection is the fact that supplier selection is a multi-objective process that in addition could be affected by uncontrollable and unpredictable factors (Kilic 2013).

Supplier selection process is well theoretically developed. First for supply management and purchasing portfolio approach was developed by Kraljic (1983). This idea became a driving force for numerous modifications and adaptations for different cases. Original Kraljic’s portfolio selection idea was proposed for different types of products, but later it is also often applied to suppliers (Luo et al. 2009). Portfolio approach for supplier selection is highly accepted by practitioners due to its intuitiveness and, at worst, it do no harm (Pagell, Wu, and Wasserman 2010).

Portfolio approach proposes a procedure of supplier evaluation according to two parameters: impact on financial results and level of supply risk (Luo et al. 2009) (See Figure 9).



Figure 9. Classification matrix of suppliers. (Luo et al. 2009).

Suppliers are divided into 4 groups. Suppliers with low supply risk and low impact on financial results of a buyer are referred as non-critical (or routine) suppliers. Suppliers with high supply risk and low impact on financial result are bottleneck suppliers. Suppliers with high impact on financial results and low supply risk are leverage suppliers and strategic suppliers are ones that have high influence on financial results and high level of risk.

For every group of suppliers a set of interaction strategies is proposed. According to Colwell (2012) and Luo et al. (2009) the following considerations could be proposed for supplier groups. Leverage suppliers as a rule act in a competitive environment. Products that are provided by these suppliers are likely to be commodities. Buyer has a higher power over these suppliers and could insist on its demands. Company is likely to have a big number of routine suppliers that are quite dependent of the buyer. In total by these companies quite a big amount of products is supplied. It could be desirable to reduce number of routine suppliers in order to reduce transactional costs with stale level of risk. Strategic suppliers are likely to be market leaders. High risk that buyer takes purchasing from these suppliers could be explained by the fact that they have some specific knowledge or products that are unique on the market. Balance of power with these suppliers could be different from case to case. Buyer purchases from preference suppliers in case if there is no or few alternatives (for example in case of technological leadership). Most of conditions of buyer-supplier interaction are determined by supplier.

It should be mentioned that considered supplier portfolio selection approach does not give enough basis to deduce strategies (Colwell 2012). It is important to consider other factors as overall business strategy, market context, specific features of every supplier (including capacity and intentions). But regardless to this described portfolio selection is considered to be an important tool for managers.

Modern research proposes wide variety of approaches for supplier selection as Taguchi loss function, analytical hierarchy process or multi-choice goal programming. But most of research is concentrated on methods where fuzzy variables are used. These methods present adaptation of classical fuzzy variable theory to different specific cases.

In case of industrial wholesaling where there is a big variety of products and big amount of suppliers “An integrated approach for supplier selection in multi-item/multi-supplier environment” could be considered as one of appropriate methods (Kilic 2013).

This method combines five quantitative and qualitative supplier evaluation criteria: (1) quality, (2) cost, (3) delivery time, (4) geographical location and (5) reliability. This method uses fuzzy Technique for Order Preference by Similarity to Ideal Solution to evaluate value of

every supplier with respect to every product. And then a mixed integer linear programming is used in order to define quantities of products that should be ordered from every supplier.

It could be concluded that within numerous techniques of supplier selection first step for supplier structure analysis could be done according to the classification proposed by Kraljic. Later on for detailed analysis more sophisticated techniques that consider more complex system of factors should be applied (Luo et al. 2009).

To summarize in this research it is suggested to use supplier segmentation and supplier selection as a main tool of supplier relationship management in order to provide necessary input information for strategic order fulfillment improvement. Supplier segmentation is a basis for supplier selection process which determines a network structure of OFP. It is suggested to use Kraljic portfolio models in order to determined critical and unwanted suppliers and influence on order fulfillment network structure and logistics performance. Example of segmentation and its results can be found in the case study chapter.

3.2.3. Inventory Management

This paragraph provides a detailed description of inventory management process in order to understand the way it contributes to strategic order fulfillment improvement. Besides, it provides a detailed description of the techniques that represent input of inventory management to OFP and can be used to improve OFP on a strategic level.

Inventory management is a processes incremented into logistics process of a company and specifically responsible for the storage of materials (Waters 2003). Waters (2003) describes the following logistics processes together with inventory management: procurement or purchasing, inward transport or traffic, receiving, material handling, warehousing or stores, order picking, outward transport, physical distribution, recycling returns and waste disposal, location, communication. Waters (2003) states that these processes are related and often overlap and one process, for example such as inventory management, should not be viewed separately from other elements of logistics function that influence on safety stock indirectly.

Lambert (2006) includes inventory management process into one of the key management processes: manufacturing flow management process. Lambert (2006) divides manufacturing flow process into two levels: strategic level and operational. Figure 10 shows place of inventory management in manufacturing flow management process.

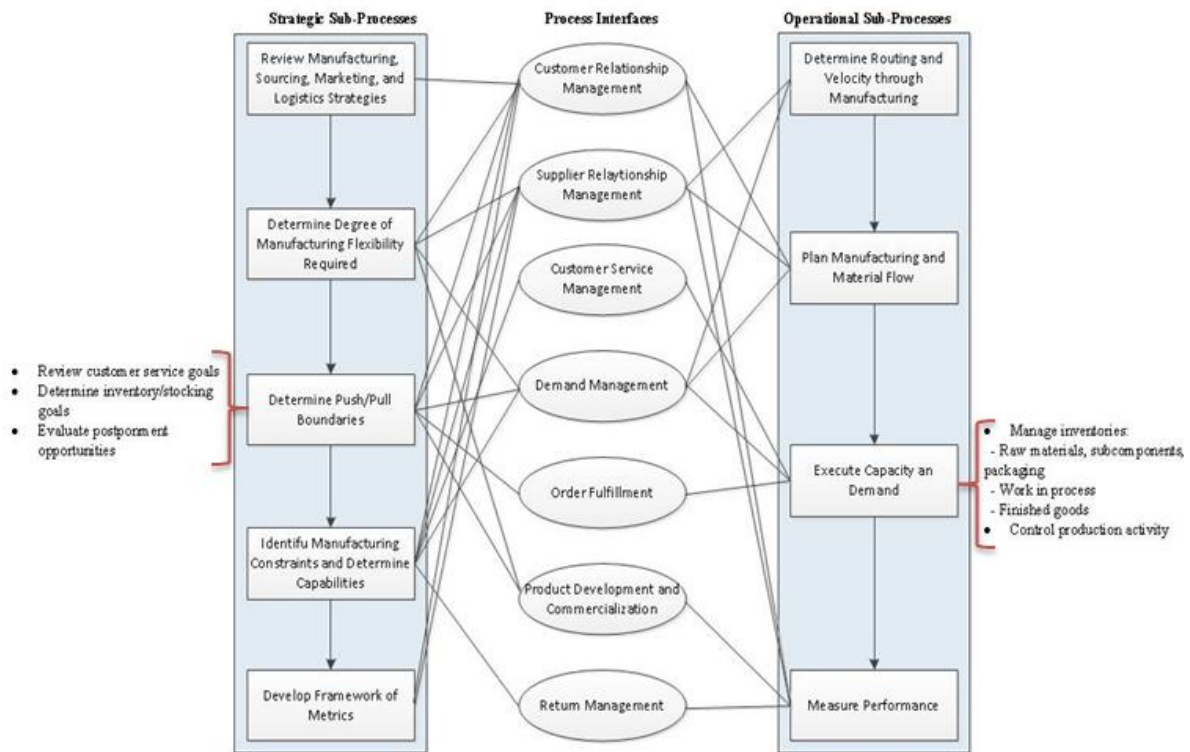


Figure 10. Manufacturing flow management elements (Lambert 2006).

It can be seen that manufacturing flow management process is linked to OFP through inventory management activities. For example to develop operational guideline for order fulfillment it is necessary to get input information about safety stock and availability of goods (Lambert 2006). Besides, this research is focused on inventory management and control processes within an organization as due to the specificity of the industry there are no production activities and thus inventory management process becomes key business process for wholesalers unless they offer private label products. In which case wholesalers are responsible for implementing manufacturing flow management process with its manufacturers (Lambert 2006). In this research it was decided to concentrate on the first situation therefore inventory management is referred here as a key business process.

According to Lambert (2006) manufacturing flow management and, if manufacturing is absent, inventory management is influenced by both downstream and upstream members of supply chain. “Downstream members influence the process through the demand for product assortment that meet expectations in terms of specific attributes, quality, cost and availability as well as through changes to plans” (Lambert 2006). “Upstream members affect the manufacturer’s ability to fulfill the customer’s expectations” (Lambert 2006).

As referred above inventory management is responsible for the storage of materials that are kept for future use (Waters 2003). According to Waters (2003) inventory management and control should answer the following questions: What items should we keep in stock? When should we place an order? How much should we order? This research is focused on the first question. Organizations aim at minimizing stock level while trying to save acceptable service level (Waters 2003). According to Waters (2003) effective inventory management and control supposes that stock of existing items is kept at reasonable levels, unnecessary items are not added to the inventory and all items that are no longer used are removed from the inventory. Waters (2003) argues that inventory rises with time if it is not controlled in a proper way. Often organizations add new items to the inventory as requirements for stock change but very seldom organizations are able to accept that old items that are no longer used should be scrapped (Waters 2003). Inventory management should both evaluate and compare costs of holding /not holding an item before it is added to the inventory and monitor the use of items that are already on stock and remove them if the holding costs rise (Waters 2003).

Inventory management is important for the organization as it directly impacts the financial performance of a company. A common measure of company’s financial performance is return on capital employed (ROCE) which is computed by dividing company profit by capital employed (Emmett and Granville 2007).

$$ROCE = \frac{PROFIT}{CAPITAL EMPLOYED}$$

Figure 11 shows variables that influence on return on capital employed.

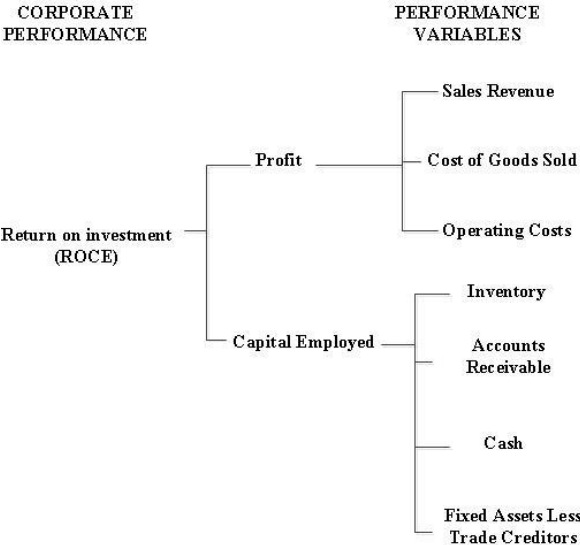


Figure 11. Elements of Return on Capital Employed (Emmett and Granville 2007).

It is clear that increase in sales and decrease in cost of goods sold, operating costs and capital employed including inventory leads to increase in ROCE (Emmett and Granville 2007).

Typical inventory costs are: unit cost (price charged by suppliers for one unit of item), reorder cost (a cost of placing a repeat order for the item), holding cost (cost of holding item on stock for one period of time) and shortage cost (cost running out of stock and losing a customer) (Emmett and Granville 2007). An organization can not unlimitedly minimize inventory as even though holding costs will go down probability of stock-out raises. Therefore shortage costs might rise as company will lose customers if there is an out-of-stock situation and these costs might be quite high (Emmett and Granville 2007).

However by doing some analysis and classification of items held on inventory a company may pick out those items that have turned into obsolete stock, non-moving stock or surplus stock (Emmett and Granville 2007). Emmett and Granville (2007) define only three reasons why non-moving stock should be retained, these are: keeping spare parts for equipment that is still being used; keeping insurance and emergency items; keeping items for a specific future use. However this is not the case for many companies especially in wholesale of machinery, equipment and supplies industry where companies may accumulate large amounts of old inventory due to high product variety and demand that is harder to predict.

ABC-analysis of inventory is useful and relatively easy way to identify various types of items that are held on stock. Emmett and Granville (2007) includes ABC-analysis into demand analysis component of inventory management. Other important elements of inventory management are demand forecasting, lead-time and balancing costs and benefits (Emmett and Granville 2007).

According to Silver, Pyke, and Peterson (1998) decisions concerning inventory management should be made at the level of individual item or product. Silver, Pyke, and Peterson (1998) use the notion of SKU or stock-keeping unit and define it as an item of stock that is completely specified as to a function, style, size, color or location. ABC-analysis of inventory is based on the Pareto principle as well as customer portfolio ABC-analysis. In the same manner around 20% of SKU account for 80% of total annual dollar usage which means that not all SKU in the firm's inventory should receive the same level of attention and effort (Silver, Pyke, and Peterson 1998).

“Group A items should receive most personalized attention from the management”(Silver, Pyke, and Peterson 1998). This is the most important class of items, usually the few of most expensive ones, as they account for between 50% and 80% of annual

dollar usage ((Silver, Pyke, and Peterson 1998),(Waters 2003)). According to Arnold, Chapman, and Clive (2012) this items require “tight control including complete accurate records, regular a frequent review by management, frequent review of demand forecasts, and close follow-up and expediting to reduce lead time”.

Items in group B are less important but still require significant amount of attention (Silver, Pyke, and Peterson 1998). This is usually the largest group of SKU (Silver, Pyke, and Peterson 1998). According to Arnold, Chapman, and Clive (2012) these items require normal amount of control, good records and normal processing.

C-items are quite large group of items that account for only minor part of annual dollar usage (Silver, Pyke, and Peterson 1998). According to Silver, Pyke, and Peterson (1998) some companies keep relatively large inventories to avoid possible inconvenience that absence of such kind of item may cause. Arnold, Chapman, and Clive (2012) argue that C items should be managed according to the following principle: “make sure that they are plenty” and the simplest control should be executed when managing them.

Silver, Pyke, and Peterson (1998) state that in general there are two rules to follow in inventory management: “have plenty of low value items” and “use the money and control effort saved to reduce the inventory of high value items. Waters (2003) argues that decision to free stock from C-items in general is wrong as some of them although slow-moving or generating low value are important for other reasons. Waters (2003) states that C-items should be stored for the following reasons: if C items are more important than the classification suggests (spare parts or ordered by critical customers); if C items allow continued sales of an old item; if they are element or associated with sales of A items; if they give high profit in relation to their low cost; if C items are new items; if availability of C items is expected by customers.

Sabath and Whipple (2004) state that it is necessary to use the customer/product action matrix which combines cumulative profit by customer and cumulative profit by product in order to facilitate decision making process in inventory management and increase level of detail of decisions. The matrix provides a possibility to make more accurate decisions when it comes to inventory management as these decisions should also be made taking into account their influence on customer behavior and other processes of organization.

The customer/ product action matrix is shown on Figure 12. It can be seen that there are 16 possible courses of action associated with a particular group of customer and particular group of product. Product categories 1 to 4 correspond to categories A, B, C and D by profitability (highly profitable products, medium profitable, low profitable and unprofitable

items). Each cell of the matrix identifies specific product and customers, their revenues and profit contribution (Sabath and Whipple 2004).

		Product Category			
		1	2	3	4
Customer Category	A	Perfection / Never Miss	Regular / Priority Schedule	Reserve Capacity / Inventory	Tough It Out / Outsource
	B	As Promised	Regular Schedule	Schedule Capacity / Inventory	Redirect / Outsource
	C	If Available / If Scheduled	If Available	Only if Capacity or Inventory are Available	Only if Transaction is Profitable
	D	Respond to Transaction	If no Conflict	Only if Inventory is Available / Cull Candidate	Cull

Figure 12. Customer/ product action matrix (Sabath and Whipple 2004).

“Appropriate actions vary from "perfect service" in the upper left cell to "cull" in the lower right” (Sabath and Whipple 2004). In the upper row all the actions represent “perfect service” as critical customers must be served even with unprofitable items as these items might be necessary requirement for their work (Sabath and Whipple 2004). On the other hand each transaction with D customer should be treated individually and checked if it is profitable enough to be carried out, selling customer D unprofitable item 4 is a clear lose-lose situation (Sabath and Whipple 2004). “Certainly, the most attention should be paid to the sweet spot of categories A-1 through B-2, where low cost and perfect response capabilities can deliver astonishing results in these four extremely profitable cells” (Sabath and Whipple 2004). Sabath and Whipple (2004) state that every company should try to move from bottom-right corner to top-left in order to increase its profitability. It can be done through better sharing of information within the company as well as with upstream and downstream partners (Sabath and Whipple 2004).

Silver, Pyke, and Peterson (1998) argue that inventory classification preferably should have several levels and need not to be done on the basis of the profit/annual dollar usage dimension alone.

XYZ classification method can be used to extend the classical ABC method (Reiner and Trcka 2004). “The ABC-XYZ classification method takes value and variability of demand into account” (Reiner and Trcka 2004). Assignment to one of the classes takes place based on how regularly the unit is consumed (Hoppe 2008). There are several criteria that can

serve a basis for XYZ analysis (Hoppe 2008) among them coefficient of demand variance (v) ((<http://logistic-info.org.ua/analiz-abc-xyz/page-2.html>), (Hoppe 2008)).

$$v = \frac{\sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}}{\bar{x}} \times 100\%$$

Class X products are characterized by a low coefficient of variation $0 \leq v \leq 10\%$; class Y products have higher coefficient of variation $10\% \leq v \leq 25\%$; and class Z products' coefficient of variation falls into range of more than 25% ((Reiner and Trcka 2004), (<http://logistic-info.org.ua/analiz-abc-xyz/page-2.html>), (Hoppe 2008)).

Future demand for X material can be forecasted relatively well as requirements for that items fluctuate slightly around a constant level and these items are characterized by relatively constant and non-changing usage over time (Hoppe 2008).

Demand for Y material is not that stable and one can often observe trends, or seasonal fluctuations of the demand for those items so that is normally harder to obtain accurate forecast (Hoppe 2008).

Z materials are characterized by sporadic demand and are not regularly used (Hoppe 2008). Therefore it is extremely difficult to create accurate forecasts for Z items (Hoppe 2008).

After ABC and XYZ analyses are done it is possible to combine the results and at the end receive 9 groups AX, AY, AZ, BX, BY, BZ, CX, CY and CZ that require particular approach. Groups AX, AY and AZ require high level of attention as these are groups of the most profitable items. However often it is reasonable to lessen the amount of items Z on the stock and sell them on the individual and transactional basis since their demand is so hard to predict (Royter et al. 2011).

To summarize in this research is focused on that part of the inventory management that determines what should be held on the inventory. Inventory classification helps to determine the most profitable and unprofitable items on the inventory or obsolete inventory and is important for cost reduction initiatives in the company. It is suggested a matrix which has customer and inventory group dimension in order to determined critical items in the inventory. Example of its implementation and results can be found in the case study chapter.

3.2.4. Evaluation of Strategic Order Fulfillment Improvement Initiatives

On the final stage of strategic order fulfillment improvement it is necessary to develop performance metrics and measures of the process (Lambert 2006). Measurement and

monitoring are very important parts of improvement process (Schneiderman 1996a). Improving a process takes effort and resources therefore with the improvement of a metric stakeholder value must improve significantly (Schneiderman 1996a). Metrics should also be used to check whether the improvement efforts are paid off and whether they are applied to a wright area (Schneiderman 1996a).

Performance measures

There are many various approaches to development of performance metrics and measures in supply chain (Lambert 2006, Cirtita and Glaser-Segura 2012, Schneiderman 1996a, b). The most important issues is a lack of the metrics that span over the entire supply chain (Cirtita and Glaser-Segura 2012, Lambert 2006). The reason for this is the lack of supply chain orientation in the companies, supply chain complexity, unwillingness to share sensitive information along the supply chain, etc. (Lambert 2006).

According to Lambert (2006) system of performance measures and metrics should be developed for each business process and for each link in the supply chain. It is important to base system of metrics and measures of both financial and non-financial elements (Lambert 2006). According to Lambert (2006) financial measures are based on the effect of relationship with customer or supplier on profitability and shareholder value. In addition each process should have a set of non-financial metrics and measures (Lambert 2006).

To capture financial performance of the supply chain Lambert (2006) suggests to develop customer-supplier profit and loss statement for each pair of customers and suppliers in the supply chain. This will allow “to assess the effect of the relationship on profitability and shareholder value of the two firms” (Lambert 2006).

Besides Lambert (2006) suggests to realign all processes and activities to achieve performance objectives and establish non-financial performance measures for each key business process. Lambert (2006) suggests to develop these measures in dependence with the impact of key business process on the economic value added.

Order fulfillment influences on company’s profit from operations through sales, cost of goods sold and total expenses (Lambert 2006). Effective and efficient order fulfillment allows company to obtain repeat business, increase share of market or customer, retain and strengthen relationships with profitable customers which has a positive impact on sales (Lambert 2006). (Lambert 2006) names the following metrics to assess order fulfillment performance in relation to company’s sales: percent increase in sales volume with customer,

percent of total customer's buy, activity cost targets and cost to serve target in monetary terms.

Efficient and effective OFP lowers cost of goods sold through efficient network design (lower transportation expenses, lower inventory carrying costs, etc.) (Lambert 2006). Corresponding metric is total delivered cost of materials.

OFP also influences on total expenses through level of completeness of order, level of damage and tracing, level of service provided to less profitable customers, level of handling costs, level of outbound freight, structure of physical network/ facilities, structure of distribution channels, amount of errors/ claims/ customer returns, level of human resources effectiveness, level of general overhead/management administrative costs (Lambert 2006). Corresponding metrics are respectively percent of orders shipped complete or percent of perfect orders; claims, damage rate, customer returns, refusals; reduced logistics activities and costs to less profitable segment of customers; number of labor hours per fulfillment activity; percent track load shipments, full pallets; facility costs, freight costs; volume moving through different channels; order pick accuracy, cycle time; headcount, productivity, cost per activity; general overhead/management/ administrative costs (Lambert 2006).

Besides OFP influences on economic value added through impact on current assets: inventory and other current assets; and fixed assets (Lambert 2006). Efficient and effective OFP allows to reduce finished goods inventory, obsolete inventory and reduce accounts receivable through faster payment (Lambert 2006). Corresponding metrics are as follows: increase in inventory turns, cycle time; value of obsolete inventory and cycle time, pick time, cash-to-cash time, asset utilization, throughput time (Lambert 2006). Influence of OFP on fixed assets is carried out through the influence on the level of asset utilization and rationalization (Lambert 2006). Corresponding metric is decrease in fixed assets or equipment due to the out sourcing of non-core activities.

Lambert (2006) does not draw a line between performance metrics and measures. In contrast Schneiderman (1996a) argues that measures are quantitative representation of one of the process features. Metrics according to Schneiderman (1996a) represent a subset which includes at most three to five measures and allows to focus on opportunities for improvement. In his work Schneiderman (1996b) suggests the following metrics to assess performance of OFP: lateness; lead time; severity and responsiveness.

Lateness is described by the percentage of the time when the order is delivered in an acceptable window around company commit date (Schneiderman 1996b). This window can be based on company's policy (example of HP: "three days early, zero days late") or customer

preferences (“just-in-time”, “five days early, zero days late”). Corresponding measures are percent of early shipments, percent of in-time shipments and percent of late shipments (Schneiderman 1996b).

Lead time metric is describes by percentage of customer request dates not met or the difference between company commit date and customer request date (Schneiderman 1996b). The other metric used is excess lead time or the actual difference between customer request date and company commit date or the date when the order was actually delivered (Schneiderman 1996b).

Severity describes the extent of lateness and includes metrics based on actual ship or deliver date: “shipped-late-how-late?”, “shipped-early-how-early?”, “still-late-how-late?” and “backlog coverage”, or late backlog divided by average ship rate (Schneiderman 1996b).

Responsiveness is described as time between order entry and communication of company commit date which allows to prevent late communication of expected date of delivery when all the items ordered are available to deliver (Schneiderman 1996b). Even though in this case lead time is short and company commit date is met customer had to wait long time for response and communication of commit date (Schneiderman 1996b).

Schneiderman (1996b) states that all the metrics described above are result metrics however it is also important to identify process metrics. Schneiderman (1996b) suggests to assign responsibility for each of the late lines to the function that is responsible for lateness. Schneiderman (1996b) identifies the following groups to which responsibility should be assigned: the divisions; the credit department; the warehouse or the customer.

Improvement of OFP, in particular in collaboration with all the critical members of supply chain, also influences on the overall performance of the supply chain (Lambert 2006). Cirtita and Glaser-Segura (2012) defines the following supply chain metrics developed by Supply Chain Council based on the SCOR model: supply chain delivery reliability; supply chain responsiveness; supply chain flexibility; supply chain costs; supply chain asset management efficiency. OFP influences on each of the named performance attributes of the supply chain (Lambert 2006). Metrics that can be used to assess performance attributes are: delivery performance, perfect order fulfillment and line item fill rate for supply chain delivery reliability; order fulfillment lead time for supply chain responsiveness; supply chain response time and production flexibility for supply chain flexibility; costs of goods sold, total supply chain management costs, value-added productivity and warranty/ returns processing costs for supply chain costs; cash-to-cash cycle time, inventory days of supply and asset turns for supply chain asset management efficiency (Cirtita and Glaser-Segura 2012).

To summarize any company should define suitable financial and non-financial performance metrics. One way to assess performance is to build performance measurement policy for a separate supply chain link and key processes involved and then replicate it over the whole supply chain. Financial performance can be evaluated by using customer-supplier performance and loss profiles. Joint financial and non-financial performance can be assessed using a set of metrics and measures developed for each process. OFP can be assessed with help of metrics that evaluate order fulfillment influence on company economic value added. Another way to assess OFP performance is by using the result oriented metrics (lateness, lead time, severity and responsiveness) and process oriented metrics (distribution of responsibility by stakeholders of the process).

Simulation modeling

Simulation modeling is widely used for experiments in logistics and supply chain research (Almeder, Preusser, and Hartl 2009, Tako and Robinson 2012, Manuj, Mentzer, and Bowers 2009). Simulation method provides possibilities to investigate behavior of the system in uncertain conditions. The method is often used when the system under consideration is so complex that it is impossible to receive analytical solution to a problem, especially in systems with stochastic components (Manuj, Mentzer, and Bowers 2009). Simulation model can provide researcher with quantitative estimations of risks (for example demand and supply uncertainties in interaction), uncertainty impact, what-if scenarios and overall sustainability of the system (Reiner 2005, Zee and Vorst 2005). These specific features make simulation modeling an important and powerful tool for evaluation of managerial decisions within managerial decision support models (Terzi and Cavalieri 2004). Simulation in supply chain context is even named as an essential decision support system that becomes a key-success factor for companies surviving (Terzi and Cavalieri 2004).

Simulation modeling is widely used in logistics and supply chain analysis from strategic to tactic levels (Tako and Robinson 2012). Nevertheless for the problems of business process management (reengineering and improvement) simulation is not so often used, according to the literature research on simulation methods in logistics and supply chain context provided by Tako and Robinson (2012). Idea of simulation found was developing within implementation to business process management in different industries. For example simulation tool was used to support in BPM in service company (Razvi and Nevin Vunka 2008), banking (Islam and Ahmed 2012) electronic manufacturing (Reiner 2005) or shoe industry (Ceroni and Nof 2005) to name a few.

Importance of simulation support for customer oriented business process improvement was developed by Reiner (2005). Reiner (2005) support the idea that improvements that are developing by various management systems lack sufficient qualitative estimation of results. All proposed improvements need to be dynamically evaluated according a system of performance measures developed due to integrate company requirements and nature of the supply chain and business processes.

So far while business process improvement simulation modeling could dynamically provide quantitative estimations of introducing improvements according to specific system of performance measures.

3.3. Description of Managerial Decision Model for Strategic Order Fulfillment Improvement

This paragraph provides a description of managerial decision model for strategic OFP improvement. Managerial decision model for strategic order fulfillment improvement is based on the review of industry's market and tendencies; business process improvement approaches; OFP interfaces with key business processes; main dimensions for the order fulfillment improvement, corresponding instruments that can be used for strategic order fulfillment improvement and main tools that can be used to evaluate its successfulness.

This model is developed with respect to theoretical approach to business process interfaces in a company described by Croxton (2003) and Lambert (2006). Croxton (2003) and Lambert (2006) state that OFP receives input from other key business processes in a company on both operational and strategic level. According to Croxton (2003) strategic sub-processes of order fulfillment are as follows:

Stage 1. Review marketing strategy, supply chain structure and customer goals;

Stage 2. Define requirements for OFP;

Stage 3. Evaluate logistics network;

Stage 4. Define plan for the order fulfillment;

Stage 5. Develop framework of metrics.

This research is focused on interfaces between strategic order fulfillment and CRM, SRM and IM which are considered to be the most important processes within wholesale of machinery, equipment and supplies industry.

This paper suggests a decision making model for strategic order fulfillment which uses input information and techniques from CRM, SRM and IM in improvement initiatives.

Managerial decision model of strategic order fulfillment improvement is presented on the Figure 13.



Figure 13. Managerial decision model for strategic order fulfillment improvement.

It can be seen that suggested model has four stages which have to be done one after another.

Customer Relationship Management

On the first stage an improvement team should answer the following questions:

- What are our market segments?
- Who are our critical customers?
- What are customer requirements?
- Should supply chain- and company objectives be readjusted?
- Should order fulfillment objectives be readjusted?

Question “What are our market segments?” need to be answered in order to understand which customers an industrial distributor wants to serve: should it be only industrial customers or should construction and private sector customers be served in addition? Each market segment normally influences on characteristics of distribution channel and the way OFP is organized. This question should be answered by extensive industry, market analysis or customer segmentation by industry or size. If company decides that some of the segments are unwanted or in contrary are attractive the whole supply chain- and company strategy will be altered.

In order to understand which customers industrial distributor wants to serve it is also necessary to answer question 2: “Who are the critical customers of a company?” This could be done using customer profitability segmentation and analysis (ABC analysis). The most profitable customers usually are the critical ones as well-being of the company depends on their willingness to buy. Other techniques that can be used for this purpose are portfolio models by customer profitability and length of relationships or by customer profitability and volume of purchase.

Besides it is necessary to find out “what are customer requirements?” Often customer requirements change with time and nowadays changes come faster. An industrial distributor should always know what customer wants as this is a key to customer satisfaction. This information can be received using customer survey analysis. As a result of analysis customers should be grouped into segments by service requirements which simplifies the process of customer satisfaction. However all the critical customers represent a separate segment and all their requirements should receive immediate attention from order fulfillment improvement team. It is also possible to identify perspective customers judging by their total annual spend on MRO and other industrial consumables and components and their annual purchase from an industrial distributor.

Questions “Should supply chain- and company objectives be readjusted?” and “Should order objectives be readjusted?” are answered the last based on the information received from industry, supply chain and customer analysis. On this stage order fulfillment improvement team compares supply chain-, company- and order fulfillment objectives with customer requirements and decides whether they correspond to each other or not. If there are any differences then supply chain-, company- and order fulfillment objectives should be readjusted. Level of customer satisfaction may also serve as a basis to determine whether company understands customer requirements. If the level of satisfaction is low then some changes needed in the way OFP and relationships with those customers are organized. However, critical customers and perspective customers should receive higher attention than customers from the less profitable groups.

Input provided by CRM dimension forms the basis for strategic OFP improvement. It secures that all the following readjustments of the process are made in connection to customer requirements and insures future customer satisfaction. Input from CRM dimension therefore is used to improve for each of the five strategic OFPs.

Inventory Management

On the next stage, it is necessary to balance customer requirements and supply chain capabilities with help of inventory management analysis.

Therefore inventory management analysis should answer the following questions:

- Which of the products sold are critical for company well-being?
- What products does company have on stock?
- What should company have on stock?
- Can all the customer requirements be met taking into account inventory capacity?
- What is the best possible way to ensure customer satisfaction for each customer segment/ critical customer under capacity and cost restraints?

First, second and third questions can be answered by inventory analysis and classification instruments. These questions should be answered in order to optimize the use of stock and provide the best possible service to customers at minimal costs. In order to understand the character of products sold an improvement team should use ABC-analysis of SKU by profitability; XYZ-analysis of SKU by stock value and XYZ-analysis of SKU by variance of usage which in this work corresponds to demand variance. At the end industrial distributor should make a decision which items should be held on stock. This decision should be made taking into account customer service requirements and customer criticality.

Customer service requirements, customer criticality and inventory costs should be taken into account when answering the following question: "Can all the customer requirements be met taking into account inventory capacity and costs?" If all the customer requirements can be met within cost and capacity restraints then the only factor which should be taken into account during order fulfillment improvement is customer satisfaction. However in most of the cases an improvement team has to find a balance between customer requirements and restraints.

In order to find the best possible way to ensure customer satisfaction under capacity and cost restraints an industrial distributor should use information received during customer analysis. One of the instruments that can be used to identify which items should be on stock and how customer orders should be filled (is there a need for customer prioritization?) is to use customer/ product matrix by profitability.

Results of this inventory analysis are used as input to improve the following strategic sub-processes of OFP: “define requirements for order fulfillment” and “evaluate logistics network”.

Supplier relationship management

The last third stage is supplier relationship management analysis. The most important questions with respect to OFP are:

- Who are critical suppliers of a company?
- What is performance level of company’s suppliers?
- Who should company order from?

Supplier relationship management analysis is mainly concerned with logistics service level analysis. Very often suppliers have a direct influence on company performance within logistics service. Therefore supplier evaluation and selection are very important in order to meet customer service requirements. It is necessary to identify critical suppliers in order to understand which of them have the great impact on companies business and what measures should be taken with respect to each of the suppliers. Kraljic matix can be used to identify unwanted partners and attractive partners by supplier criticality and supplier performance. In order to evaluate supplier performance company might use fuzzy approach, weighted approach and other approaches.

It is also important to know what products should be ordered from which suppliers: critical products for critical customers should not be ordered from suppliers with low performance level. In order to do this analysis company may match critical suppliers (which should also be suppliers with high performance), critical customers and critical products and ensure that right products are ordered from right suppliers to satisfy customer needs.

Input from SRM may be used to improve the following strategic sub-processes of order fulfillment: “evaluate logistics network”; “define plan for order fulfillment” and “develop framework of metrics”.

Success evaluation

On the fourth stage it is necessary identify performance metrics of OFP and build a simulation model for OFP. Performance metrics help to evaluate current OFP performance and judge whether the improvement of the process was successful. Metrics should be chosen in accordance with the results of customer requirements analysis, inventory analysis and supplier analysis. This research suggest such metrics as lateness, lead time, severity and

responsiveness. Finally, simulation model should be built to check whether the improvement initiatives will lead to increase in performance.

Outcomes of model implementation

Developed model allows to receive some valuable OFP improvement initiatives that are primarily focused on customer satisfaction through readjusting OFP towards customer service requirements. This influences performance of OFP and company profitability by increasing company revenue. At the same model allows readjust OFP areas connected to IM or SRM. Developed initiatives for OFP improvement may influence order filling rate through product availability and customer prioritization or service level of OFP through supplier selection. This in turn decreases company costs and as customer requirements and criticality are taken into account it can be assumed that cost reduction is achieved without significant or any loss in customer satisfaction. Taking this into account managerial decision model developed allows improving OFP and achieving higher levels of company profitability and supplying chain profitability by influencing on company's revenue and costs.

To summarize managerial decision model developed in this research provides improvement team with necessary guidelines during strategic order fulfillment improvement process. It explains which instrument can be used to receive necessary inputs to readjust strategic order fulfillment sub-processes. The suggested model has four main stages which should be performed in the following order: CRM analysis, inventory management analysis, SRM analysis and identification of performance metrics.

4. Methodological Basis of Research

The chapter presents methodological basis of the research. First it explains why exploratory case study was selected in order to demonstrate a real case application of a managerial decision model for strategic OFP improvement for industrial distributor in machinery, equipment and supplies wholesaling industry and why TOOLS Molde was chosen as a company for single case study. Then research model is presented in order to describe the logic of the study and how research objectives are to be explored. Further down in this chapter research methods that were used within the research are presented and explained. Further the main data sources are presented as well as approaches for data collection and analysis.

4.1. Exploratory Case Study

In order to demonstrate a real case application of a managerial decision model for strategic OFP improvement for WME&S industry it was decided fulfill a single case analysis within exploratory case study framework. This approach is supported with following considerations.

According to Durepos, Mills, and Wiebe (2010) exploratory case study should be performed in case if a distinct phenomenon should be studied when there is a lack of preliminary research. Therefore an explanatory case study should be considered as “a preliminary step of an overall causal or explanatory research design” (Durepos, Mills, and Wiebe 2010). Taking into account that first, OFP and other business processes are not extensively studied in the literature and second, managerial decision model developed is not studied or applied before in the literature exploratory case study is considered as a necessary step before further research in this area could follow.

Moreover broad concept of exploratory case study provides researches with a high flexibility and independence in choice of research methods, data collection and analysis (Durepos, Mills, and Wiebe 2010). This feature of exploratory case study is especially important for the research as far as due to new research area it is quite desirable to use different research methods in order to capture different important aspects of phenomena under consideration.

This research is based on an example of TOOLS Molde which is selected for a single case study by two main reasons. First, single case study is chosen due to the fact that this research is the first research in this area and it is more important to provide a detailed analysis of one company. Second, TOOLS Molde could be considered as a typical industrial distributor in the region. Therefore research findings could be generalized at least for other

subsidiaries of B&B TOOLS Group which includes more than two hundred companies in Scandinavia (B&B_TOOLS 2013a).

The study was conducted from December 2012 to May 2013 following a methodological approach that is described by Vakola and Rezgui (2000), Sola and Baines (2005), Seethamraju and Marjanovic (2009), Yin (2009). The research team contained researches and selected manager from TOOLS Molde.

4.2. Case Study Research Model

In order to demonstrate a real case application of a managerial decision model for strategic OFP improvement for industrial distributor in machinery, equipment and supplies wholesaling industry it was decided to perform the following tasks within research objective:

- Describe company and its place on the market and in the supply chain;
- Develop a set of order fulfillment improvement initiatives according to developed managerial decision model;
- Evaluate whether order fulfillment improvement initiatives have a significant impact on company- and supply chain performance according to the model;

In order to accomplish research objective case study was performed within the research model presented in the Figure 14.

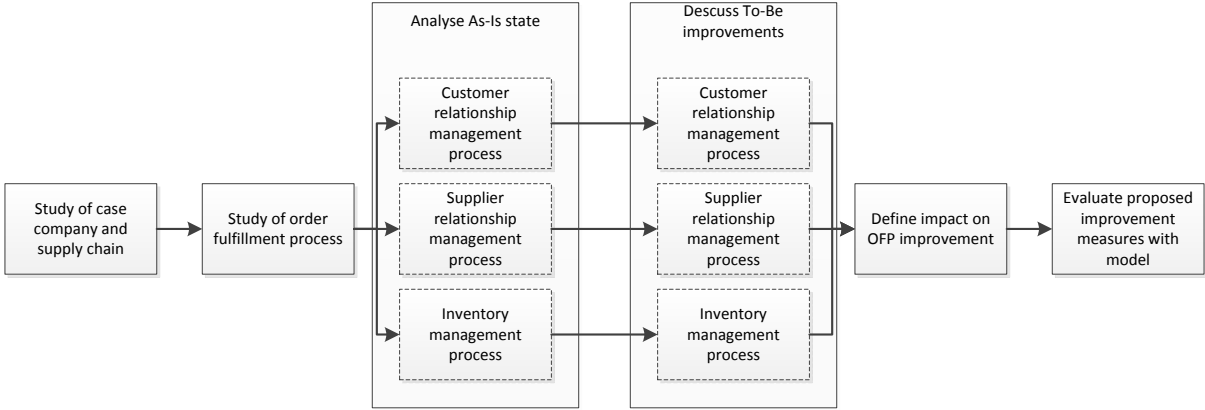


Figure 14. Case study research model.

Exploration of second research sub-problem required two steps of preliminary analysis. First, the company and related supply chain were studied. Due to the fact that the research is aimed at exploration of OFP that connects all members of the supply chain the description is given from the supply chain perspective. Second, it was necessary to explore current organization of OFP at the moment of the research.

Since managerial decision model developed is based on interfaces of CRM, IM and SRM processes with order fulfillment and instruments suggested to improve OFP correspond to each of these dimensions it was decided to perform a preliminary study and description of CRM, IM and SRM processes in the company.

In order to develop a set of improvement initiatives for OFP input information from CRM, IM and SRM was received with help of corresponding instruments such as: customer segmentation by profitability and by customer service requirements, supplier portfolio analysis and extended ABC-XYZ analysis.

Then the impact of every suggested improvement initiative on OFP-, company- or supply chain performance is estimated in qualitative and quantitative manner. The impact of some of the improvement initiatives is evaluated with help of the simulation model of OFP.

As an outcome of the case study a set of improvement initiatives for strategic OFP is presented with estimated influence on performance of the supply chain and focal company.

4.3. Research Methodology

In order to provide multidimensional insights to the research problem the study is bases on combination of qualitative and quantitative paradigms. This approach is named as supply chain management and logistics methodological triangulation by Mangan, Lalwani, and Gardner (2004).

According to the classification given by Hussey and Hussey (1997) research is based on combination of the methodologies from both positivist and phenomenological paradigms (see Mangan, Lalwani, and Gardner (2004)). Case study of a company operating in WME&S industry is supported by theoretical ground within Phenomenological paradigm. Positivist paradigm is presented by modeling (including simulation modeling) of the OFP, and customer survey directed on identification of customer needs.

Positivist paradigm	Phenomenological paradigm
Cross-sectional studies	Action research
Experimental studies	Case studies
Longitudinal studies	Ethnography
Surveys	Construct elicitation
Models and simulation	Grounded theory
	Hermeneutics
	Participative enquiry

Figure 15. Methodologies used in the positivist and phenomenological paradigms (Hussey and Hussey 1997).

A multi-methodological perspective is chosen in order to broader and deeper understanding of phenomena in the area of the research (Alex da Mota, Näslund, and Jasmand 2012).

4.4. Research Methods

Within the presented methodologies in order to investigate research questions and to connect them with an object of the research the set of research methods was chosen according to the approach of Mixed Methods of Research presented by Remus and Wiener (2010). This approach realizes Methodological triangulation idea and encourages researchers to use various research methods in order to provide a “wider range of coverage, improve trustworthiness and wideness the scope of the study” (Remus and Wiener 2010). Research triangulation has a direct positive impact on validity ,reliability and quality of the research (Yin 2009). In the present research idea of triangulation is used within data sourcing (data triangulation), in basic theoretical ideas (theory triangulation) and in methods used (methodological triangulation).

Exploratory case study is considered to be a main research method for the second research sub-problem. To support case findings, to clarify some aspects and to get some additional information a set of other primary research techniques within logistics and supply chain management is utilized within the research (according to the classification by Frankel, Naslund, and Bolumole (2005)): (1) interview, (2) observations, (3) survey and (4) experiments.

Interviews and Observations

Interviews and observations are used to explore both theoretical and empirical research sub-problems.

Interviews and observations are necessary methods for preliminary description and analysis of a case company. Specialists that know industry from inside can provide researchers with information on specific features of industry and processes. Information about a case company received during interviews is extremely helpful for better understanding of a case company, statistical data and specific conditions of analysis. Observations of all stages of order fulfillment are necessary for correct mapping and understanding of the process.

A set of interviews was conducted with management and most of the employees of TOOLS Molde that participate in OFP. Interviews were dedicated to identification and

description of business processes, definition of bottlenecks of processes, important factors of demand.

Working meetings were conducted with executive manager of TOOLS Molde on average once a week. Meetings were dedicated to discussion of data analysis, research topics and achieved results.

In order to describe the processes within the supply chain a set of real-world observations was performed in TOOLS Molde as well as at the customer site.

Survey

According to managerial decision model it is necessary to define customer service preferences in order to customize OFP. Current customer preferences were defined by means of customer survey. Further, based on the results of survey OFP improvement initiatives are formulated. Besides, customer survey results help to estimate an effect OFP improvement initiatives will have on customer satisfaction.

The survey contains 24 questions on the following topics: company profile, size, amount of purchase, customer service requirements, customer evaluation of service provided by TOOLS Molde and ability to predict demand (see survey in the Appendix A). The survey contains various question types, however their majority these are closed questions with single or multiple choice.

The survey was distributed electronically to 160 randomly selected customers of TOOLS Molde (25% of total number of customers). 53 unique responses were received (response rate is 33%).

The survey was realized on the basis of QuestBack platform, time period for the survey: 2 weeks from 15.04.2013 to 26.04.2013.

Experiments (simulation modeling)

According to managerial decision model on the last stage OFP improvement initiatives could be evaluated with a help of simulation. Simulation modeling is one of the mathematical modeling methods that is widely used research methods in logistics and supply chain research(Manuj, Mentzer, and Bowers 2009). Simulation model of the order fulfillment process was developed in order to provide quantitative estimation for developed process improvement initiatives. Simulation was chosen as a basis for experimental analysis in order to achieve high precision in testing hypothesis (by manipulation with variables) (Manuj, Mentzer, and Bowers 2009).

A simulation model of the OFP was developed by means of discrete event simulation software ARENA. Basic model describes behavior of the main actors in a state as it is now (“As-Is”, or “current” state). Further, to describe the behavior of a system and to test an impact of OFP improvement initiatives according to the managerial decision model, the basic simulation model was modified and a set of alternative simulation models was created in order to describe the impact of suggested changes on the behavior of the system.

Development of the simulation model was realized within the methodology of discrete-event simulation in logistics and supply chain research proposed by Manuj, Mentzer, and Bowers (2009).

Development of the simulation model was realized according to the following steps:

- Problem formulation.
- Model parameters and variables specification.
- Conceptual model development.
- Data collection.
- Simulation model development and verification.
- Simulation model validation.
- Performance of simulations.
- Analysis and documentation of results.

Thus, the research methods described above are used within a single case study based on example of TOOLS Molde AS in order to investigate second sub-problem: to demonstrate a real case application of a developed managerial decision model for strategic OFP improvement. Use of different research methods provided a possibility to study subject of the research from various perspectives: from company’s perspective (interviews and observations), from customer’s perspective (survey) and from statistical and mathematical perspective (experiments with a model).

4.5. Data Collection, Cleaning and Analysis

“Data Analysis is both the Art and Science” (O’Rourke 2000)

Two main sources of data were used in the research: statistical data within the case study and data obtained as a result of the survey.

Case study provides the research with statistical information about operational and financial results of TOOLS Molde AS. These data were obtained from an ERP system Penguin installed in TOOLS Molde. The information was received in three main blocks and some supportive tables.

General information block provides data on orders that were received by TOOLS Molde from the customers. The data include order number, name and number of the customer, items that were ordered with article numbers and amounts, name of the supplier for every item. Also for every item and every order the TOOLS' margin is defined.

The other set of information provides data on orders that were made by TOOLS Molde to up-stream suppliers. The data include information about orders, suppliers, ordered items and delivery condition: delivery to stock, transit order or direct delivery to the customer. The data set contains also information on the time when the order was created and last changed.

The third set of information presents data on deliveries from TOOLS Molde to the down-stream customers. For every delivery the corresponding order number, customer name and amount of delivered products are presented. Completeness of delivery was marked by TRUE/FALCE marker (delivery is considered to be incomplete when the number of delivered items was less then ordered).

The fourth set of information contains data on the products on stock for the beginning and the end of the year 2012. For every SKU number information about amount of products on stock, amount of products sold for the last year is given as well as inventory policy parameters such as reorder points and order amounts.

A set of additional data was received in order to clarify and clean the data referred above. For example, information about workers from service department of TOOLS Molde, SKUs on delivery solutions, delivery times and reliability of suppliers was received in addition to the main data sets.

Survey could be considered as a second source of data that contains information about customer behavior with respect to company's specific features as type of industry, size, amount of year purchase, amount of suppliers, length and satisfaction from the customer-supplier relations with TOOLS Molde, expectations of the "ideal" products, ability to forecast the demand and parameters of ERP systems.

According to social research data classification proposed by Bryman (2012) collected data can be categorized as primary and secondary, qualitative and quantitative empirical data.

Before any analysis was conducted all collected data were "cleaned" or "screened" in order to identify cases of real or potential errors in the data entry (O'Rourke 2000). All data sets that the research is based on were tested for errors according to the methodology proposed by O'Rourke (2000) that contains procedures of visual check, testing for impossible events, analysis of exceptional events, events contradicting with common sense, and

checking the inconsistencies of the data from the different data sets. All detected errors were corrected if possible or eliminated from the data set.

The data set contained the following errors and problems. Information contained meaningless data (for ex. zero price or zero delivery quantity). Data set contained information from the companies that should not be considered within the research (like orders from other branches of TOOLS Norge or guarantee service). All these data were removed from a data set.

Names of customers, suppliers, SKUs were often ambiguous. This impeded automatic data processing and could lead to wrong conclusions. These data were corrected based on a common sense.

Besides this, received data asset could be considered as incomplete, as far as it covers only orders received and delivered in the year 2012 and does not include information about orders placed in 2011 or orders placed in 2012 but delivered in 2013.

In addition a set of misprints was discovered.

Data analysis was performed by means of the following software: MS Excel and MS Access were used for analysis of aggregated data using queries, pivot tables to construct charts and tables. Statistical packages IBM SPSS Statistics, Minitab were used to test hypothesis for randomness of data, definition of data distribution, for defining clusters. ARENA simulation software was used in order to test for statistical significance of results of simulation experiments.

It is important to notice that due to confidentiality reasons all names of customers were replaced with a number.

Data collection and preparing for further analysis, performed within case study, could be considered as highly time consuming, non-value-adding but necessary process. Numerous errors in data, problems with data processing and a large size of data sets significantly slowed down the process of analysis. Error-correction procedure was performed in close cooperation with management of TOOLS Molde AS. It resulted in creation of a data set that reflects main business activity of TOOLS Molde in the year 2012.

5. Case Study for Managerial Decision Model

The case study was performed in order to demonstrate a real case application of a managerial decision model for strategic OFP improvement for industrial distributor in WME&S industry.

This chapter contains four logical parts. In the first part a preliminary study to main research problems is presented. It contains case company / supply chain description and description of core business processes. The second part presents results and discussion of data analysis. Every core process is analyzed according to managerial decision model in order to develop a set of OFP improvement initiatives. The third part describes main improvement initiatives developed according to the managerial decision model. The fourth part describes simulation model developed as a tool for dynamic evaluation of OFP improvement initiatives.

5.1. Case Description

The paragraph contains an overview of supply chain and company selected for a case study. This could be considered as a first part of the research which creates a necessary basis for further analysis. It contains:

- general description of TOOLS Molde AS in order to present a focal company of the research,
- description of the company from the supply chain perspective in order to identify units of further analysis such as “supply chain with TOOLS Molde as a focal point”, “OFP of the supply chain”, “CRM, SRM processes in the supply chain” and “IM process of the focal company”.

5.1.1. Focal Company Description

The following paragraph presents the description of a focal company. TOOLS Molde AS is described in the context of industry and corporate structure of B&B TOOLS Group it belongs to. Besides, main parameters of company's business activity are described in the present paragraph.

B&B TOOLS AS

An object of the present case study is a supply chain of WME&S industry. It provides industrial producers in Scandinavia with consumables for Maintenance, Repair and Operations – MRO (B&B_TOOLS 2012). Focal company of supply chain analysis is TOOLS Molde AS that is one of the local branches of B&B TOOLS AS.

B&B TOOLS is the “largest supplier of industrial consumables, industrial components and related services for the industrial and construction sectors in northern Europe” (B&B_TOOLS 2013b).

Main products of considered wholesaling industry belong to four areas:

- Tools & Machinery;
- Personal Protective Equipment (PPE);
- Fastening Elements;
- Work Environment & Consumables.

According to the information from the official internet page of B&B_TOOLS (2013b), the company has main customers in offshore, construction, civil engineering, property maintenance, public administration and defense sectors. Biggest part (70 percent) of B&B TOOLS total sales belongs to the industrial sector, the construction sector is responsible for 20 percent, the DIY (Do-It-Yourself)/Private market – 3 percent, when other industries have about 7 percent of sales.

From the upstream supply chain side B&B TOOLS combines two main strategies. First, it is development of strategic partnership with world-leading suppliers all over the world. The second strategy is to develop company’s own brands in the in selected product segments. These products are produced in Asiatic countries by sub-suppliers. The major part of product range is produced in Europe, but the proportion of products manufactured in Asia increases.

Company’s mission is embodied in the following areas (B&B_TOOLS 2012):

- Proximity to customers: local presence and daily contact provide better customer satisfaction;
- Customer needs: maintaining an efficient supply of consumables to customers; meeting customers’ needs based on a total-cost perspective;
- Comprehensive offerings: creating unique comprehensive solutions for customers;
- Customer satisfaction: providing customer value to each customer.

The strategic objective of B&B TOOLS consists of gradual development and offering of “increasing number of comprehensive solutions to ensure that the customers have a reliable supply of industrial components and industrial consumables for the MRO processes” (B&B_TOOLS 2012).

B&B TOOLS operates on highly competitive market. Main competitors of B&B TOOLS in Norway are Tess, Würth, Proffpartner and Albert E Olsen (B&B_TOOLS 2012).

TOOLS Molde

B&B TOOLS AS is a holding company that owns companies both upstream and downstream the supply chain (see B&B_TOOLS (2012)). Upstream supply chain companies (Essve, Skydda, Luna and TOOLS Momentum) deal with organization of procurement for the majority of the products in the supply chain. They are specialized wholesales for the downstream branches of TOOLS in all Scandinavia. Every upstream company has a national division that is responsible for trade with downstream companies from specific country (for example in Norway - Essve Norge AS, Skydda Norge AS, Luna Norge AS, Momentum Norge AS).

Downstream part of B&B TOOLS is also represented by national-based companies in Norway, Sweden and Finland. TOOLS Molde AS is one of 58 local branches that B&B TOOLS has in Norway. It belongs to north-West Department.

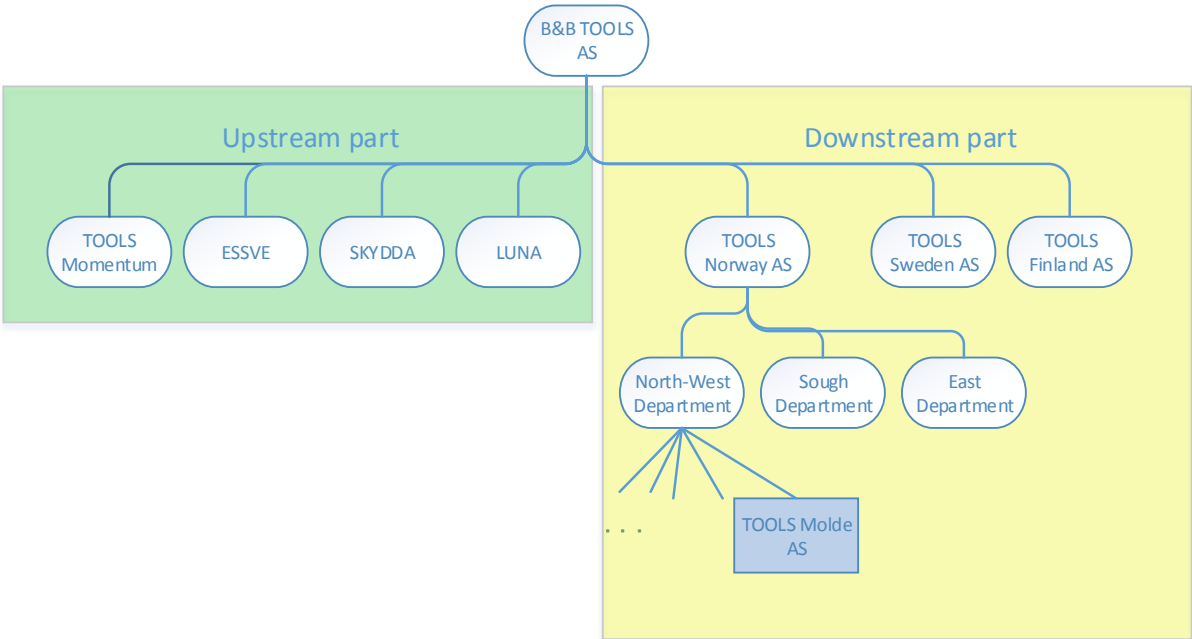


Figure 16. TOOLS Molde in B&B TOOLS Group

TOOLS Molde AS is mainly concentrated on supplying big industrial producers in the region including shipbuilding and other construction companies, oil and gas companies, and producers of industrial components. Total revenue of TOOLS Molde in 2012 was equal to 56.9 MNOK (see Table 1). It should be mentioned that in this research only revenue that is gained as a result of main activity of TOOLS Molde represented by distribution is considered.

TOOLS Molde delivered nearly 13 thousand of different products to 646 customers in Møre og Romsdal from 330 suppliers all over the world. In 2012 TOOLS Molde received 8 795 orders from customers and sent 9 412 orders to suppliers.

Table 1. Main business parameters of TOOLS Molde for 2012.

Parameter		Value
Number of customers served	(customers)	646
Number of suppliers	(suppliers)	330
Number of products delivered	(SKUs)	12 737
Number of orders from customers	(orders)	8 795
Number of orders to suppliers	(orders)	9 412
Total revenue	(NOK)	56 900 514
Total margin	(NOK)	14 404 165

Position of TOOLS Molde on the market could be described in the following way. Total market volume of industrial consumables and industrial components in Scandinavia is estimated up to 40 143 MNOK (B&B_TOOLS (2013b) reports about SEK 40 to 45 billion). Revenue of B&B TOOLS AS in 2012 was 8,201 MSEK that is 18% of total market (B&B_TOOLS 2012). The market in Norway currently accounts for nearly 30 percent of the Group’s total revenue that is about 2 195 MNOK (B&B_TOOLS 2013b). Therefore TOOLS Molde with annual revenue of approximately 57 MNOK is responsible for 3% of Group’s revenue in Norway.

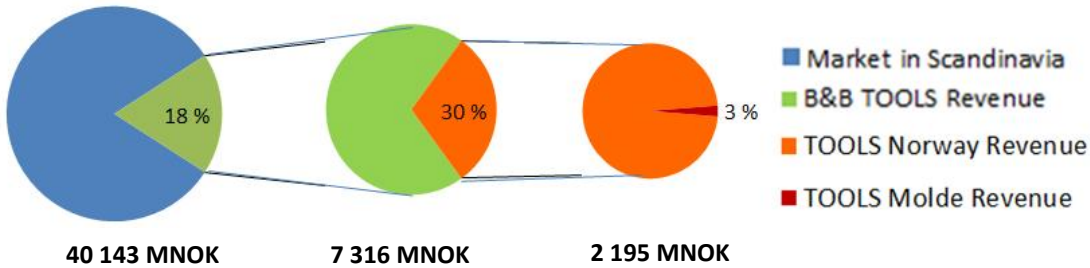


Figure 17. Share of TOOLS Molde in the context of the company and market

5.1.2. Supply Chain Description

In the paragraph main units of further analysis are presented. The paragraph contains description of the supply chain with TOOLS Molde as a focal point and description of core business processes of TOOLS Molde.

CRM, SRM and IM processes are presented in a general descriptive manner while OFP is described in details as far as it is a main focus of the research. In addition a map for OFP is presented.

5.1.2.1. Supply Chain Network Structure

For description of the supply chain three primary structural aspects in the supply chain are taken into consideration: supply chain members, structural dimensions of the supply chain and main processes that take place across the supply chain (according to Lambert, Cooper, and Pagh (1998)). Overall supply chain structure with TOOLS Molde as a focal point of the research is presented on the Figure 18.

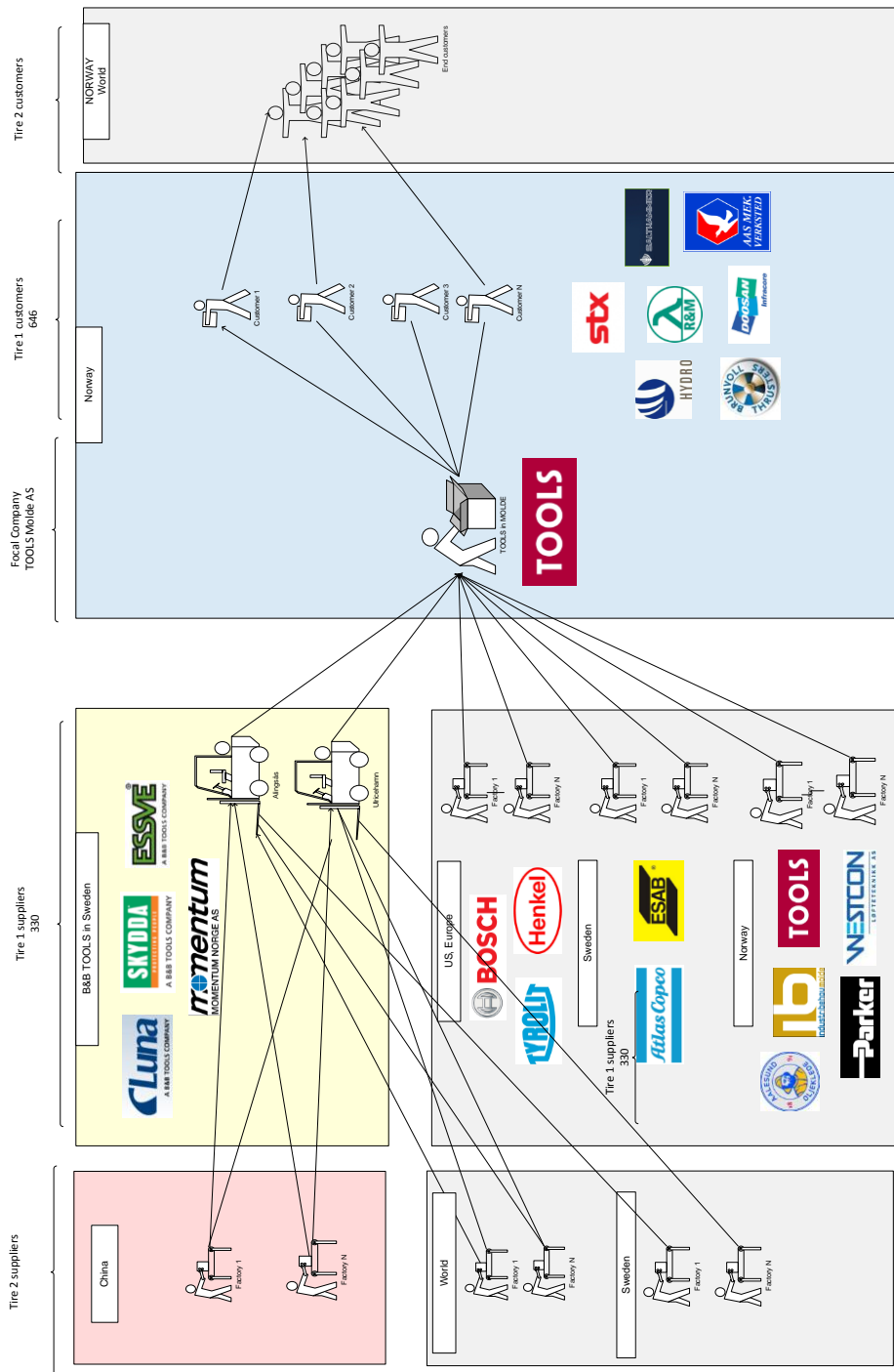


Figure 18. Supply chain Network structure with TOOLS Molde as a focal point

Upstream part of the supply chain is represented by 330 first tire suppliers. TOOLS Molde orders products from all over the world. Main countries of origin of the products are China, Sweden and European countries such as Germany, Austria or Czech Republic.

There is a significant level of integration in the upstream part of the supply chain. TOOLS Molde orders more than 40 % of total volume from suppliers that belong to the B&B TOOLS Group. Biggest share of orders (57%) is sent to the companies from the supplier part of B&B TOOLS (that is Essve Norge AS, Luna Norge AS, Momentum Norge AS and Skydda Norge AS). The rest is ordered from other branches of TOOLS Norge AS (for example from Ålesund, Trondheim or Verdal). One of the examples when TOOLS Molde purchases products from these branches is if required lead time does not allow waiting for the delivery from main supplier.

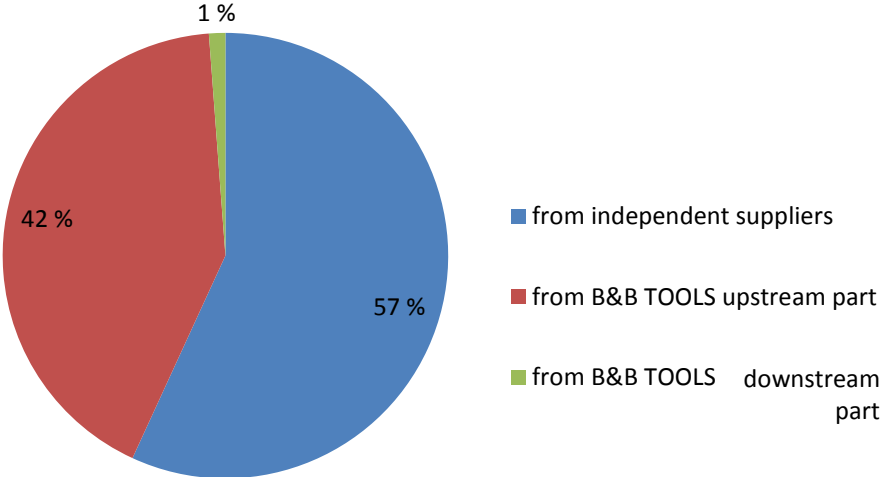


Figure 19. Share of amount ordered from different groups of suppliers (in NOK)

For more detailed statistical analysis of suppliers see paragraph 5.2.3 with research findings in Supplier Relationship Management.

Downstream of the supply chain is presented by more than 600 customers from the following sectors of the economy:

- Construction;
- Industrial production;
- Mining;
- Food production (including aquaculture and fisheries);
- Public sector;
- Private sector;

- And other branches.

The biggest customer that is responsible for 19% of total revenue is from raw material production industry. The other top ten biggest customers in their majority belong to construction industry (shipbuilding in general). For more detailed information about customer segments see paragraph 5.2.1.

As it was mentioned before main products provided by of TOOLS Molde are industrial consumables and industrial components. In case of industrial consumables (such as Personal Protective Equipment, tools or products for work environment) customers of TOOLS Molde could be considered as consumers as far as supplied components are used in their production process. In case of industrial consumables number of tires in downstream could hardly be evaluated. Assuming that TOOLS Molde as a rule deals with products that are not considered as main components in the final product of customers (as screws or pipes) the research will be limited to only tire 1 links of downstream supply chain.

TOOLS Molde can customize standard products for needs of exact customer. For example, clothes or personal protective equipment (PPE) could be labeled with customer's logo. In addition TOOLS Molde offers vendor managed inventory (VMI) solution to its 14 customers. It implies placing of shelves with defined products at customer production area. Customer consumes necessary amount of products when needed. Every week TOOLS Molde refills inventory if needed.

The supply chain of TOOLS Molde could be characterized as relatively short but wide network. It consists of hundreds of suppliers and sub-suppliers and hundreds of customers.

The supply chain contains elements that are vertically integrated (in upstream) and horizontally integrated (as other branches of TOOLS Norge AS).

In the considered supply chain members are connected with each other by means of process links. Relationships with other supply chain members are characterized by different level of integration.

In the upstream of the supply chain managed process links connect TOOLS Molde and vertically integrated suppliers from B&B TOOLS. With second tire suppliers managed process links connect supply companies from B&B TOOLS and some of the Chinese producers. These links represent connections that could be directly influenced by TOOLS Molde or B&B TOOLS using instruments of contracting and internal government directions. In the downstream of the supply chain process links between TOOLS Molde and customers with delivery solutions (such as Vendor managed inventory) could be considered as managed

ones. In all these cases TOOLS Molde integrates internal processes with customers/suppliers on a regular basis.

TOOLS Molde has a relatively big number of monitored process links that connect the focal company with the rest of 1st tire suppliers and customers excluding the ones described in the previous abstract. TOOLS Molde monitors and audits on the regular basis process links to these customers and suppliers.

Most of the second tire suppliers are connected with TOOLS Molde by means of non-managed process links. In these cases TOOLS Molde is not actively involved in monitoring these links and trusts other members of the supply chain to manage connections.

Processes in the supply chain with TOOLS Molde as a focal point are influenced by a range of decisions made in other supply chains of the companies that are local branches of B&B TOOLS in Norway. These are non-member process links. As it was mentioned before branches of B&B TOOLS could order one from another some products in case of rush orders.

5.1.2.2. Core Business Processes

Customer Relationship Management Process

TOOLS Molde and B&B TOOLS have common policy when it comes to customer relationships. The main goal of B&B TOOLS is to secure that corporate mission and vision are reflected in day-to-day operations of corporate units. OFP should be performed in accordance with the following principles:

- Proximity to customers,
- Focus on customer needs,
- Creating comprehensive solutions,
- Securing customer satisfaction.

However there is no developed and continuously applied system of CRM from the business process point of view. Company employs sales representatives whose goal is to visit customers and collect all the necessary information about customer needs so that the company could provide these customers with suitable offerings. Customer relationships are not reviewed on the continuous basis at TOOLS Molde and company doesn't have any accurate data on whether relationship with a particular customer is profitable or not. Although it is supposed that resources of the company are deployed in the equal manner between customers that differ in profitability.

TOOLS Molde does not have a formally developed routine for CRM business process as described by (Sharma and Lambert 1994). Customer segmentation is applied very seldom to understand customer base and customer requirements.

What concerns information system in CRM area TOOLS Molde uses Super Office to store the data about customers and their demand. Although this information system is not collaborative in type and doesn't have any connection to other information systems of organization. Information system for CRM is not integrated with CRM of other corporate units, which means that a lot of companies in B&B TOOLS have their own CRM. However nowadays B&B TOOLS is working on the common CRM solution for the group.

With some of the largest customers TOOLS Molde is working within contracts initiated by B&B TOOLS that fix prices for some period of time.

In addition TOOLS Molde offers tailor-made solutions within OFP to some customers. This includes delivery solutions (such as VMI) or coordination of ordering processes. In case of Bits&Pieces coordination of ordering process is not fully integrated with ERP system of TOOLS Molde (information is imported to ERP of TOOLS Molde manually). It reduces significantly positive impact of the solution.

To summarize, it is evident that due to absence of well-formulated and continuously applied approach to CRM as a business process and lack of integration of CRM technological solution between different corporate units and with other IS of one company TOOLS Molde and B&B TOOLS as a whole have a relative competitive disadvantage.

Inventory Management Process

Inventory management process in TOOLS Molde contains a set of activities that provide conditions for smooth material flows to meet customer demand.

TOOLS Molde delivers to customers a big variety of products (stock keeping units – SKUs). All products could be generally divided in two groups: products that are included in TOOLS catalog and in their majority kept on stock (ordinary products) and other company-specific products that are kept on stock in rare cases and characterized by variable demand (SKAFF products).

For all ordinary products management of TOOLS Molde defines parameters of inventory policy such as order amount, reorder point and safety stock that are implemented in ERP system. While ordering from suppliers these parameters could be corrected by purchaser

according to statistical data, personal experience and tradeoff between lot size and ordered amount.

Within ordinary group TOOLS Molde defines products that are delivered within VMI. In companies that signed agreement TOOLS Molde places a box with predefined products. Customer's employees use products as needed and TOOLS Molde refills inventories once a week. For customers with delivery solutions TOOLS Molde tries to provide a service level close to 100%.

SKAFF products are products that are not included in the general catalogue of B&B TOOLS. As a rule these products are characterized with unstable demand and relatively high value. SKAFF products are supposed to be ordered from producers every time customer demands it.

According to the statistics of the last year around 44% of all products kept on stock were not purchased during the year. In order to deal with such a big amount of a capital tied up in inventories within products that are not demanded by customers, management of TOOLS Molde holds regular meetings.

In general management considered inventories of TOOLS Molde as quite high and demands to decrease capital tied up in inventories.

Supplier Relationship Management Process

Supplier relationship management of B&B TOOLS is conducted at the corporate level. The main principles of supplier selection are formulated in corporate code of conduct and supplier code of conduct. These include:

- Economic criteria
- Ethical criteria
- Environmental criteria

With companies that belong to upstream part of B&B TOOLS Group, TOOLS Molde has well-developed strategic partnership due to vertical governance of the Group. In this case partnership conditions are mostly defined by Group policy.

In addition TOOLS Molde develops strategic partnership with some other critical suppliers. Decision on development of strategic partnership depends on volume of trade, availability of substitutes at other suppliers, or importance of products for critical customers.

As in case with CRM there is no well-developed and continuously applied system for SRM. SRM as a business process does not have any well-formulated principles that are applied either at the corporate or local level. Contracts with suppliers are signed at the

corporate level, which means that the initial supplier selection is the responsibility of B&B TOOLS.

Supplier evaluation is done rarely after the contract with supplier is signed. This basically means that company rarely monitors supplier performance although it has a direct influence on company's efficiency and ability to satisfy customer needs. In general company bases its supplier selection exclusively on experience and their perception of market. Company tries to empirically identify market leaders and build closer relationships with market leaders. TOOLS Molde identified price as the main criteria for supplier selection on the day-to-day basis.

Finally, no data were found concerning SRM information system used by TOOLS Molde.

To summarize, it can be seen that due to the absence of well-formulated and developed system of supplier evaluation supplier relationship performance is monitored rarely, in the majority of cases only at the stage of signing the agreement. It is considered to be a competitive disadvantage of the company and a weak side as suppliers are directly responsible for performance of the focal company.

Order Fulfillment Process

In the considered supply chain OFP starts when the customer identifies a need in some product that is supposed to be ordered from TOOLS Molde and ends when the product is delivered to the customer. The process is composed of set of interconnected and coordinated activities which could be performed by supply chain members all over the supply chain. The map of generalized order fulfillment business process is presented on the Figure 20. On the picture the general logic of order fulfillment is presented with corresponding information and goods flows.

There are 4 main groups of participants in OFP: customers, TOOLS Molde, Wholesalers within B&B TOOLS and producers.

The OFP contains the following steps:

(Performed by Customers)

Customer creates an order for the products and sends an order to TOOLS Molde B&B by e-mail, fax, telephone or special ordering system as Bits&Pieces. After the order is processed by TOOLS Molde customer receives the package with products.

(Performed by TOOLS Molde)

The order from Customer is received in TOOLS Molde by “Reception” (or Orders Office). Then order is registered in the ERP system. For every product in the order amount of inventory is checked. If there is enough products on stock – the directions for order picking and packing is sent to the warehouse. If there is no product on stock (or not enough), the order is redirected to the TOOLS procurement department. For some urgent cases sales department orders products directly from suppliers.

Procurement department collects information about products that should be ordered from suppliers. Order to supplier aggregates two sources of demand – external and internal. External demand is generated by Customers. Internal demand is generated by ERP in case if the level of the products on stock is lower than reorder point.

As a rule Procurement Department sends order to specific supplier once a day. In case if ERP of TOOLS Molde is coordinated with ERP of supplier the ordering process takes less time. Procurement department waits for order confirmation from the supplier and, if necessary, corrects data in the ERP system (mainly about product prices).

Suppliers (both producers and wholesalers from B&B TOOLS AS) receive the order from TOOLS Molde, if necessary produce the product, and send it to TOOLS Molde or in case of direct deliveries send it to customer.

Warehouse in TOOLS Molde receives products and performs necessary procedures such as unpacking, registration, checking, placing in the inventory, rearranging and packing for delivery. In most of the cases products are delivered as soon as possible. Otherwise, for example when order is made within vendor managed inventory agreements, order is being sent to the customer on a specific date of delivery.

Deliveries of the packages to TOOLS Molde and from TOOLS Molde to customers are as a rule performed by logistics companies (Bring, DHL, Tollpost etc.).

Detailed map of order fulfillment business process is presented in the Appendix B.

TOOLS Molde operates with different types of orders:

- L type. (Lager)

Products in this order are supposed to be on stock. Order is generated by ERP of TOOLS Molde if there is not enough products on stock or in case of stockout situation.

- T type. (Transit)

Products from these orders are not supposed to be on stock and every time they are ordered from suppliers. These orders demand less time from warehouse workers than L orders as far as they do not require rearranging and, as a rule, packing and unpacking. Most of these products are marked as SKAFF products.

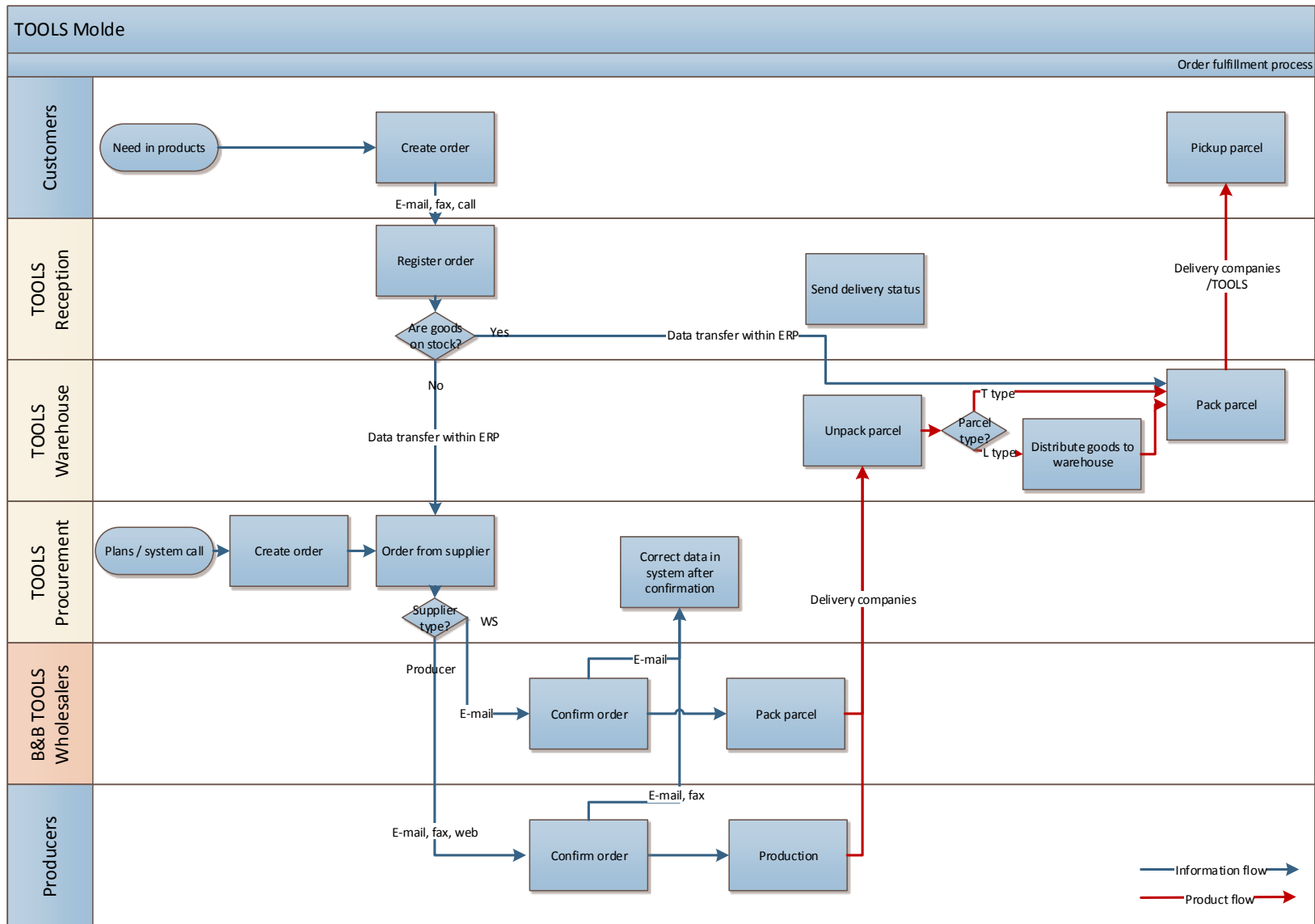


Figure 20. Map of generalized OFP for the supply chain with TOOLS Molde as a focal point.

- D type.(Direct)

These orders are supposed to be delivered directly from supplier to customer. They do not arrive to the warehouse of TOOLS Molde at all.

- X type.

These orders combine products of L and T type.

It is important to notice that in the research only “regular” OFP is considered, when products are ordered by customer and delivery is organized by TOOLS Molde. Orders that demand some specific service, for example, guarantee repairing (except labeling) are not taken into consideration.

Further this research describes and discusses the results of business process analysis according to managerial decision model.

5.2. Research Findings and Discussion

This chapter presents main results of empirical analysis of the case company according to managerial decision model.

5.2.1. Customer Relationship Management Analysis

According to managerial decision model OFP improvement should start with customer structure analysis and analysis of customer service requirements. This paragraph is dedicated to customer segmentation by revenue, profitability and service requirements and some ideas on customer service improvement and OFP orientation towards customer needs.

First, customer structure is analyzed. Main aspect for analysis is impact that customers have on financial result of TOOLS Molde in terms of volume of sales and profitability.

As far as main idea of customer segmentation from OFP perspective is to define customer group for which OFP could be customized the alternative customer segmentation approach is presented. This approach is based on the information obtained from customer survey concerning importance of different order fulfillment parameters for companies.

The next part of the paragraph provides with data about customer demand for service basing on the information from survey. This will be helpful while customization of OFP for different customer groups.

The last part of the paragraph contains a discussion and summary of OFP improvements that could be made on the basis of CRM process.

5.2.1.1. Customer Structure Analysis

In the year 2012 TOOLS Molde had 646 customers (companies and individuals that received product delivery from TOOLS Molde in 2012). As it can be seen TOOLS Molde has diverse structure of customers (Figure 21). On the Figure 21 contribution of every customer to total revenue is represented. The blue line represents commutative revenue of TOOLS Molde from N customers ranked by increasing amount of purchase.

There are few large customers that provide TOOLS Molde with 80% of total revenue. Share of big customers is shown on Figure 21 with red rectangle. What concerns medium customers, they are more numerous and are responsible for 15% of total revenue. Green rectangle represents commutative share of big and medium customers of TOOLS Molde. The majority of customers could be considered as small customers as far as they provide only 5% of total revenue.

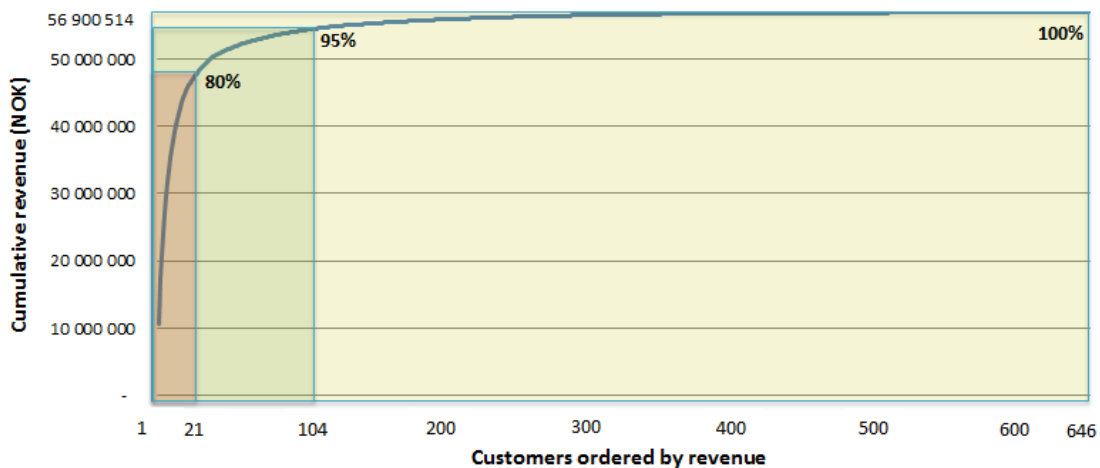


Figure 21. Cumulative revenue of TOOLS Molde

It is important to notice that in the current case the size of a customer is related to the relative amount of purchase from TOOLS Molde and does not depend on scale of customer's business. Therefore a "small" customer can be a big company, but with relatively small amount of purchase from TOOLS Molde.

More precise numbers are represented in the Table 2. It seems that distribution of revenue from clients follows the Pareto principle according to which very small amount of participants in the process are responsible for the largest share of results (Chen, Chong, and Tong 1994).

Table 2. Customer-revenue Pareto analysis.

Number of customers ordered by revenue	% of total number of customers	% of Revenue	% of Margin
21	3%	80%	77%
104	16 %	95 %	94%
646	100 %	100 %	100%

So far 80% of the profit is provided by only 21 companies that is 3 % of total amount of customers. These customers provide TOOLS Molde 77% of profit (Table 2). In the research these customers will be considered as group I. Customers from this group buy from TOOLS Molde goods for more than 430 000 NOK a year.

Next 83 customers that are responsible for 15 % of total revenue are included in group II. Together with customers from group I they buy from TOOLS Molde 95% of the products and bring 95% of total margin. Annual purchaser of customers from group II varies between 31 000 NOK and 430 000 NOK a year.

Last group consists of 542 small customers that purchase only 5 % of products. Customers are considered to be small in case if they buy for less than 31 000 NOK a year. Most of them (323 customers) made order from TOOLS Molde only once.

List of characteristics corresponding to different groups of customers can be seen in Table 3.

Table 3. Customer groups' characteristics

Customer group	Number of customers	% of Revenue	% of Margin	Year purchase
Group I	21	80%	77%	More than 430 001 NOK
Group II	83	15 %	17%	31 000 – 430 000 NOK
Group III	542	5 %	6%	Less than 30 999 NOK

According to managerial decision model customers can also be classified by profitability. For the purpose of this case study it was chosen to compute customer profit as difference between customer's revenue and cost of goods sold. This simply means that gross margin is used as a measure of customer profit. According to Pfeifer, Haskins, and Conroy (2005) gross margin may be considered as "a special case of the more general concept of customer profit".

Table 4. Revenues and Profits for 25 Largest Customers of TOOLS

Rank by CP	Customer Name	Revenue (NOK)	CP (NOK)	Cumulative CP (NOK)	Rank by Revenue
1	Customer 1	10 681 210	2 348 970	2 348 970	1
2	Customer 2	3 337 822	1 245 555	3 594 525	4
3	Customer 3	6 702 054	954 069	4 548 594	2
4	Customer 4	2 690 881	874 783	5 423 377	6
5	Customer 5	2 834 288	831 973	6 255 350	5
6	Customer 6	1 335 386	646 336	6 901 686	10
7	Customer 7	1 803 100	574 867	7 476 553	8
8	Customer 8	1 998 391	526 828	8 003 381	7
9	Customer 9	1 284 429	429 555	8 432 936	11
10	Customer 10	3 509 466	420 379	8 853 315	3
11	Customer 11	1 748 321	309 014	9 162 329	9
12	Customer 12	1 112 333	308 486	9 470 815	13
13	Customer 13	799 288	272 414	9 743 228	16
14	Customer 14	893 280	245 953	9 989 181	14
15	Customer 15	648 902	231 961	10 221 143	18
16	Customer 16	1 219 646	185 475	10 406 618	12
17	Customer 17	529 091	153 897	10 560 514	19
18	Customer 18	757 613	145 875	10 706 389	17
19	Customer 19	380 672	131 488	10 837 877	23
20	Customer 20	494 358	131 359	10 969 236	20
21	Customer 21	430 625	129 582	11 098 818	21
22	Customer 22	285 546	96 129	11 194 947	26
23	Customer 23	270 011	94 374	11 289 322	27
24	Customer 24	869 908	91 872	11 381 194	15
25	Customer 25	311 943	91 859	11 473 053	25

In comparison to the customer grouping by revenue it can be seen that four more companies can be included in group G1, or the most profitable segment of customers. These are Customer 19, Customer 22, Customer 23 and Customer 25. Besides, there are some changes in the placement of customers which supports the idea that “each dollar of earned revenue does not report contribute equally to the firm’s reported operating profit” (Pfeifer, Haskins, and Conroy 2005).

Customer 1 is the largest customer both in terms of revenue and in terms of customer profitability. In turn such companies as Customer 24, Customer 10, Customer 16, Customer 11, Customer 3, Customer 8 and Customer 18 have lost their positions and gone down in the list. Although those customers are responsible for higher levels of revenue costs incurred by serving

them are higher compared to other customers that either retained their position in both lists (for ex. Customer 5) or improved one if sorted by CP (for ex. Customer 4 and Customer 6).

According to Table 5 top 25 customers are responsible for 80% of cumulative profit. In turn the largest Customer 1 is responsible alone for 16% of cumulative profit and first 7 customers account for around 50% of the cumulative profit. This means that a very small amount of customers, only 4%, generates 80% of TOOLS Molde profit. All these customers should be included in group 1 according to their profitability.

Group 2 (G2) includes 94 customers, 18% of total amount of customers, and group 3 (G3) includes the rest of 527 customers out of 646.

Table 5. Customer groups according to ABC analysis by profitability

Customer Group	Cumulative % of Customers	Number of Customers	Cumulative CP	Cumulative % of CP
G1	4 %	25	11473053	79,65 %
G2	18 %	119	13669960	95 %
G3	100 %	646	14404165	100 %

Thus first 21 customers by revenue and first 25 customers by customer profit are responsible for 80% of either cumulative revenue or cumulative profit of TOOLS. These customers should be included in group 1 (G1) according to ABC analysis by revenue and profitability. These comparative Total revenue – Income ABC analysis of customers showed that results of these two approaches are nevertheless quite close. Further research will be based on the customer segmentation by total revenue (for ex. for the purpose of inventory management and simulation model).

Further down this paper shows an example of customer segmentation by service requirements.

5.2.1.2. Customer Segmentation by Service Requirements

According to the managerial decision model next step in customer analysis is customer segmentation by service requirements.

In this paper graphical method is used for the purpose of customer segmentation. This method is based on ideas presented on guest lecture by Aleskerov (2013). His method of buyer behavior analysis in the retail stores was adapted to and developed in this research. According to this method customers are segmented by similarity of requirements profile presented in a

graphical way without any regards to customer size or other descriptive characteristics. As far as efficiency of customer satisfaction depends on how well supplier fulfills its specific requirements it does not matter how big or small customer is. If both big and small customers have same requirements, they should be served in the same manner.

According to the graphical method a requirement profile graph for every customer was constructed based on the results of customer survey in the manner described below.

Customers were asked to evaluate on the scale from 1 to 7 importance of the following factors: lead time, price, correctness of delivery and availability of additional services such as labeling, consulting support, after sale service. Grade 1 means very low level of importance while grade 7 shows that factor is of critical importance to customer.

Graphical representation of an “average” customer profile (on the basis of 54 unique responses received from customers) is presented in the picture bellow (Figure 22).

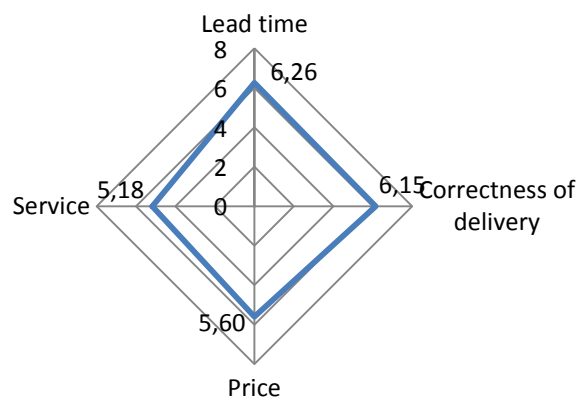


Figure 22. Profile of “average” customer.

On average all four defined factors are quite important. It can be seen that lead time has a bit higher importance compared to other factors. In its turn available services are of lower importance to customer. However this difference is not significant. Therefore it is difficult to define specific key success factors in serving these customers.

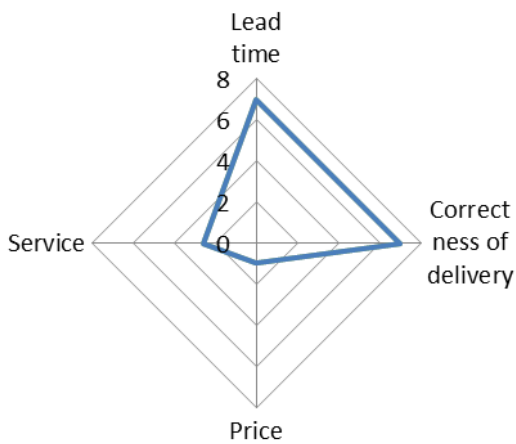
So far analysis of service requirements allowed defining the following groups of customers (more detailed description see in Table 6):

- 1) Companies that demand **fast and correct delivery** and are ready to pay for it a reasonable price.

- 2) Companies that are focused mainly on the **price** in their supplier selection process.
- 3) Companies that demand both **low price and short lead time**.
- 4) Companies that require high **correctness of delivery for customized products**.
- 5) Companies that state high **correctness** of delivery as a main factor in their supplier evaluation.
- 6) Companies for which **“everything is equally important”**.

Table 6. Customer groups according to service requirements.

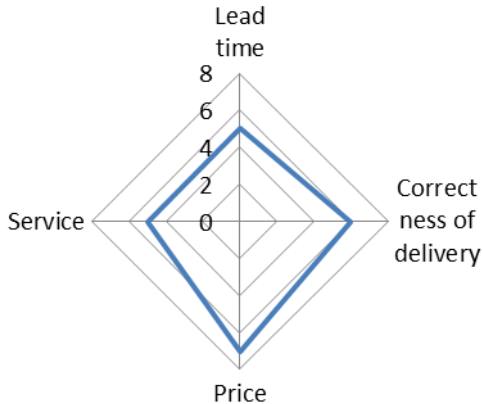
Customer group	Description
1) Fast and correct delivery by any means	



The company’s main priorities are very short lead time and delivery accuracy. These customers require reliable OFP to support their production process. They do not consider price as important factor and are ready to pay more for fast and accurate delivery.

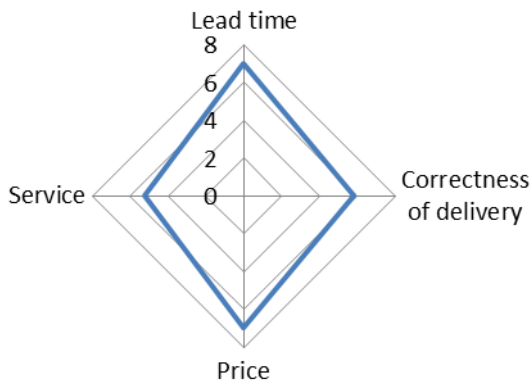
As service requirement quite low it is assumed that products that are demanded by the company are quite simple and standard and do not need any special service. However these companies may also order some customized products.

2) Most important factor is a price



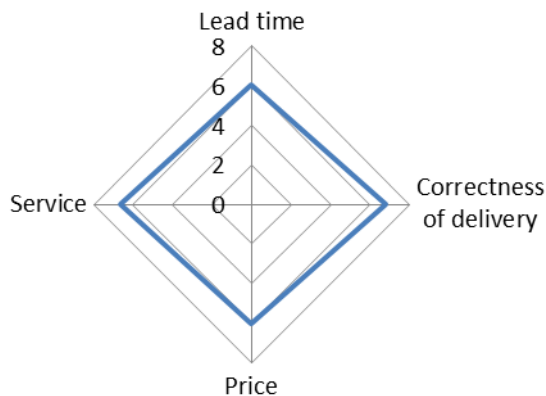
The most important factor for the company is price. These customers are ready wait for delivery and do not demand specific services. At the same time correctness of delivery is also important.

3) Low price and fast delivery of standard products



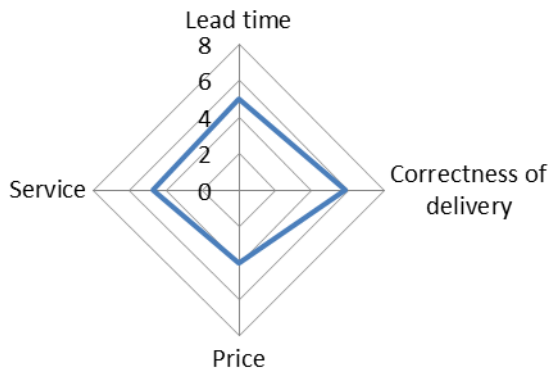
These companies demand both short lead time and low price. They are not so interested in customized services. Some of these customers can accept some level of incorrect deliveries. To be profitable for TOOLS Molde these customers should be offered standard products and should be encouraged to actively share information about future demand with supplier.

4) Correct customized deliveries



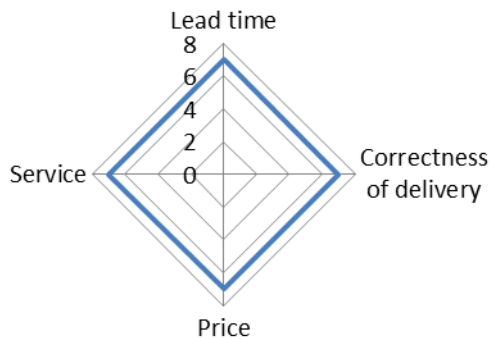
Companies of this group demand additional services and expect customized products to be delivered according to a plan. In addition lead time is more or less important for these customers.

5) Correctness is a main factor



Companies from this group value correctness of delivery. They could be more or less sensitive to the price or speed of delivery, but main criteria is absence of mistakes. It can be seen that high level of service is not that important for these customers.

6) "Everything is equally important"



These companies consider all factors as critical. It could be explained by several reasons. First, production processes of customer could be so well tuned (for example in case of lean production) that any mistake in delivery or any other form of "waist" are critical for the whole process.

Second, it could be possible that customer while answering the question did not really show its real preferences and results could not be considered as valid. Therefore more detailed analysis of customers falling into this group is needed.

This classification can not be considered complete as it is possible to define other customer groups by similarity of only one factor priority. For example for Customer 1, Customer 2 and Customer 3 available service is a most important quality of a supplier. Or Customer 4, Customer 5 and Customer 6 pay most of attention to correctness of delivery.

According to managerial decision model customer segmentation by service requirements is necessary in order to developed OFP improvement initiatives according to customer needs. It should be notices that customer segmentation can be performed with respect to other descriptive factors than revenue and profitability (for ex. customer industry, its size or relationship potential) and other classification parameters.

5.2.1.3. Customer Satisfaction Management

Further down customer satisfaction analysis is presented in order to receive more detailed description of customer needs and develop OFP improvement initiatives.

In the research the following set of factors important for customer satisfaction is considered: length of lead time, accuracy of delivery (right product, on agreed time, correct documentation), ability to timely correct mistakes, price level, level of product quality, level of product variety, product design, availability of additional services (for example labeling, customer consulting, post purchase service), possibility to change order conditions before final delivery and possibility to order products from defined original suppliers (importance of product brand).

Every customer that participated in the survey for every of these parameters defined level of importance and level of satisfaction form TOOLS Molde as a supplier) as it was described in the previous paragraph). In order to simplify the research all these parameters were aggregated into four parameters that influence on customer satisfaction: lead time, correctness of delivery, price and availability of additional services.

The evaluation of overall customer satisfaction from TOOLS Molde as a supplier could be defined by comparison between desirable value of parameter under consideration and subjective evaluation of TOOLS Molde performance. If level of lead time importance is equal or lower than evaluation of lead time provided by TOOLS Molde, than it is concluded that TOOLS Molde fully satisfies the customer's necessity according to this parameter (see examples in Figure 23). In Figure 23 blue line corresponds to level of a parameter demanded by a company and red line corresponds to customer perception of service level that is provided by TOOLS Molde. If the

service level provided for all considered parameters is higher or equal to demanded one it could be assumed that TOOLS Molde satisfies customer needs.

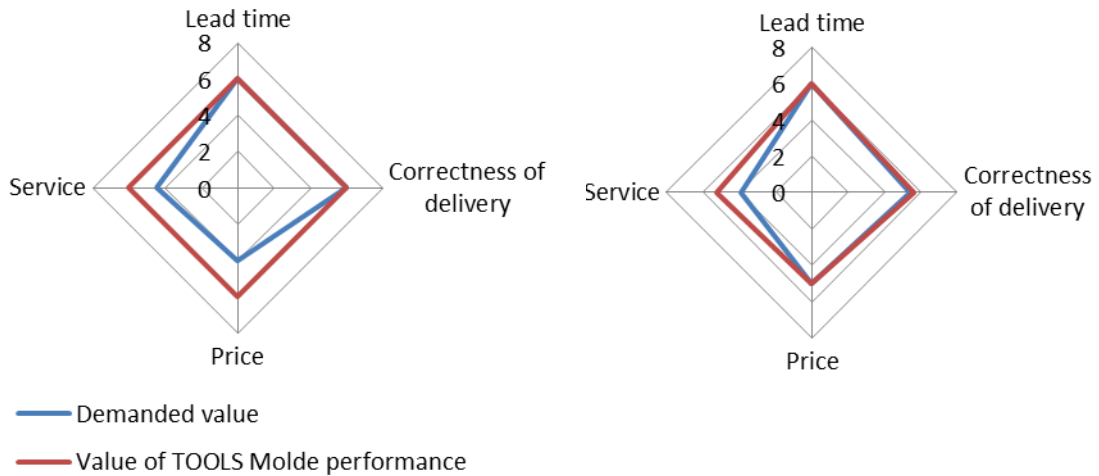


Figure 23. Customers whose necessities are covered by TOOLS Molde.

In some cases customer requirements are higher than service level provided by TOOLS Molde. In this case level of importance for selected parameters will be higher than evaluation of TOOLS Molde performance according same parameters (see examples in Figure 24). In Figure 24 blue line showing required level parameters is much higher than red line showing the level of subjective evaluation of TOOLS Molde performance. This gives a reason to say that TOOLS Molde does not provide customers with demanded needs in lead time, product price, correctness of delivery and additional services.

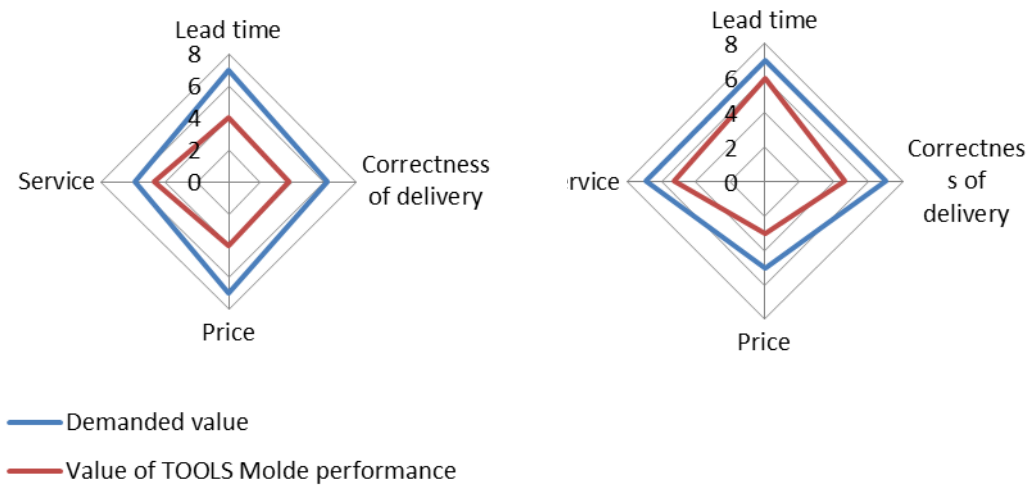


Figure 24. Companies that are demand more than TOOLS Molde provides

In most of the cases TOOLS Molde is able to provide demanded level of service according to one of the parameters. But according to other parameter service level should be increased. For example in the Figure 25 Customer 1 requires lower price level than one proposed by TOOLS Molde, delivery speed, service opportunities exceed expectations and correctness of delivery is at demanded level. Customer 2 would prefer to have faster and more correct deliveries but is quite satisfied with price level and service options.

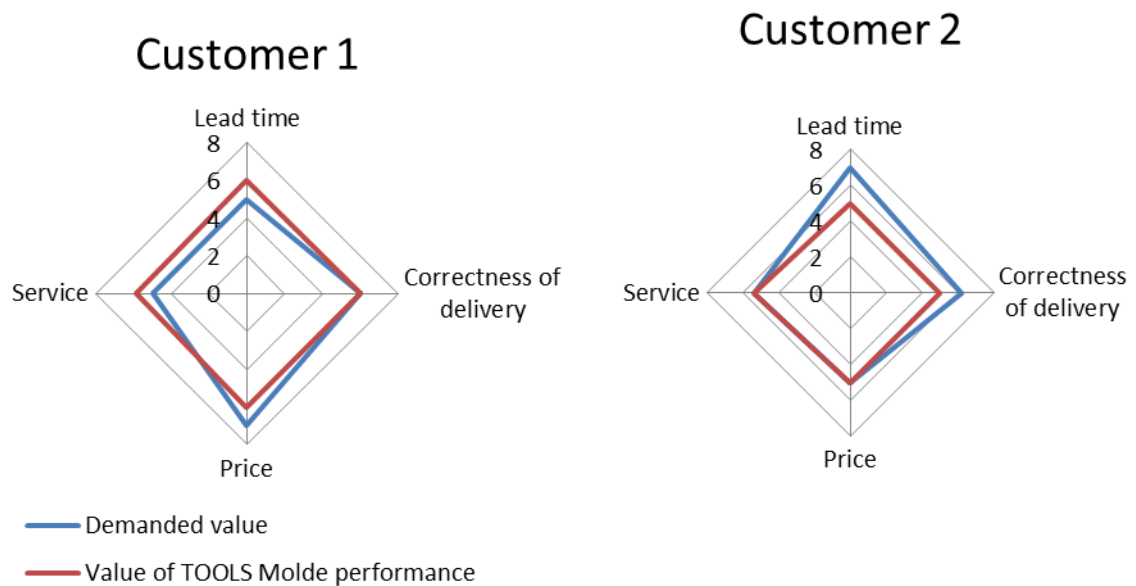


Figure 25. Companies with partly covered needs by TOOLS Molde

This kind of analysis could be performed for every customer and together with customer segmentation described in previous paragraph could give important information for OFP improvement and orientation towards customer needs.

Aggregated customer satisfaction level could be presented by the share of companies that are satisfied with current level of TOOLS Molde performance according to every parameter (see Table 7). Note that aggregation is based on the information obtained by means of survey and contains 44 valid unique responses.

More than half of customers (57%) would like to have shorter delivery time and lower price. Nearly every third customer is not satisfied with current level of delivery correctness. TOOLS Molde is able to fully satisfy customer requirements of additional service in 64% of cases.

Table 7. Level of customer satisfaction by different parameters. (44 companies are taken into consideration)

	Satisfied	Not satisfied
Lead time	43 %	57 %
Correctness of delivery	27 %	73 %
Price	43 %	57 %
Service	64 %	36 %

From the managerial perspective it could be mentioned that improvement of every parameter for a company could be costly.

Shortening of lead time and price reduction could be most expensive initiatives. Lead time reduction could demand significant improvements in SRM, transportation, inventory management. From other side customers would always try to reduce costs and nearly any price will seem too high.

As it was mentioned before availability of additional services in Industrial Suppliers Wholesaling Industry is getting a very important factor on competitive market. According to the survey results customers of TOOLS Molde are quite interested in introduction of new services and development of existing ones. 87% of customers would like to have some improvements in services.

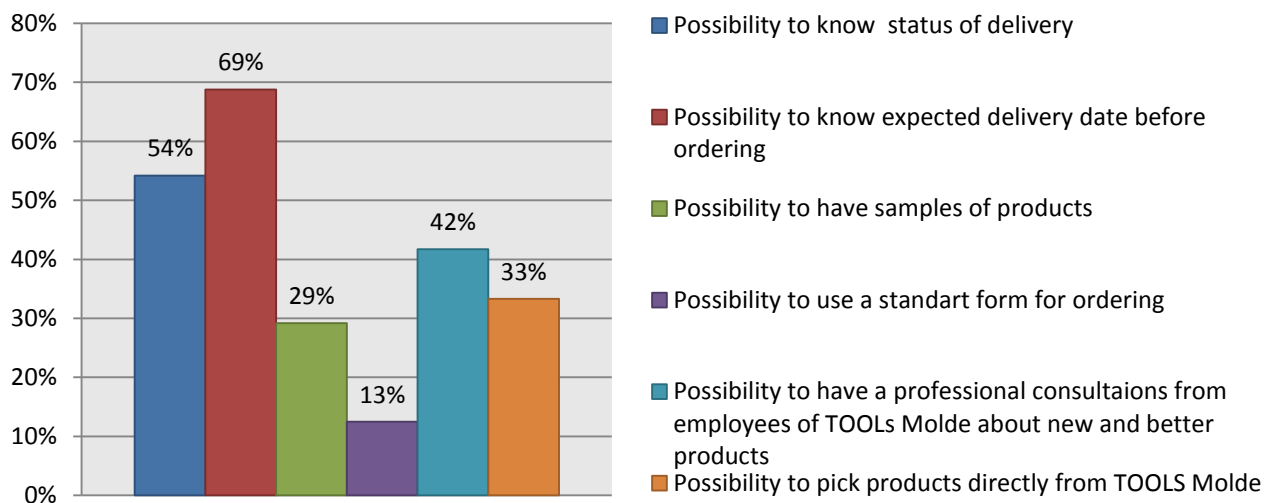


Figure 26. Percentage of customers that desire to have additional services from TOOLS Molde. (48 customers are taken into consideration)

The most desirable information that customers would like to have is an expected delivery time. 69% of customers would like to have this information in order to be able to plan better

production process and corresponding product flows. Providing customers with this information will lead to establishment of closer relationship between supplier and customer, but also could increase risk for supplier to lose part of customers in case if planned delivery time exceeds expectations.

More than a half of customers would like to know status of delivery. This information will also allow customer to better plan its production. Also customers are quite interested in professional consultations from employees of TOOLS Molde who would help them to find products that suit best to customer needs and/or would present new products.

One third of customers would like to have sample of products that are ordered from TOOLS Molde. Mostly it is related to cloths. It could be quite difficult to define right size regarding only item description in the catalog.

Possibilities of self-pick-up of products from TOOLS would be interesting to every third customer. Implementation of this additional service will not demand high investments. This will require mostly organizational changes. However this will allow to decrease price for customer because of transportation savings, and to decrease lead time.

Some customers (13%) would like to order by means of standard ordering form. This will help to save some time while ordering both for customer and TOOLS Molde.

In general additional services described above are not supposed to provide a comprehensive overview of all possible and desirable improvements. They rather aim to illustrate that with low initial investments it is possible to increase customer satisfaction level and gain competitive advantages.

Another direction of customer satisfaction improvement for TOOLS Molde is improvement of delivery correctness. 73% of respondents would like to have higher level of delivery correctness than they have at the moment.

It is important to notice that level of delivery correctness is highly dependent on OFP organization and performance on operational level.

5.2.1.4. Discussion of OFP Improvement Initiatives within CRM Context

First step for implementation of the idea of OFP customization implies customer segmentation and identification of customer needs.

In the analytical part two segmentation approaches were considered. First one is ABC analysis based on customer impact on wholesaler's income or profit. And second one is based on customer grouping according to the profile of service requirements.

First ABC customer segmentation shows, according to Giltner and Ciolli (2000) that existing OFP at TOOLS Molde is more suitable for the needs of customers in group G1 (21 biggest customers responsible for 80% of income) as they generate the largest revenue and profit under existing BPs and supply chain design.

However according to the customer satisfaction analysis some of the companies from these first group (for example, Customer 1) evaluate performance level of TOOLS Molde as quite low. This means that TOOLS Molde does not provide all the companies with services they demand. Moreover service preference profile is quite different from company to company in the same group by revenue. In most of the cases this depends on company's business organization and nature rather on its size. So far it could be concluded that ABC analysis could hardly be used for purpose of OFP customization.

Nevertheless such ABC analysis could be useful from managerial perspective for evaluation of impact that quality of CRM could have on financial results of the company. As far as structure of TOOLS Molde is quite concentrated (few very big companies and a lot of small companies) problems with even one big customer could have a significant negative influence. Besides, as OFP customization requires a lot of resources identification of critical customers helps to allocate company resources in the most effective manner.

Within considered customer segmentation approaches grouping by service requirements seems to be more appropriate for order fulfillment customization purpose. Companies within one group have similar service requirements. Therefore customers in one group could be served by means of the same OFP process.

For each customer segment on the basis of service requirements profile similarity the following adjustments of OFP could be proposed (similar as it is described by Sharma and Lambert (1994)).

All customers within one group demand similar service approach, similar way of product delivery organization. For example for customers from group 1 it is important to organize OFP according to lean principles. All possible waste in supply chain should be eliminated. Increased costs for process maintenance will be covered by customer. It could be useful to standardize

operations. Delivery status of delivery could be important information for customers. If amount of orders from one customer is significant some simplification of payment process could be introduced (for example payment in the end of the months).

As price level is the most important criterion for customer in group 2 TOOLS Molde should focus on cost reduction initiatives. OFP for customers from group 2 could be organized in a way that purchase and transportation of these products will be coordinated with other deliveries in order to save transportation and administrative costs.

For both customer groups 1 and 2 it would be useful to implement ERP coordination in ordering process. It will lead to time savings (which is critical for group1) and decrease fixed costs per order (which is critical for the second group).

In order to increase profitability of customers in group 3 it is important to offer standardized products. In this case most of the demand should be satisfied from the shelf and general inventory management practices could be implemented for inventory control.

Both for groups 4 and 5 correctness of delivery is a critical factor. So far a set of additional checks or a system that prevents mistakes is desirable.

As it was mentioned before customers from group 6 could be represented by companies with highly developed production process that demands high level of collaboration (excluding companies that join the group due to overestimating of necessities). For some customers from group 6 (as well as from groups 1 and 3) it could be useful to increase level of collaboration (for example to implement ERP instruments for ordering process or organize demand sharing procedures). A set of specific assets could be necessary for development of such collaboration.

It is important to notice that all these recommendations are based on analysis of customer groups by preferences. In real life a lot of other factors could be critical for companies in the process of supplier selection that were not taken into consideration. For example, frame contacts between customer and other supplier or geographical location of customer and supplier to name a few. So far in order to customize OFP according to customer segmentation requirements a deeper analysis should be performed with respect to every customer specific feature that could not be captured within present research.

Other prepositions of OFP improvement deal with customer satisfaction management. Within considered factors of customer satisfaction in theory it would be good for TOOLS Molde to improve all of them (lead time, price, correctness of delivery and availability of additional

services). While improvement of two first parameters (decrease of lead time and decrease of price) could be quite costly for the company, improvement of the rest could be achieved with relatively low cost (by implementation of measures that support order accuracy or providing customers with rather simple additional services as delivery order status). More detailed presentation of services that customers demand from TOOLS Molde is presented in the 5.2.1.3 Customer satisfaction management paragraph.

For the moment of the research TOOLS Molde does not provide systematic adaptation of OFP for the needs of customers. Some customization elements are introduced but without a systematic approach. So far presented methods and directions for processes improvement could be used as a basis for further development and establishing a systematic introduction of customized procedure in OFP for increase of customer satisfaction.

5.2.2. Inventory Management Analysis

According to the managerial decision model developed on the second step order fulfillment improvement team should receive input information with help of inventory analysis and classification instruments in order to balance customer requirements with company and supply chain capacity. The following paragraph provides analysis of inventory structure and demand characteristics.

First part of the paragraph provides an extensive ABC-XYZ SKU analysis which was done based on the demand data (or annual data describing amount of SKUs delivered to customers) and warehouse data (or annual data describing SKUs that were held on the inventory). The former analysis corresponds to demand structure analysis and the latter corresponds to inventory analysis.

ABC-XYZ analysis provides classification of Stock Keeping Units (SKUs) by demand variability, profit and stock value.

Second part of the paragraph provides example of statistical analysis of customer demand from the perspective of randomness. This analysis could be helpful for customer demand forecasting activities.

The last part of the paragraph contains a discussion and summary of OFP improvements that could be made taking into account input information received from CRM and IM processes.

General information

At the end of 2012 TOOLS Molde had around 13000 various SKUs on their stock (Table 8). TOOLS Molde sold during the same year around 12750 various SKUs including items that belong to SKAFF group and which are usually not stored at TOOLS. If to exclude those items from the total list of sold SKUs TOOLS Molde sales amounted to 10700 various SKUs according to delivery data. Apparently if to compare delivery data and warehouse data around 3000 ordinary SKUs were sold without being held on stock.

Warehouse data state that in 2012 and 2011 were sold at least once 7215 and 7751 various SKUs respectively. The number of SKUs that were kept on stock but were not sold during 2012 and 2011 equals respectively to 5743 and 5913 of various SKUs. This means that on average in these two years around 45% of SKUs are held on stock but not sold at all during a year. These inventories represent non-moving inventory for the company.

Table 8. Number of sold and unsold SKUs held on the inventory.

Year	Number of SKUs Sold	Number of SKUS Not sold	Total Number of SKUs	% of Sold	% of Not Sold
Year 2012	7215	5743	12958	55,7 %	44,3 %
Year 2011	7751	5913	13664	56,7 %	43,3 %
Average	7483	5828	13311	56,2 %	43,8 %

5.2.2.1. Assortment Analysis

To understand the character of sold goods and their influence on company's revenue all the SKUs sold were divided into groups according to the ABC and XYZ analysis based on demand data and ABC and XIY1Z1 analysis based on warehouse data. Demand data classification allowed to segment units that were actually ordered in 2012 and understand the demand data in terms of revenue by item and demand variance by item. Warehouse or inventory data allowed understanding of the structure of inventory held in 2011 and 2012 in terms of revenue generated by item and money locked up in inventory by item.

First, items were segmented into ABC groups based on demand data. It can be seen on the Table 9 and Figure 27 that in total 2191 SKU which corresponds to 17,2% of total number of SKUs sold generate 80% of sales. 45,1% of SKU sold generate 95% of revenue and the rest 54,9% of goods sold generate just 5% of sales.

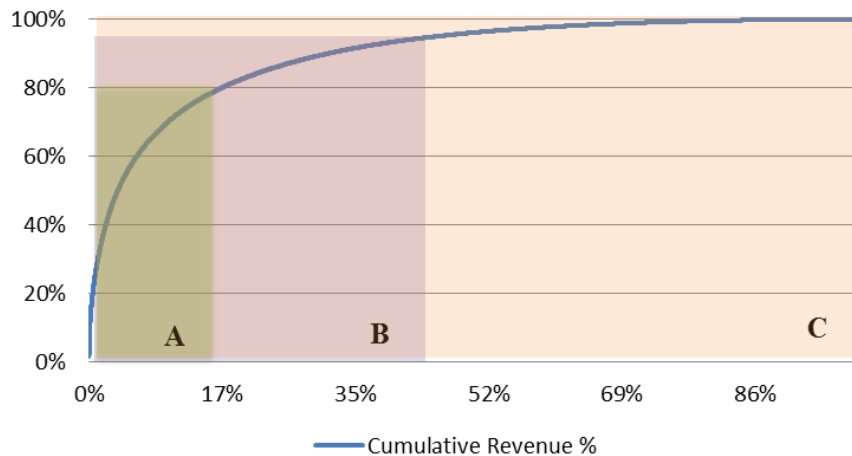


Figure 27. Pareto-curve: ABC-classification of goods sold by revenue (delivery data)

Table 9 shows that among A-SKUs 436 items belong to SKAFF units which are not held on stock, however other 1755 units are ordinary units that are offered by TOOLS catalog and might be held on stock. In total 52% of SKAFF items generate high or middle revenue and another 48% generate low revenue.

Table 9. ABC-classification of goods sold by revenue generated (delivery data)

Group by Revenue	Ordinary SKU	SKAFF	Total
A	1755	436	2191
B	2925	630	3555
C	6014	977	6991
Total	10694	2043	12737

The same analysis was done using warehouse data and annual usage (price of the item \times amount sold during the year), which equals in essence to revenue variable used in previous classification, as a variable for grouping items. In order to get better understanding of inventory structure average value of annual usage for years 2011 and 2012 was used as a basis for the classification. This kind of analysis will help to identify non-moving items on the inventory and divide these non-moving items into two groups: items that have not been sold for the last two years and items that have not been sold in 2012. Data received are shown on the Table 10. It can be seen that among 15087 items held on stock at the end of 2011 and at the end of 2012 number of sold items is 7205 SKU, 617 of these items belong to the group A, 12821 items belong to the group B and 5306 items belong to the group C. It can be seen that 41,4% of items in group C have not been sold for two years 2011 and 2012 and another 16,6% have not been sold in 2012.

This means that around 58% of items in Group C have not been sold in the last year. It is necessary to mention that out of 5241 items that were not sold during 2011 and 2012 there are 155 items that do not have any data of unit price. As this amount represents around 3% of the group of SKUs that were not sold in 2012 and 2011 and 1% of all the items held on stock it was decided not to exclude these items from the analysis.

Table 10. ABC-classification of SKUs held on inventory by annual usage (warehouse data)

Group by AU	Moving SKUs	Non-moving SKUs (2012 and 2011)	Non-moving SKUs (2012)	Total
A	617	0	128	745
B	1282	0	401	1683
C	5306	5241	2112	12659
Total	7205	5241	2641	15087

According to Figure 28 4,9% of all items that are held on stock are responsible for 80% of average annual usage and 16,1% of items are responsible for 95% of average annual usage. Around 83% of all items are responsible for 5% of average annual usage. Most of the items in C group represent non-moving stock that does not generate any value for the company.

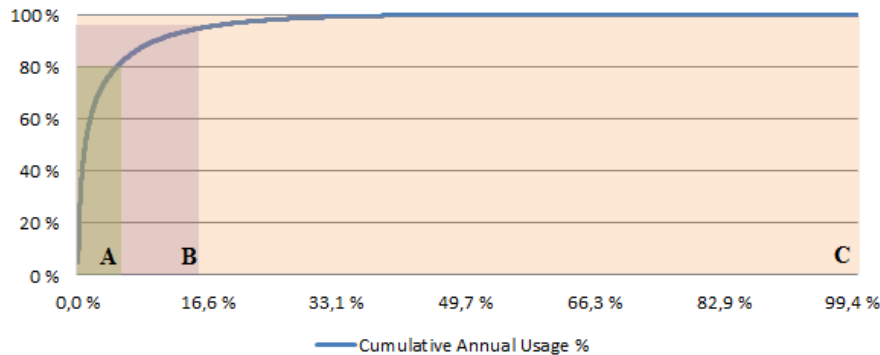


Figure 28. Pareto-curve: ABC-classification of SKUs held on inventory by average annual usage for 2012 and 2011 (warehouse data)

To closer analyze items sold it was decided to conduct XYZ analysis on the basis of demand variability. Amount ordered in units of quantity was chosen as a variable for XYZ analysis as with help of this variable it is possible to identify which units are ordered in stable quantities during equal periods of time which means that their demand might be relatively easy to predict. Yearly data of amount ordered for each SKU were divided by quarters. The formula and decision rule described in theoretical paragraph on inventory management was used to get the result.

According to Table 11 demand for 39 items can be relatively easy predicted on a quarterly basis. Demand variance of these items is less than 10%. 228 items are characterized by medium level of predictability and demand for 12470 items is relatively hard to predict on a quarterly basis.

Table 11. XYZ-classification of SKU sold by amount ordered (delivery data)

Group by Variance	Ordinary SKU	SKAFF	Total
X	38	1	39
Y	228	0	228
Z	10428	2042	12470
Total	10694	2043	12737

Among 39 SKU with high level of predictability one belongs to SKAFF group which means that this article number is ordered with relative frequency and in relatively stable quantities. The rest of the SKAFF items belong to Z category or to the category of items that are characterized by relatively low demand predictability.

Then items were classified on the basis of annual stock value in order to identify items responsible for the largest amount of money locked up in the stock. To separate these two approaches to XYZ analysis of inventory it was decided to name the groups X1, Y1 and Z1 respectively.

Table 12. XYZ-classification by average annual stock value: general information

Group by Average ASV	Sold 2011-2012	Not sold 2011 or 2012	Total
X1	1331	1324	2655
Y1	2173	6345	8518
Z1	1598	2316	3914
Total	5102	9985	15087

It can be seen in the Table 12 that there are 2655 relatively expensive items on stock. These items represent 17,6% of total amount of SKUs held on stock and are responsible for 70% of the stock value. Out of these items 49,9% were not sold in either 2011 or 2012. In total 66,2% of all items held on stock were not sold in either 2011 or 2012. Group Y1 is the largest group in terms of number of items represented. It is responsible for 55,5% of the whole stock and is responsible for another 20% of stock value. Group Z1 represents 25,9% of total number of items held on inventory and is responsible for the last 10% of the value held on stock.

Further down the results of both ABC and XYZ classifications based on demand data were combined in one group and results of ABC and X1Y1Z1 classification based on warehouse

data were combined in another group to receive more comprehensive and detailed overview of inventory structure.

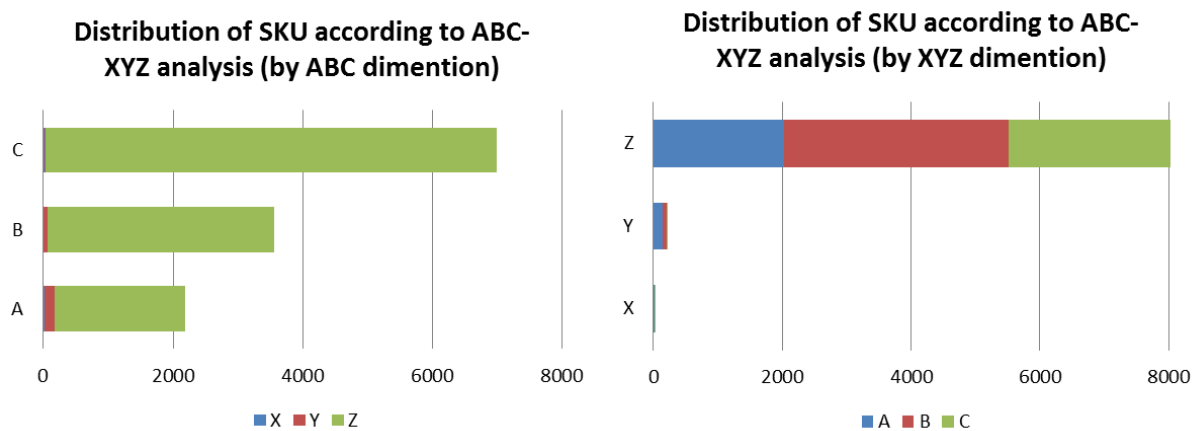


Figure 29. Distribution of SKU in ABC-XYZ groups (delivery data)

9 groups of items were received in each of the cases. According to the classification based on demand data group numbers are shown on Figure 29, Table 13, Table 14 and Table 15. It can be seen that according to the analysis of sold goods or historical demand data analysis the largest group by far is group Z (12470 SKUs) and in particular CZ (6957 SKUs): items generating low revenue and characterized by relatively low demand predictability. Items in group AZ and BZ represent items that generate either high revenue or middle revenue for the company respectively and are characterized by low demand predictability.

Table 13. ABC-XYZ analysis for all SKU sold (delivery data)

For all SKU	A	B	C	Total
X	20	8	11	39
Y	148	57	23	228
Z	2023	3490	6957	12470
Total	2191	3555	6991	

As can be seen in Table 13, Table 14 and Table 15 that 21,5% of group AZ is represented by SKAFF units: often expensive and rarely ordered units that are not included in TOOLS catalog. What concerns SKAFF units in their majority they belong to the group Z and are characterized by relatively unstable demand that is hard to predict. There is only one exception: “SKAFF 115 CASTOLIN DO 11” which belongs to group AX. It is ordered in same quantity every quarter and therefore demand for this unit is relatively easy to predict based on the demand

data for 2012. In addition this SKAFF unit is relatively expensive and generates high revenue for the company.

Table 14. ABC-XYZ analysis for SKAFF units sold (delivery data)

For SKAFF	A	B	C	Total
X	1	0	0	1
Y	0	0	0	0
Z	435	630	977	2042
Total	436	630	977	

What concerns ordinary units 19 (Table 15) of these SKU belong to category AX, which means that these units generate relatively high revenue to the company and besides are characterized by relatively high demand predictability. There are in total 19 SKUs in groups BX and CX both these groups are characterized by relatively predictable demand however group BX generates medium level of revenue to the company compared to the group CX that generates low level of revenue.

Groups AY, BY and CY are characterized by medium demand predictability and by high revenue generated, medium revenue and low revenue generated respectively.

Table 15. ABC-XYZ analysis for SKU sold: SKAFF excluded (delivery data)

SKAFF Excluded	A	B	C
X	19	8	11
Y	148	57	23
Z	1588	2860	5980

Groups AZ, BZ and CZ are the largest group for ordinary units which means that the greatest part of TOOLS Molde demand is relatively hard to predict. 15,2 % of group Z is represented by group AZ: relatively expensive items. However the largest part of group Z 57,3% consists of relatively inexpensive items that belong to the group C according to the revenue generated.

According to the warehouse data the following 9 groups were received: see Table 16. 50% of inventory held is represented by group CY1. I total 34,5% of all A items; 43% of all B item and 13,2% of all C items fall into X1 category or the category of items that lock up significant amount of money in the inventory. Items of C group represent 63% of items that fall into X1 group, which means 63% of items that lock up significant amount of money in the inventory generate low revenue for the company. Items that generate high revenue (group A) represent are

divided between groups by stock value in the following proportion: AX1 is 35% of items A, AY1 is 39% of items A and AZ1 is 26% of items A. It means the only 26% of total amount of items that generate high revenue tied up relatively low amount of money in inventory.

Table 16. ABC-X1Y1Z1 classification of inventory held (warehouse data)

Group	A	B	C	Total
X1	257	725	1673	2655
Y1	292	666	7560	8518
Z1	196	292	3426	3914
Total	745	1683	12659	15087

Afterwards product/ customer matrix was applied on the basis of ABC analysis of customers and products ordered in 2012 (Table 17 and Table 18).

Table 17. Customer category and SKU group matrix (demand data).

Customer group/ SKU group	A	B	C	Total Amount of SKU ordered
G1	1873	2648	4836	9357
G2	759	946	1253	2958
G3	291	559	1235	2085

Table 17 shows absolute number of unique SKU ordered by each group of customers. Total number of unique SKU ordered irrespective of customer group (by all customers) equals to 12737 items. Customers in group G1 order 73,5% of all items ordered in 2012, customers in group B – 23,2% and customers in group C – 16,3%.

Table 18. Customer category and SKU group matrix in % of SKU type ordered by each customer category (demand data).

Customer group/ SKU group	A	B	C	Total Amount of SKU ordered
G1	20,0 %	28,3 %	51,7 %	100,0%
G2	25,7 %	32,0 %	42,4 %	100,0%
G3	14,0 %	26,8 %	59,2 %	100,0%

According to Table 18 the largest portion of demand from G1-customers is represented by items C or low value items.

Table 19 compares such parameters as stock value of SKU, demand volatility and revenue generated of the items that were sold from stock. The numbers are given in percentage of X1Y1Z1 group. For example, in the top left corner cell value 0,3% means that 0,3% of items that

are characterized by high stock value generate high revenue and their demand is relatively stable. The color of the cell corresponds to criticality of the activity. If the color is red some activities and measures should be taken immediately. If the color is green the situation is normal and these goods need regular inventory control.

Table 19. Demand volatility, stock value, revenue generated matrix (in percentage of X1Y1Z1 group)

	AX1	AY1	AZ1		BX1	BY1	BZ1		CX1	CY1	CZ1
X	0,3 %	0,0 %	0,0 %		0,5 %	0,2 %	0,2 %	X	0,1 %	0,2 %	0,2 %
Y	2,2 %	0,5 %	0,2 %		3,8 %	0,3 %	1,5 %	Y	0,5 %	1,6 %	1,6 %
Z	11,5 %	7,7 %	7,0 %	Z	39,0 %	10,6 %	8,1 %	Z	42,1 %	78,9 %	81,1 %

It can be seen that in total 0,9% of SKUs sold from the warehouse in 2012 and characterized by high stock value are at the same time characterized by relatively stable level of demand (highlighted by yellow). These items can be relatively easy transferred to Z1 category without any decline in service level.

In total 92,6% of goods are characterized by high stock value and relatively high demand volatility. These goods represent the most critical part of inventory as they tighten large amount of investments and are ordered either very seldom or in very different quantities. These are the goods that fall into categories Z-AX1, Z-BX1 and Z-CX1.

5.2.2.2. Discussion of OFP Improvement Initiatives within IM Context

The following paragraph provides inventory analysis summary and discusses which OFP improvement initiatives could be developed on the basis of input information from CRM and IM dimensions and what possible impact could these initiative have on OFP-, company- or supply chain performance.

What concerns inventory management and control at TOOLS Molde the conclusion was made that this business process though being regarded as a critical one is not mature and well-developed. Inventory management and control is to a large extent empirical and intuitive. This finding applies to both strategic and operational level of inventory management and control. There are no periodic activities that aim at review and adjustment of inventory structure, re-order

point for each SKU or re-order quantity and optimal quantity held on stock. Through the inventory structure, re-order policy and safety stock size inventory management and control process influences on OFP and its performance measures (fill rate, lead time, correctness of delivery, etc.) and on customer satisfaction. On one hand the higher is the safety stock the higher is service level. On the other hand the higher is the inventory the higher are the costs of the company and the lower is its profit. Reduced inventory costs cause increase in profit, and therefore company may lower the prices on products for the most important or attractive customers in order to enlarge its market. However lower inventory at the same might be connected to lower service level. Therefore it is necessary to remember about trade-off between inventory level and customer satisfaction. Implementation of well-developed inventory management and control will allow the improvement of performance of OFP through increase of customer service level and cost reduction.

One of the main problems of inventory management and control at TOOLS Molde is the absence of policy that would help to manage and monitor inventory structure, or types of goods held on the inventory. It was found that in total 66,2% of all items held on stock in 2011 and 2012 were not sold in either 2011 or 2012. Stock value of these items represents capital tied up in inventory which doesn't generate enough revenue to pay off itself. In other words slow-moving and non-moving items held at inventory represent net loss of investments.

It was detected that around 25% of all items sold from the inventory in 2012 represent items with high stock value (expensive items or items held in surplus quantities) with more than 90% of these items falling into a category of SKU characterized by volatile demand. In total the amount on stock should be lower for around 30% of all SKUs sold from the stock in 2012.

Around 95% of all the items sold from stock in 2012 are characterized by volatile demand. This requires implementation of modern forecasting methods and demand sharing techniques in order to get better control over those items and smoothen demand volatility.

In total out of 12737 items sold in 2012 including transit, SKAFF and other types of items delivered not from stock 12470 or around 98% of items are characterized by volatile demand. Around 56% of those items generate low amount of revenue.

As expected the majority of the items is ordered by customers from group 1. At the same time customers that generate low revenue tend to order items very sporadically. 16% of items

sold from stock in 2012 and characterized by volatile demand was sold to customers that generate lowest revenue.

Thus, TOOLS Molde needs to apply regularly stock segmentation by revenue generated, frequency and variability of consumption and stock value and segmentation of items sold based on demand stability and revenue generated. Regular analysis of inventory structure will allow to timely identify those items that are increasing in stock value or turn into slow-moving or non-moving stock.

Second, some taken to lower inventory holdings will cause change in OFP for different groups of customers, first of all for those customers which generate the lowest amount of revenue. These customers receive the lowest priority when served from the stock. Besides, the order is fulfilled only when item is available on stock or if a particular item ordered should be delivered from the supplier the transaction should take place when the level of profit is restively high. This will seriously influence performance of OFP for customers in group G3. As an example, G3 customers will be served at standard service level and with longer lead times. It might cause service level for G3 customers to move downward. Thus, company may indirectly influence on the amount of G3 customers served as some of the customers will be willing to order from competitors.

Lower inventory will also influence OFP of G1 and G2 customers. Large amount of items might be transferred into SKAFF or transit category due to unstable demand and higher price which may influence lead time and order fill rate.

The main change in OFP will be caused on operational level. To implement prioritization policy according to the customer group and to decide which customers should be served from the inventory and which customers should be rejected or served with longer lead time company needs to implement integrated CRM system, IM system and OF system.

5.2.3. Supplier Relationship Management Analysis

According to the managerial decision model developed on the third step order fulfillment improvement team should receive input information from SRM process with help of corresponding instruments in order to balance customer requirements with company and supply chain capacity and ensure that customer service requirements are fulfilled in the best possible way. The following paragraph provides analysis of supplier structure by profitability and supplier portfolio analysis.

First part of the paragraph provides general information about suppliers of the company which includes descriptive segmentation (for ex., by profitability).

Second part of the paragraph provides supplier portfolio analysis based on Kraljic matrix in order to suggest appropriate relationship strategy for group of suppliers.

The last part of the paragraph contains a discussion and summary of OFP improvements that could be made taking into account input information received from SRM process.

General information

In the year 2012 TOOLS Molde ordered products from 330 suppliers all over the world. Most of the demand (nearly 40%) was satisfied by upstream supply companies within B&B TOOLS Molde (as Luna, Skydda, Essve, and Momentum). Other products were delivered from Scandinavian, European, Asiatic and American suppliers. Supplier structure of TOOLS Molde is quite heterogeneous. As in case of customers, small share of suppliers is responsible for significant share of financial result (see Figure 30).

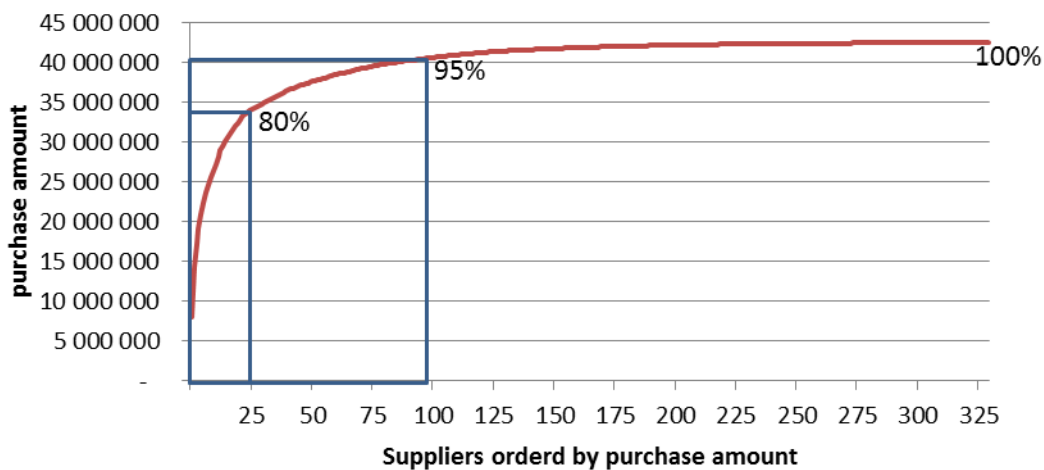


Figure 30. Amount of purchase from suppliers.

On the Figure 30 the red line represents cumulative amount of purchase from suppliers ranked by amount of the purchase from TOOLS Molde. 80% of all products are ordered from only 26 suppliers. 232 smallest suppliers provide TOOLS Molde with only 5% of products. This diversification makes TOOLS Molde dependent of efficient supplier relationship with big suppliers and demands a lot of administrative work (per purchased unit) with small companies.

In the table Table 20 some statistics on supplier structure analysis is presented. According to Pareto thumb rule 8% of suppliers provide TOOLS Molde with 80% of products.

Table 20. Supplier structure. Pareto-analysis.

Number of suppliers ordered by purchase amount		Purchased amount	
Cumulative number	Cumulative %	Cumulative amount MNOK	Cumulative %
26	8%	34,2	80%
98	30%	40,6	95%
330	100%	42,5	100 %

5.2.3.1. Supplier Portfolio Analysis

Information collected within the research gives a possibility to make a first step of supplier analysis according to basic idea of supplier structure portfolio selection (see paragraph 3.2.3).

Analysis is presented for 61 biggest suppliers of TOOLS Molde that provide 84% of products (by amount of purchase). Suppliers that are not considered in the classification provide TOOLS Molde with less than 0.2% of products and could be considered as not significant.

For each of these suppliers a level of supply risk was defined with a help of employee of TOOLS Molde responsible for purchasing. As an evaluation of impact on financial result of TOOLS Molde a total amount of purchase from the supplier was considered.

Delivery risk was evaluated with a help of 7-grade scale. Every supplier is given a grade that evaluates risk of delivery from concrete supplier. The higher is the grade, the higher is the level of delivery accuracy, and the lower is the risk of delivery. For the purpose of this research supply risk is considered to be low in case if delivery risk is evaluated with level 5, 6 and 7. Supply risk is high if delivery risk is evaluated with a grade of 1, 2, 3, and 4.

Supplier is assumed to have a high impact of financial result on the business of TOOLS Molde in case if total amount of purchase exceeds 425 000 NOK (or more than 1% of total purchase).

Figure 31 represents distribution of suppliers of TOOLS Molde according to risk / financial-impact criteria. On the Y-axis impact of the supplier on the financial result of TOOLS Molde represented on the basis of logarithmical scale in order to achieve better visualization of results. Delivery risk is represented on X-axis. The higher grade corresponds to the lower supply risk.

Financial impact / supply risk field is subdivided into four quadrants with:

- Low supply risk – low impact on financial results. Case of routine suppliers.
- Low supply risk – high impact on financial results. Case of leverage suppliers.
- High supply risk – low impact on financial results. Case of preference suppliers.
- High supply risk – high impact on financial results. Case of strategic suppliers.

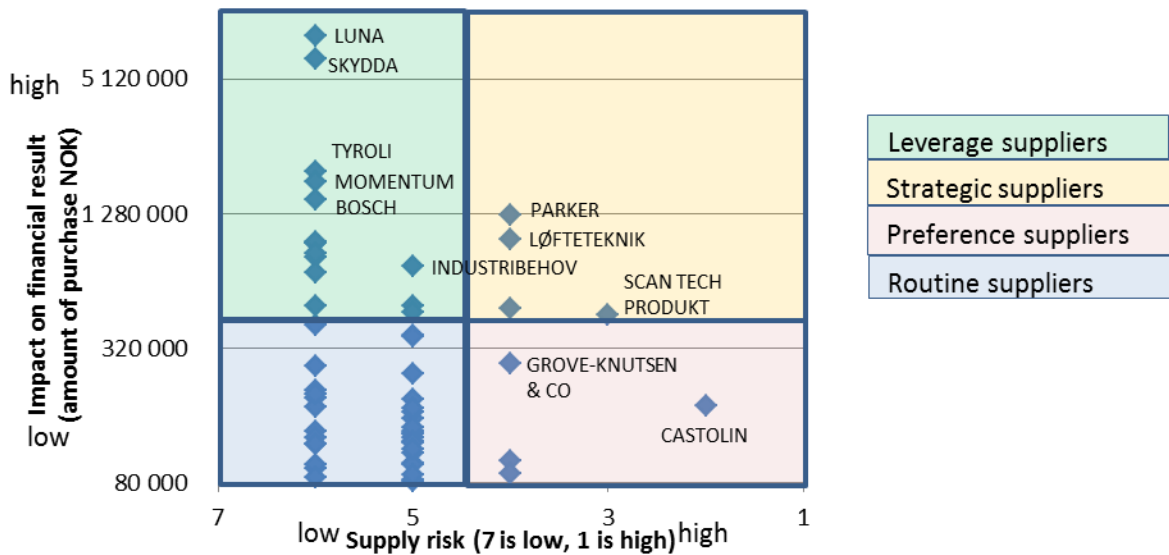


Figure 31. Suppliers of TOOLS Molde classified according to Kraljic (1983) and Luo et al. (2009)

In the group of **leverage suppliers** there are 14 companies that are responsible for 26 % of total purchase:

- Luna Norge AS,
- Skydda Norge AS,
- Tyrolit AS,
- Momentum Norge AS,
- Robert Bosch AS,
- Henkel Norden AB,
- Esab,
- Aalesund Oljekledefabrikk AS,
- Atlas Copco Tools AS,
- Industribehov AS,
- Atlas Copco Kompresorteknikk,
- Essve Norge AS,

- Kwintet Norge AS,
- Safex AS.

On the basis of strategies developed by Caniëls and Gelderman (2005) in case of leverage suppliers TOOLS Molde needs to develop strategic partnership with these suppliers. This kind of strategic partnership is already established within hierarchical structure of B&B TOOLS with Luna, Skydda, Essve and Momentum. With other companies within this list TOOLS Molde has agreements about collaboration (with Tyrolit, Robert Bosch, Henkel Norden, Esab, and Aalesund Oljekledefabrikk). Industriebhov is studied for the subject if TOOLS Molde needs this supplier. Kwintet Norge and Safex are competitors of TOOLS Molde. So far TOOLS Molde tries to avoid ordering from these suppliers and tries to use them only in case of rush orders.

The group of **strategic suppliers** consists of only 4 suppliers:

- Parker Hannifin AS,
- Westcon Løfteteknikk AS,
- Saint - Gobain Abrasives AS,
- Scan Tech Produkt AS.

These suppliers are quite important for TOOLS Molde but could be responsible for some problems with delivery. Parker Hannifin, for example, is a German supplier that has some unique products ordered by key customer 1. TOOLS Molde has an agreement with this supplier but deliveries are quite unpredictable, therefore TOOLS Molde needs to increase amount of these products on stock. Saint - Gobain Abrasives is a supplier that provides products both for TOOLS Molde and Luna.

Group of **preference suppliers** consists from 6 companies:

- Sandvik Norge AS,
- Castolin AS,
- Anchor Inserts ltd,
- Hemnes Plast Irene Ekeheien,
- Schwepper Beschlag gmbh,
- Stafa Holland BV.

Among these suppliers Castolin, Anchor Inserts and Hemnes Plast Irene Ekeheien mainly produce products that are necessary for key customers such as Customer 1 and Customer 2.

These companies have quite big supplier power as far as there are not so many competitors on the market. Tools Molde quitted purchasing from Stafa Holland.

The last group consists of 36 **routine suppliers**:

- 3M Norge AS
- Trelleborg Industrial Products
- Nilfisk-Advance AS
- Norengros Ødegaard Engros AS
- Penselmesteren AS
- Arvid Nilsson Norge AS
- Motek AS
- Atlas Copco Anl.- OG Gruvetekn
- TR Fastenings Norge A/S
- Grove-Knutsen & Co AS
- Maskin K Lund AS
- HR Maskin AS
- Otto Olsen AS
- Aga AS
- Ing. Yngve Ege AS
- Blåklader AS
- Tesa AS
- AS Einar Kunsts ETF
- Carl Stahl AS
- Aco Kjemi AS
- Ferro Bet AS
- Stokvis Tapes Norge AS
- Wenaas Sport Og Fritid AS
- Molde Jarnvareforretning AS
- Elmeko AS
- Binzel Norge AS
- Hultafors Group Norge AS
- Kolberg Caspary Lautom AS

- A/S Hamas Industri Og Landbr.
- Nederman AS
- Industrilim AS
- Fuglesangs AS
- Presto Brannteknikk AS
- Aeo Midt-Norge AS
- Maske Gruppen AS
- Makita Norway

The annual amount of purchase from these suppliers is less than 500 000 NOK. Actual number of routine suppliers as well as number of preference suppliers is bigger due to the fact that in the analysis only 61 biggest suppliers were considered.

5.2.3.2. Discussion of OFP Improvement Initiatives within SRM Context

Main volume of trade TOOL Molde has with leverage suppliers. With all these suppliers it is important to build strategic partnership if possible. At the moment TOOLS Molde has already established partnership relations nearly with all leverage suppliers. As far as the majority of products are purchased from these suppliers improvement of delivery process (in terms of time and costs) will have a significant positive effect on the financial results of the company. In relationships with leverage suppliers TOOLS Molde should exploit its buying power while bargaining if it is possible. For example, buying power of TOOLS Molde will be higher if they will cooperate together with other companies from B&B TOOLS Group.

According to Caniëls and Gelderman (2005) in relationships with strategic suppliers TOOLS Molde should consider a possibility to build a partnership relationships in order to counterbalance the supply risk. Partnership idea is already realized in case of two suppliers. This will help to develop mutual trust and cooperation with upstream members of the supply chain. In case if supplier or TOOLS Molde (or B&B TOOLS) is not interested in strategic partnership two options exist: to accept the situation (for TOOLS Molde it will mean increase of inventories for products provided by these suppliers) or to quit relationship (and to find another more reliable supplier) as far as uncertainty of deliveries from these suppliers could have a large negative impact on the financial results of TOOLS Molde.

The main reason to accept dependence on preference suppliers for TOOLS Molde is if these companies own some unique knowledge or products. In this case TOOLS Molde needs to assure supply for reasonable costs (by increase of inventories, for example). If it is not possible to accept such level of risk TOOLS Molde can either search for other suppliers (as it is done in the case of Stafa Holland) or exclude products from these suppliers from the assortment.

According to rule of thumb by Caniëls and Gelderman (2005) orders from routine suppliers require 80% of the purchasing department's time, while they often represent less than 20% of the purchasing turnover. For these suppliers it is important to organize efficient order processing. Most amount of work with these suppliers should be standardized, purchasing requirements should be bundled. Moreover when it is impossible to pool purchasing requirements individual ordering systems could be adopted (for example with purchase card) in order to reduce transactional costs and related administrative activities (such as invoicing and ordering).

It is important to notice that presented supplier selection process to the concrete case could be conducted in different ways. First, for evaluation of supplier risk only a parameter of delivery risk was taken into account. Product risk and other connected risks are not taken into consideration. Levels of "high" and "low" risk and influence on financial results were set voluntary on the basis of common sense. Specificity of products delivered by suppliers under consideration was not taken into account. All these factors weaken obtained results. But, as it was mentioned in theoretical review on supplier selection (paragraph 3.2.3) such kind of analysis could be a good basis for further supplier relationship analysis (for example for supplier selection of the basis of fuzzy variables mentioned in theoretical part).

5.3. OFP Improvement Initiatives

The following paragraph contains summary of OFP improvement initiatives developed according to managerial decision model. Main initiatives that could be recommended for implementation for OFP improvement will be presented. For each improvement initiative its impact on the performance of OFP, TOOLS Molde AS and related supply chain will be estimated. Besides initiatives that will be tested by means of simulation model will be selected.

Improvement initiatives are presented in three groups according to managerial decision model structure. The first part of initiatives describes improvements of customer relationship management process, the second deals with inventory management process and the last one contains improvements for supplier relationship process.

Table 21. Improvement initiatives

Improvement initiative	Expected effect from improvement
CRM	
Build customized CRM process for customer groups defined according service requirement profile similarity	The measure will allow better understanding customer needs, increase customer satisfaction in general as well as for problem customers (with low level of customer satisfaction). It will allow better control for future financial results of the company.
Tailor OFP for every group of customers according to those needs and preferences as it was described in discussion.	The measure will allow to improve key customer satisfaction parameters of OFP (as lead time, price, availability of additional services and delivery accuracy) in different combinations according to customer requirements. It will allow to gain competitive advantage and to build tighter relationship with companies that were “neutral” before. It will lead to improvement of process orientation and improvement of process maturity.
Implement practices that will control accuracy of OFP	The measure will allow to increase accuracy of company performance, Increase customer satisfaction, and customer loyalty. Can lead to increase of lead time but not significantly. It will lead to improvement of process orientation.
Introduce additional services as information sharing about delivery status, expected date of delivery, professional consultations or others	It will lead to increase of customer satisfaction. It can also help to gain competitive advantage for companies that were “neutral” before, initiate more orders.
Increase level of collaboration with	The measure will lead to better resource

selected customers, for example, by implementation of tools for demand information sharing	planning, cost savings (for example for inventory keeping), lead time decrease. It will allow to improve partnership relations.
Decrease number of small customers	Decrease total order processing costs, concentrate on more important customers, which will help to increase critical customer satisfaction by increasing service level and therefore company- and supply chain performance.
IM	
Introduce customer prioritization in order filling according to the group of customer by revenue and inventory availability	It is assumed that this policy might move down the amount of customers that generate lower value by decreasing service level for those customers. Besides it is assumed that inventory costs may decrease due to that fact that items ordered only by G3 customers will not be held on the inventory. In addition this policy may increase service level and OFP performance for critical customers. Each of this outcomes will positively influence company- and supply chain performance.
Reduce amount of items with high stock value in order to lower the amount of capital locked up in inventory	It is assumed that reduction of items with high stock value will increase inventory turnover ratio if cost of goods sold will stay constant. It is assumed that cost reduction will be achieved with minimal or without any decrease in service level if adequate inventory planning is established for those units. This will help to offer competitive prices to customers and therefore will influence on company- and supply chain

	performance.
Reduce amount of items on stock characterized by highly variable demand	It is assumed that reduction in amount of Z items held on inventory will reduce inventory costs without decrease in customer service level. Thus, it will positively influence company- and supply chain performance. However, on the other hand lower inventory stock might lead to higher lead time and lower order fill rate and lower order fulfillment performance in general.
Introduce collaborative ERP system which will allow to connect CRM, IM and SRM together	It is assumed that collaborative ERP system will improve decision-making during OFP process in company and facilitate customization of OFP for critical customers. Therefore it will positively influence company- and supply chain performance.
Collaborate with customers on sales inventory and operations planning	It is assumed that collaboration with customers will improve demand forecasting and inventory planning especially for items characterized by variable demand. Cost reduction and service level increase are expected as a result. Therefore it will positively influence company- and supply chain performance.
SRM	
Maintain and develop collaboration with leverage and strategic suppliers	It will allow developing partnership with key suppliers and assuring OFP to be smoothly performed.
Improve delivery process from leverage suppliers	Improvement of order lead time, and significant cost savings (in transportation and administration part).

Together with other companies from B&B TOOLS Group exploit its buying power towards leverage suppliers when possible	Increase of profit and explore effects of higher buyer power.
To increase inventories for products bought from selected strategic and preference suppliers	Decrease delivery risk. Increase costs for inventory keeping, decrease negative impact on financial result of the company initiated by penalties for not proper deliveries to customer.
Quit relationship with selected strategic and preference suppliers (and to find other more reliable suppliers)	Decrease delivery risk and decrease negative impact on financial result of the company
Improve ordering process for routine suppliers	Reduce transactional costs (order processing costs), increase company's capacity to fulfill more orders.
Implement more advanced techniques of supplier selection process	Improve division of suppliers for groups. Take into consideration more important factors while SRM process.

It was decided to test the following improvement initiatives by means of simulation model:

- Deliver only when order is complete;
- Increase reliability of suppliers;
- Decrease number of products with variable demand on stock;
- Increase service level for products with stable demand on stock;
- Increase price for small customers.

5.4. Managerial Decision Support Simulation Model

On the last step according to managerial decision model OFP improvement initiatives should be evaluated with help of performance measures and by means of simulation model. In order to provide a tool for dynamic evaluation of parameters of OFP improvements the simulation model of OFP was developed. The model imitates OFP in the considered supply chain with TOOLS Molde as a focal point.

In this paragraph the simulation model is described according to the methodology of Simulation Model Development for Logistics and Supply Chain Research developed by Manuj, Mentzer, and Bowers (2009). The description of the model is realized in eight blocks dedicated to simulation model problem formulation, specification of independent and dependent variables and parameters, development and validation of the conceptual model, data collection, development and verification of the computer-based model, model validation, performance of simulations and analysis of the results.

5.4.1. Model Development

Simulation model Problem Formulation

The main purpose of the simulation model is to create a simplified representation of the OFP for supply chain with TOOLS Molde as a focal point in a state as it is now (model “As Is”). The model should be able to imitate the flows of goods and information within the OFP between the main members of the supply chain. Simulation process should provide information for performance evaluation of the whole supply chain as well as of the focal company. A set of managerial decisions are supposed to be tested with a help of the model by manipulations with physical and informational structure of the model. The model should be able to reflect the influence managerial decisions have on supply chain and company performance.

The model consists of three main blocks: customers (downstream supply chain), TOOLS Molde and suppliers (upstream supply chain). Customers are represented by “customer groups” according to ABC analysis (see classification in case analysis, paragraph 5.2.1.1). Suppliers are represented by supplier groups defined on the basis of supplier portfolio analysis (see supplier portfolio analysis in paragraph 5.2.3.1).

The downstream part of the model describes the OFP which starts when the customer of TOOLS Molde sends an order and ends with the delivery of all ordered products to the customer.

The upstream part corresponds to the process of procurement for TOOLS Molde starting with the moment when TOOLS Molde orders from suppliers until the product is delivered from the supplier to TOOLS Molde warehouse or to the customer. The two parts of the process are connected in case of “Transit” (T) type of orders.

Parameters and variables

According to Manuj, Mentzer, and Bowers (2009) the choice of the variables and parameters in the model should be based on literature review, case study and the research objective. Some of the variables reflect performance of the system and are used as performance indicators.

System parameters influence on system behavior depending on the values of the attributes of the current entity. For example, the model makes decision about amount of product groups in a current order with respect to the type of the customer that generated order. Probability of every product group to be in the order is defined for every customer group and remains the same for all simulation period. The list of the parameters and short description can be seen in the Table 22.

Table 22. List of parameters in the model

Parameter	Description	Comment
<i>Frequency of orders from customers</i>	How many orders arrive to TOOLS Molde from different types of clients a week.	In number of orders. Number of orders arrived a week is calculated on the basis of random weekly demand. See Appendix D
<i>Diversity of product groups in the order</i>	How many different product groups are usually contained in one order from customer group.	In % of total number of orders for every client group. Parameter depends on customer group.
<i>Frequency of ordering for different product groups</i>	How often one group of the products is ordered by each type of the customer.	In % of total number of orders for every client group. Parameter depends on customer group.
<i>Fill rate</i>	Fraction of demand that is satisfied directly from shelf. It reflects how often the product is on stock and how often the product is ordered from the supplier.	In % of total demand for every product group. Parameter is calculated independently for every product group.
<i>Share of Transit orders</i>	Share of Transit orders in total amount of orders.	In % from total number of orders. Parameter is calculated independently for every product group.
Frequency of L orders from	How often TOOLS Molde	In number of orders per day.

suppliers	sends orders to the customers in order to refill its inventories.	
<i>Supplier choice rule</i>	With which frequency product will be ordered from exact supplier type.	In % of total orders from suppliers. Parameter is calculated independently for L orders and T orders for different customer groups.
<i>Expected time for delivery from the supplier group</i>	Expected delivery times from the suppliers and level of variation of this parameter.	In days for every group of suppliers.
<i>Distribution of orders within a week</i>	What share of weekly demand arrives to TOOLS Molde on every day of the week on average	In % of weekly demand for every day of the week (including weekends)

While parameters remain the same for the whole the whole simulation period and for all replications, variables are the subject to constant updating. Variable *OrderCounter* counts number of orders generated within the model. Variable *DirectDelGrX* defines actual level of demand share satisfied directly from the shelf for every product type. *OrderFromSupGrX* counts share of demand for products that are not supposed to be on stock (T orders) and that were ordered from supplier. *BackorderGrX* counts number of stock outs for products that are supposed to be on stock. *DelLevSuppl* counts number of orders that were sent to supplier of specific type.

The model includes possibility to measure the following performance parameters: lead time for a product, lead time for an order, amount of orders that are in the process of delivery from suppliers (for every supplier type), amount of backordered products (% of stockout), P2 service level for the system, share of transit orders, WIP (work in progress, amount of orders that are not fulfilled, i.e. order is received but not completely delivered). In addition some financial performance indicators can be estimated (such as total revenue or total margin).

Conceptual model

Conceptual model for the simulation model is presented on the picture below (see Figure 32). The model represents a logical scheme of decision making process. In the beginning of the day a set of orders is generated according to random distributions that characterize demand of different customer groups (point 1). For every customer order the system defines amount of product groups in the order and assigns type for every product group according to probability distributions for every customer group (point 2). Probability that product is on stock is defined

according to actual fill rate for every product type (point 3). If the product is on stock it is taken from warehouse and sent to the customer. If the product is not on stock the system for every product type defines if it is a situation of stock out (the product was supposed to be on stock and it is a failure of inventory management) (point 4). For the products that should be ordered directly from the supplier, supplier type is assigned according to the probability distribution of the order from exact customer to be delivered from exact supplier type (point 5). Similar logic is applied for orders generated by TOOLS Molde within inventory management process. Every product ordered from the supplier is delivered to TOOLS during the period of time with respect to the level of delivery risk characteristic for every supplier type (point 6). After product is delivered to TOOLS Molde it goes either to customer or on stock (depending on order type L or T). In case of backorders the product is delivered according to average delivery time for this product type (point 7). Products that are delivered to TOOLS Molde are sent to customer. If in one order there are products that arrived on different days, products are delivered to customer ASAP (as it is realized in TOOLS Molde at the moment of the research).

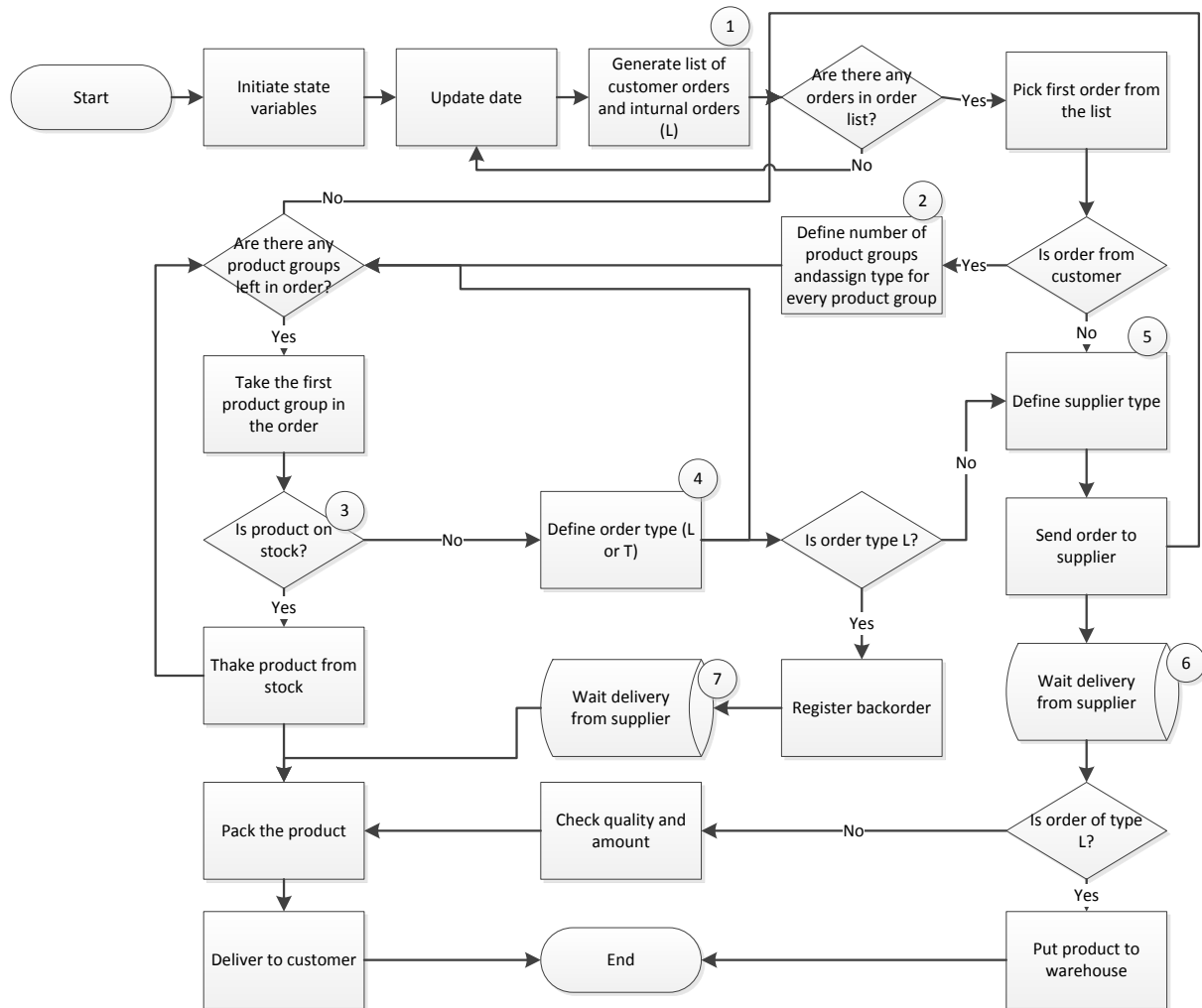


Figure 32. Conceptual model for OFP simulation

Data collection

All data for the simulation model were collected while studying TOOLS Molde AS and relate to the financial year 2012. An ERP system of the case company was the main source for statistical data. Some independent variables were operationalized with an empirical distribution from observed data, according to the classification of Banks (1998). For example, Diversity of product groups in the order, Frequency of ordering for different product groups, Fill rates, Expected time for delivery for the product, Share of Transit orders, Frequency of L orders from suppliers, Supplier choice rule and Expected time for delivery from the supplier group. Presentation of data tables see Appendix C.

Frequency of orders from customers was operationalized by fitting a probability distribution of the observed data. Weekly demand of three different customer groups could be

considered as random (with exception of weeks that contain Christmas, Easter, New Year and some weeks of summer holidays).

Table 23. Probability distribution for customer demand. Results of Goodness of Fit Tests¹.

Customer group	Demand distribution	Parameters: Shape and Scale	P statistics	Anderson-Darling statistics
Group 1	Weibull	11,60481; 122,70411	0,118	0,6
Group 2	Gamma	27,53196; 1,36811	>0,250	0,332
Group 3	Weibull	3,82859; 25,88041	>0,250	0,441
L orders	Weibull	8,65307; 206,20626	>0,250	0,217

Data for managerial solution testing were received from quantification of qualitative managerial decision data. This will be described in a paragraph with corresponding testing.

Computer-based model: Development, Verification and Validation

The simulation model was developed using Arena Simulation Software by Rockwell Automation. It contains the following logical parts.

Order creation block. On this stage the model generates weekly demand for every customer group. Entity name is “order”. Weekly demand is distributed by weekdays with help of “waiting” modules. For every order “order number” is assigned. With respect to customer group for every order “number of groups” is assigned. Further entity name is “product group”, or “product”. For every product group “group type” according to the ABC classification is assigned.

¹ Goodness of Fit Tests were made in MINITAB 16 Statistical Software. Parameters for distribution are estimated with Maximum Likelihood Estimation Method.

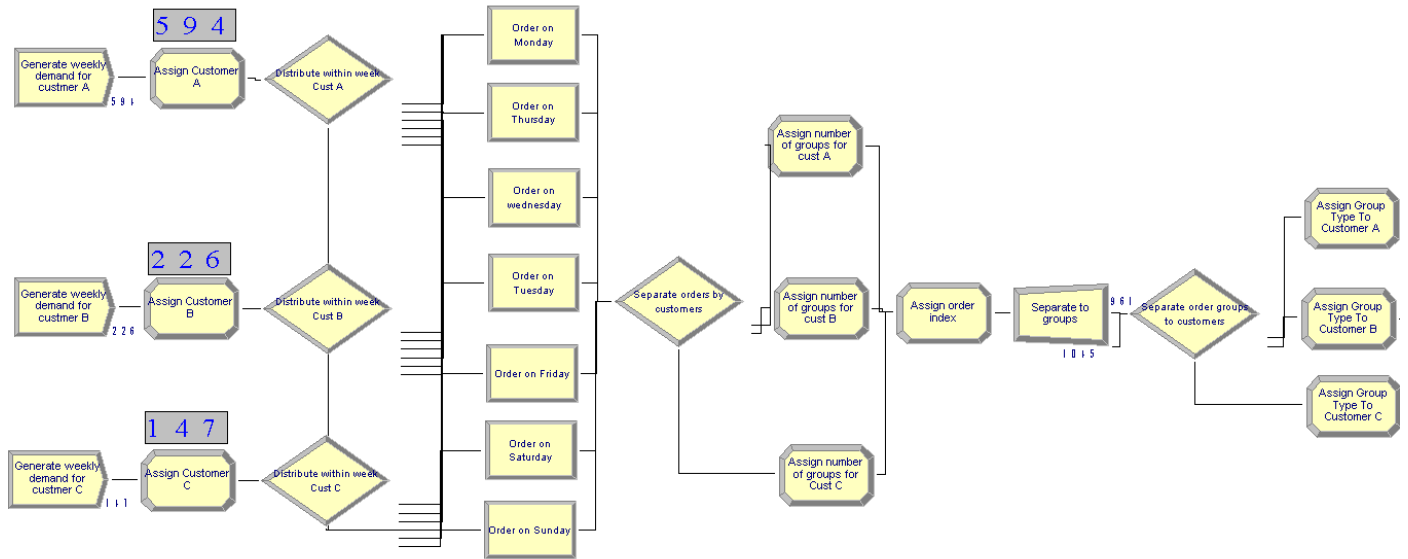


Figure 33. Simulation model. Order creation block.

Order processing block. On this stage the model decides about how the product will be processed further. For every product type the model has a separate sub-block (see Figure 34). With defined probability the product is on stock. If the product is on stock it is considered to be taken from inventory. This is recorded by mean of “tally” block. If the product is not on stock it could be either of “L” type (it is supposed to be on stock, a situation of stock out) or “T” type (the product is not supposed to be on stock, it should be ordered directly from the supplier). Stockout case is registered and order is sent to supplier. As in case of “T” order, the product goes to “Order from supplier block”. The product is sent to the “Delivery block” after it is taken from the inventory. In case of backorder product is sent for delivery after it is received by TOOLS Molde. T order is sent to the customer after checking by employees of TOOLS Molde. Note that there are 9 order processing blocks, the same amount as number of product groups.

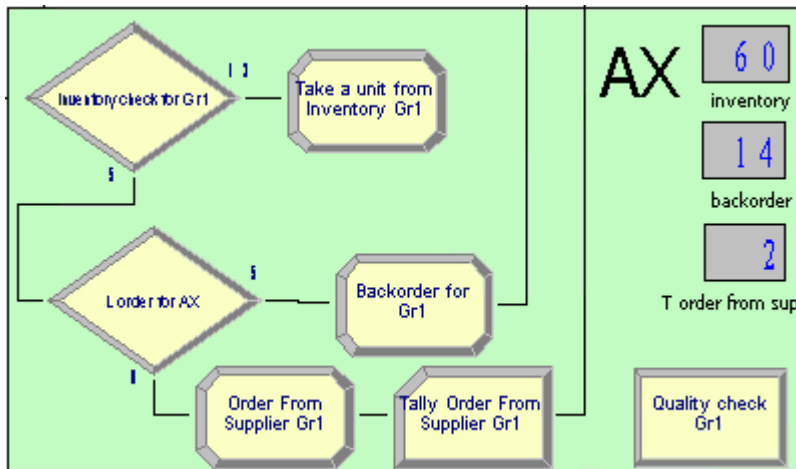


Figure 34. Simulation model. Order processing block for product AX.

Order from supplier block. The block represents procedure of decision making about supplier for orders that were received from customers (of “T” type) and orders that were generated by TOOLS Molde in order to refill stock. System generates “internal “L” orders in order to imitate orders that are created by inventory management block of ERP system of TOOLS Molde. Weekly demand is distributed within week day according the same logic as in “Order creation block”. Orders are distributed with empirical probability distribution to suppliers of four groups: leverage, preference, routine and strategic defined within supplier portfolio analysis. Delivery time (expected duration and deviation) depends on supplier type. If delivered product is of type “L” it should be placed on stock, if it is of type “T” it goes to order processing block for checking and further delivery. Counter under “delivery from NN supplier” reflects amount of orders that are in the process of delivery. Counter “Delivered from NN supplier” reflects amount of orders that were already delivered from NN supplier.

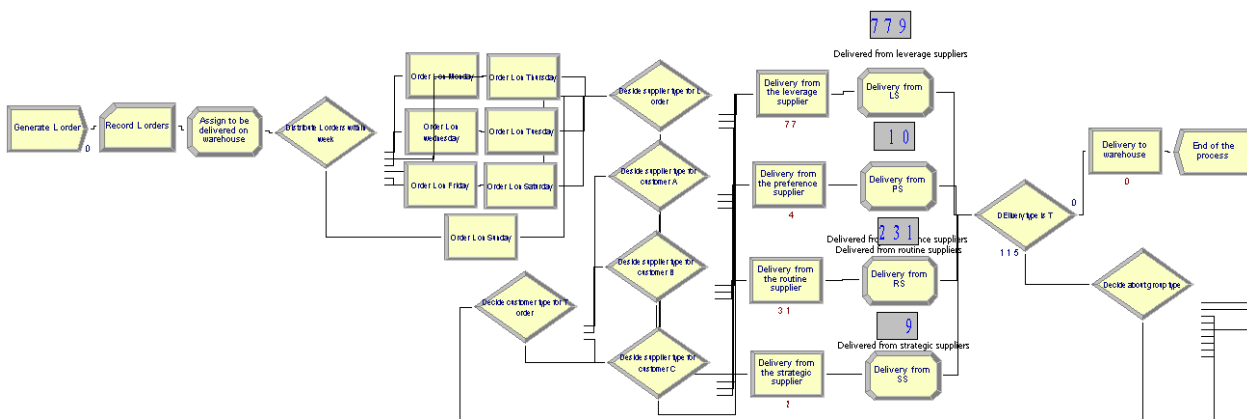


Figure 35. Simulation model. Order from supplier block.

Delivery block. This block does not reflect any decision making process. As far as delivery to the customer is performed mostly by transportation companies TOOLS Molde cannot directly influence on delivery time as well as delivery time from TOOLS Molde to customer could not be considered as significant for strategic decision making. The block represents a structure that provides statistics on lead time of products and orders. Currently TOOLS Molde deliver products as soon as they arrive to the company. The difference between the time order is registered and a product form this order is delivered is counted as “lead time for the item”. Difference between the time order is registered and the last product form this order is delivered is counted as “lead time for the order”.

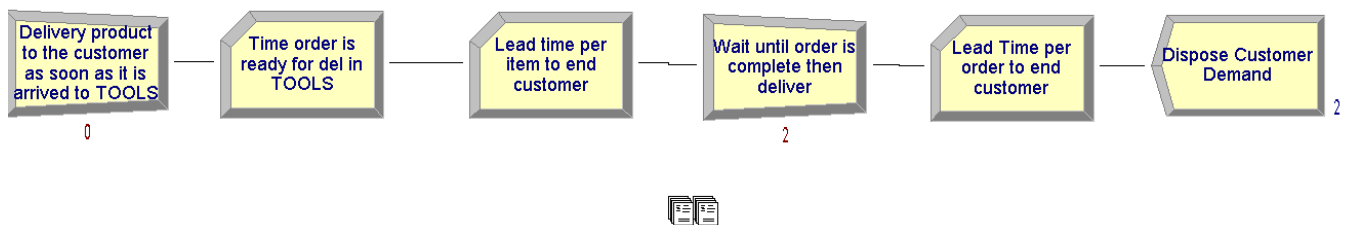


Figure 36. Simulation model. Delivery block.

The model was developed under continuous verification process. For model verification the following techniques were used. The model structure was step-by step verified by analysis of the system state dynamics after each event occurred and comparing it with results of calculations performed in parallel (“trace” technique). Debugging was performed interactively by stopping the simulation at selected point of time. The simulation was tested using different sets of the input parameters. Results of the simulation were compared with exact and approximate alternative calculations. Dynamics of main parameters of the model was observed with help of animation.

Another realized approach for model verification was its constant reviewing by several persons (including two model developers, two simulation consultants, one representative of TOOLS Molde). After iterative process of verification it could be stated that presented simulation model behaves in the way it was intended according to the modeling assumptions.

The basis for model validation were consultation with the executive managers of TOOLS Molde during conceptual development of the model and relationships between components.

As far as the basic model reflects the state of the OFP as it was in the year 2012 the main test for model validation is to check whether the results of model run give approximately the same results as real OFP. It is important to notice that the model has two main simplifications that differ the real process and modeled process. First, it is a “demand simplification”, when the model does not reflect demand fluctuations during vacation time (as Christmas, Easter etc. Second is that the model does not reflect delivery of some products according to “delivery solutions”. So far lead time for products will reflect the time when the product is delivered to TOOLS Molde, but not to the customer (as far as for customers that use delivery solutions products are delivered once a week).

In order to verify the model performance was compared with real data (see Table 24). For verification reasons the model was running for 366 days (year 2012) with 31 days of warming period (December 2011). Number of replications is 25.

Table 24. Data for simulation model verification.

Parameter	Actual data	Data from the model	Difference
Amount of orders from A customers (orders)	5556	5615	1,05 %
Amount of orders from B customers (orders)	1772	1776	0,23 %
Amount of orders from C customers (orders)	1115	1094	-1,92 %
Amount of L orders	9412	9258	-1,66 %
Average lead time of products (days)	4,8	3,45	1,3
Average lead time of orders (days)	8,3	5,5	2,8
Total revenue (NOK)	56 900 513	55 348 849	-2,80 %
Number of orders delivered to customers (orders)	8443	8485	0,49 %

In most of cases the model produces the result which is quite close to actual data. In most of considered cases difference does not exceed 5%. Model shows lower value of lead times for products and orders than in real life. This could be explained by the fact that in practice in some

cases products are delivered several days later then they are delivered to TOOLS Molde. For example, in case of delivery solution TOOLS Molde delivers orders only once a week. In other cases customers want delivery on a fixed day and order waits until a specific date to be sent to customer. Model does not consider these delays. According to the model specifications product is delivered to customer the next day after it was delivered to TOOLS Molde. So far it could be concluded that the model reflects the real world process with acceptable level of accuracy and the simulation model could be considered as valid.

Performance of simulations

Main dimensions for simulation performance are number of independent model replications (sample size) run length and warm-up period (Manuj, Mentzer, and Bowers 2009).

In order to define number of replications the following technique was implemented. Number of replications was gradually increased until confidence intervals for main performance indicators were less than 1 % and half width intervals were less than 5% of indicator value. So far all experiments were performed with 25 replications.

Length of the simulation process was defined by the nature of collected data. As far as the data were collected for one year (2012), length of one replication is equal to 366 days.

When the model starts to run it has no predefined amount of “Work in process”. So far to reach a state of normal functioning it is important to use a warm-up period. Warm-up period should cover the time when all parameters will come to a stable dynamic. From the theoretical perspective this period could not be less than expected delivery time from suppliers which is 17 days (expected delivery time from preference suppliers). For demonstrative reason the warm-up period was increase to 31 days that is a length of one month before modeled period (December 2011).

So far for all experiments with a model the following experimental parameters will be used: 25 replications, 366 days of experiments and 31 warming-up days for every replication.

5.4.2. Managerial Decision Testing

On the basis of develop order fulfillment simulation model the following decisions will be tested.

1. Deliver order only when it is complete

What will happen with average lead time if TOOLS Molde will deliver orders to customers in full?

At the moment of the research most of the products are delivered to customers as soon as possible. It means that if only part of the order is ready for delivery, it is delivered to the customer without waiting for the rest of products that will be delivered later.

From one side some customers could be annoyed by receiving a lot of parcels with products from one order as far as they spend more time on administrative non-value added activities. From other side for the wholesaling company (i.e. TOOLS Molde) delivery of orders in one delivery could lead to saving on transportation. As far as much less transportation units will be purchased from logistics companies. Moreover complete delivery could be a good performance indicator on how well company works.

Lead time of an order will always be more or equal to lead time of any product in a given order. So far by delivering all products belong to one order at once TOOLS Molde will increase average lead time. The simulation model will help to estimate how big will be increase of a lead time.

Table 25. Results for test with complete deliveries.

Scenario	Avg. product lead time (days)	Avg. order lead time (days)	Max. product lead time (days)
Basic	3,45	5,5	94,72

For this purpose the model has two performance indicators: Lead time of the product (time between order is received and product is delivered) and lead time of the order (time between order is received and the last product from this order is delivered).

Model estimates average difference in lead times equal to two days. It means that in case if TOOLS Molde will wait until all products will be ready for delivery to the customer on average customer will wait two days more for the delivery.

This estimation could be used for sails department in TOOLS Molde when they discuss with customers about expected delivery date. In case if customer wants (or does not mind) to wait until all products will be ready for delivery, on average it will wait two days more.

2. Increase reliability of suppliers

How increase overall reliability of suppliers will influence on lead times?

On the basis of supplier portfolio analysis it was mentioned that some suppliers are less reliable than others. With a help of establishment of partnership relations with selected suppliers (or other means of SRM) management of TOOLS Molde tries to increase suppliers' reliability. Costs of establishment and maintenance of partnership relations with a supplier could be quite high. So far it is important to define what impact increase of supplier reliability will have on company and supply chain performance.

It is expected that increase of supplier reliability will influence on lead times of products and orders. As far as there were two groups of suppliers with relatively high delivery risk (strategic and preference suppliers) we can assume that in ideal case all these suppliers will be replaces by more reliable ones (leverage and routine suppliers coordinately). So far as a quantitative measure for this managerial decision we can use the following approach: delivery times with standard deviations of not reliable suppliers will be replaces by delivery times with standard deviations not reliable suppliers. Statistical parameters of delivery for strategic suppliers will be replaces with ones from leverage suppliers, while statistical parameters of delivery for preference suppliers will be replaces with ones from routine suppliers. The impact of these changes will be measured with respect to lead times.

Table 26. Results for test with reliable suppliers.

Scenario	Avg. product lead time (days)	Avg. order lead time (days)	Max. product lead time (days)
With reliable suppliers	3,4	5,39	27,53
Basic	3,45	5,5	94,72

Model testing showed that increase of reliability of suppliers will have nearly no influence on average lead times (both for products or orders). But it will significantly decrease amount of

products that will have long delivery. Maximum lead time is much lower in case if all suppliers are reliable.

So far increase of suppliers' reliability will lead to decrease of maximum delay in deliveries but will not influence on average lead times. Thus if managers want to decrease average lead time, improvement of suppliers' reliability will not help. However improvement of suppliers' reliability is very important in order to stabilize delivery process. It will reduce significantly maximum lead time and lower probability of negative customer experience.

3. Decrease number of products Z on stock

How decrease of inventories for Z products it will influence on service level and lead time and how much TOOLS Molde will save in capital tied up in inventories?

Note that products Z are characterized with unstable monthly demand. These items are main source for creation of non-moving stock. Most of capital tire up in products of X type on stock. So far in order to reduce capital tied up in inventories the main managerial attention will be to concentrated on Z items.

From a positive side reduction of Z items on stock will lead to decrease of capital tied up in inventoried. But from other side it will increase a lead time for customers. So far satisfaction of customers could decrease.

Experiments with a model combined with calculations will help to estimate the influence reduction of Z inventories will have on lead time and inventory costs.

Table 27. Simulation results: impact of Z-inventory reduction.

Scenario	Service level P2	Decrease in Stock Value (NOK)	Item lead time for customer A (days)	Item lead time for customer B (days)	Item lead time for customer C (days)
Basic	AS-IS	0	3,29	3,68	4,46
S1	50%	480 083	3,52	3,95	4,66
S2	35%	1 727 230	4,20	4,72	5,43
S3	25%	2 785 031	4,83	5,45	6,29
S4	10%	4 371 734	5,75	6,46	7,48
S5: There is no Z items on stock	0%	5 429 535	6,36	7,18	8,29

It can be seen from the Table 27 that decrease of inventory of Z-items leads to the increase of lead time for all customer groups but decreases stock value. Taking into account that stock

value of Z-items comprises more than 50% of current sock value reduction of Z items kept on stock will significantly reduce capital tied-up in inventory. For example, in case 35% of Z-items is sold from inventory then TOOLS Molde will decrease stock value on 1,7 mln NOK. However this will increase average item lead time for 1 day approximately. If to focus on an extreme case when no Z-items are kept on inventory then TOOLS Molde will reduce stock value for more than 50%, but item lead time will increase in two times.

It is important to notice that reduction of Z-inventories will have a significant positive impact on inventory cost savings and negative impact on lead time. Reduction of Z inventoried should be released with respect to following considerations: for products that are on delivery solution lead time should not exceed one week (5 working days), Z-items for same-day-delivery to key customers should stay on stock.

Negative effect on lead time from reducing inventoried of Z products could be compensated by more careful demand forecasting and demand sharing. These measures will help to get information about demand in advance. TOOLS Molde will be able to purchase necessary Z products directly before they will be demanded, keep high level of customer satisfaction and low inventory keeping costs.

4. Increase service level P2 for products X

How increase of inventories for X products it will influence on service level and lead time and how much TOOLS Molde will increase capital tied up in inventories?

X products are characterized with quite stable and predictable demand. Demand for these products is commonly satisfied “from the shelf”. Share of demand satisfied from the shelf is a P2 service level. It is relatively easy to keep high service level and low inventory costs for these products as far as the company just needs to find optimal ordering policy using standard formulas for stable demand.

Table 28. Simulation results: increase amount of X-items on stock.

Scenario	Service level P2	Increase in Stock Value (NOK)	Item lead time for customer A (days)	Item lead time for customer B (days)	Item lead time for customer C (days)
Basic	AS-IS	0	3,29	3,68	4,46
S1	90%	5 488	3,25	3,66	4,52
S2	95%	8 203	3,23	3,67	4,50
S3	99%	10 389	3,23	3,67	4,45

According to Table 28 it is possible to increase service level for X-items to 99% without significant investments: stock value will increase only for 10 389 NOK. This means that in 99 percent of cases all X-items will be sold from stock and ready for same-day delivery. This is especially important for AX items that generate large amount of revenue for TOOLS Molde. As long as X-items are characterized by relatively stable (predictable) demand their service level can be increase without increase in their stock value as these items can be ordered from suppliers shortly before they are ordered by customers.

It should be noticed, however, that increase of service level for X-items will not influence lead time. The average lead time will remain the same.

5. Increase price for small customers by 5%

How 5% increase of the price for small customers will affect profit of TOOLS Molde?

Order processing costs represent fixed costs for the company. Therefore the smaller is amount of orders processed during the year the smaller are company's fixed costs. Taking this into consideration, company should aim at selling orders that generate large revenue rather than low-revenue-orders. Average revenue per order from large customer is 3,7 times higher than average revenue per order from small customer (G3-customer).

Thus TOOLS Molde may consider a possibility to decrease amount of orders from small companies. In order to decrease number of orders, company may increase the price. Increase of the price for small customers and possible decrease of their demand (decrease of number of orders) will influence G3-customers' profitability. Sensitivity analysis (Table 29) shows how price changes together with possible demand change will affect profit of TOOLS Molde if fixed and variable costs remain the same.

Table 29. Total Marlin from small customers (NOK). Price-demand sensitivity analysis.

Number of orders	Change of customer demand	Change of price				
		0 %	1 %	5 %	10 %	20 %
1215	0 %	894 495	920 218	1 023 111	1 151 727	1 408 960
1203	-1 %	885 550	911 016	1 012 880	1 140 210	1 394 870
1154	-5 %	849 770	874 208	971 956	1 094 141	1 338 512
1094	-10 %	805 046	828 197	920 800	1 036 555	1 268 064
972	-20 %	715 596	736 175	818 489	921 382	1 127 168

Sensitivity analysis shows that increase of price for 5 % or more will bring TOOLS Molde a positive effect (in terms of increased Total Margin and decreased amount of orders) if demand will reduce for 10% or less. Profit will increase and TOOLS Molde will save on fixed order processing costs.

Notice that this test was performed using determined scenario analysis approach (without simulation modeling).

Analysis of simulation results

Within the research a simulation model of order fulfillment process was developed. It contains general representation of information and goods flows that move from main supply chain actors (as customers, focal company TOOLS Molde and suppliers). The model reflects main performance characteristics of the process that are important for the company and the supply chain.

Basic model represents the process as it was performed at the moment of the research. Main performance characteristics of the model correspond to parameters of the real process that took place in the supply chain in 2012. A set of modified models was created in order to test some managerial decisions that intend to improve order fulfillment process.

Performed test results showed that in inventory management TOOLS Molde has wide possibilities for improvement of order fulfillment, as well as general performance of the company. Simple changes in article structure on the warehouse will allow company to improve customer service level and decrease costs. For example, decrease of stock for products with rear

demand will help TOOSL Molde to save up to half of stock value (up to 5 MNOK). Of course decrease of inventories will lead to increase of lead times. It is up to management to decide about the tradeoff between capital cost and capital savings. The model will provide managers with necessary quantitative estimations. Other possibility to improve service level is to increase Stock for products with low volatile demand. It will cost company small (and short-term) investments but will result in increased customer satisfaction. Amount of investments is estimated on the level of 10 000 NOK.

Other test result shows that for TOOLS Molde it would be desirable to increase price level for small customers. For example, in case of 5% price growth, with corresponding decrease of demand for 10% or less, it will bring to TOOLS Molde growth of total margin and saving of order processing costs.

If TOOLS Molde will improve reliability of suppliers it will not influence on lead time of products and orders, but will help to prevent big delays in deliveries. If TOOLS Molde will implement the policy of delivering only complete orders (when all products could be delivered at once) average lead time will increase for two days.

6. Managerial Decision Model Discussion

The following chapter provides discussion on managerial decision model developed in this research.

Developed model is based on the following principles:

- holistic approach to business process improvement;
- solid framework of specific instruments;
- system of specific measures and modeling tools for success evaluation.

After the model is implemented and corresponding analysis is done a company receives a set of improvement initiatives that can be used to increase OFP-, company- and supply chain performance.

Initiatives developed with help of the model take into account interfaces between key business processes and, thus, OFP is improved taking into consideration trade-offs between customer satisfaction and company and supply chain costs. Improvement initiatives in this case suggest optimal OFP configuration for the whole company as a system of business processes rather than aim at local optimization of OFP. Key business processes CRM, IM and SRM which are used as dimensions providing input information for OFP improvement ensure that developed initiatives secure customer satisfaction and cost reduction. In addition model provides some means to manage supply chain complexity and facilitates decision-making process when it comes to the development and choice of specific OFP improvement initiatives due to its holistic character. However, managerial decision model in its current state does not include all the processes that influence OFP in an industrial distributor. One of the most important dimensions demand management is analyzed by using analysis of inventory structure by revenue and demand variability. Therefore OFP improvement initiatives are only to some extent influenced by the demand nature but influence of demand management process on OFP requires further analysis.

Managerial decision model contains set of specific instruments, measures and modeling tools which facilitates OFP improvement in the company and provides a solid business framework for process improvement. These analytical instruments, performance measures and modeling tools are relatively easy to implement and therefore improvement team does not need any special training except basic simulation modeling techniques. However, some companies may consider instruments and metrics used in the model to be oversimplified and may opt to use more sophisticated analytical tools in order to receive higher degree of precision.

Besides, some instruments used in the model receive controversial assessment by business practitioners and scientists. For example some of the researchers consider analysis of customers by profitability an important tool that provides management of the company with critical information about how to treat various customers (Sabath and Whipple (2004), Pfeifer, Haskins, and Conroy (2005), Andon, Baxter, and Graham (2001), van Raaij, Vernooij, and Sander van (2003)). At the same time other researchers consider customer analysis by profitability to be very limited (Giltner and Ciolli 2000). Based on case company analysis this research supports the former point of view. Customer profitability analysis is considered to be an important step in OFP improvement, however it should be combined with customer segmentation be customer requirements.

In the case study part of this paper customer segmentation according to service requirements was done with help of graphical method offered by Aleskerov (2013). Method offered by Aleskerov (2013) initially developed to define buying behavior of customers in retail stores was adapted for the purpose of this paper to segment industrial customers. This simple method provides relatively precise results and allows effective and fast grouping of customers into segments. However, this method has been used in business and research to a limited extend and therefore might have some errors.

In addition, what concerns instruments suggested by the model, inventory analysis and classification instruments provide mainly statistical assessment of the inventory and demand without taking into account complex nature of products sold. There are other techniques that can be used by companies to receive more precise inventory input information for OFP improvement.

The application of the model was demonstrated on an example of a case company and received set of improvement initiatives is expected to foster OFP-, company and supply chain performance according to simulation tests. This allows to assume that model may be implemented in a real life by business practitioners. However, a real case application of managerial decision model is conducted by means of single case study. Due to that fact this research is not able to conclude with high enough degree of certainty that managerial decision model developed is appropriate to use for industrial distributors in WME&S industry. Besides, managerial decision model has some limitations concerning case study performed for the purpose of the research. These are mainly connected to the data analysis, first of all, related to the received internal data of a case company which required some cleaning before analysis could be

performed (all the data that were considered suspicious based on the common sense were excluded from the data set). Therefore received results could lose some degree of precision compared to the real life data.

Another limitation connected to case study is that customer survey was used to collect information about customer service requirements. Conclusions about customer service requirements or satisfaction that were made may have all typical limitations of the survey such as dependency of conclusions on subjective opinion, possibility to receive sampling errors and/or invalid information due to respondent inhibitions, indifference to the topic of the research. In order to receive more reliable results amount of customers participating in the survey should be increased, some questions should be modified and statistical analysis of responses should be performed.

Besides, simulation model built in the case study could not be considered as complete one (like any model in principle) as far as it includes only parameters that are relevant for the present research. It contains very simplified model of OFP that represents the process in general. Amount of managerial decisions that could be tested using current modification of the model is quite limited. The model includes inventory management process simulation by using only decision making parameters without representation of actual inventory level. Also from the side of supplier and customer OFP is represented in a highly generalized manner. The model is functioning under conditions of “normal” demand. It means that it does not reflect demand fluctuations during Christmas, Easter and so on (but in reflects demand fluctuations during the week). Also the model does not reflect delivery of some products according “delivery solutions”. For more realistic reflection of OFP it would be important to develop the model by implementing products delivered according “delivery solution” as well as demand fluctuations within a year.

Taking into account both strengths, weaknesses and limitations of a model this paper concludes that developed managerial decision model can be implemented in a real-life by business practitioners. In spite of some weaknesses the model can be valuable for company implementing it provides a set of improvement initiatives which increase OFP-, company- and supply chain performance.

7. Conclusions and Further Research

The following chapter is the final part of the research. It provides conclusions of the research and suggests main directions for further research.

7.1. Conclusions

The main goal of the research is to develop a managerial decision model for OFP improvement for industrial distributor in WME&S industry and demonstrate its real case application.

The first two research questions explored in this paper: identify specific WME&S industry features and appropriate business process improvement approach, predetermined that developed model is based on WME&S industry characteristics and on holistic approach to BPI. Industry specificity predetermined the answer to the research question about dimensions of analysis and methods used for OFP improvement. Developed model embraces CRM, IM and SRM as main input processes for OFP improvement as these processes are considered to be one of the most important ones for the industry. Besides, according to the former research question model suggests specific set of instruments corresponding to each of the business processes: customer segmentation by revenue, profitability and other descriptive characteristics and by service requirements; inventory classification by SKU revenue, SKU profitability, by SKU usage or demand variability and by SKU stock keeping value; customer/ product profitability matrix and supplier segmentation by service level and supplier portfolio models by risk and purchasing share. With respect to the research question about success evaluation of OFP improvement developed model suggests such performance measures as lateness, lead time, severity and responsiveness and other; and simulation modeling as a modeling tool to evaluate impact of improvement initiatives on OFP-,company- and supply chain performance.

In general the model provides a solid framework for OFP improvement in the WME&S industry. Therefore the model itself can be considered a theoretical contribution. First of all, the main advantage of a model is that it provides a solid holistic framework for OFP improvement that takes into account main managerial trade-offs (customer satisfaction improvement vs. cost reduction) and ensures that received improvement initiatives are aimed at systems' improvement rather than at improvement of one local process.

Second, according to the performed research developed model can be relatively easily generalized for other companies in the industry, other industries and other processes within a

given company. Any company which is situated in the middle of supply chain and therefore has CRM and SRM processes as well as IM process may use the model in order to improve OFP. As developed model is based on a holistic approach it potentially may be used to improve other key business processes in a given company as all the key business processes interact with each other through input and output information. For example, manufacturing flow management process improvement requires same input from CRM, demand management and SRM. Therefore this model can be used without any significant changes except a broader analysis of demand management which currently is included into inventory management. Any process which depends on CRM and SRM input information may be analyzed with help of developed model: demand management, customer service management, manufacturing flow management, product development and commercialization and returns management. To be implemented for improvement of these processes the model needs to undergo minor adjustments. It also can be used to improve CRM or SRM processes but to a limited extent.

To answer a second sub-problem a real case application of a model is demonstrated on the example of TOOLS Molde which is considered a typical industrial distributor operating in WME&S industry. According to the results of conducted case study this paper concludes that managerial decision model can be used in a real-life by business practitioners in order to improve OFP-, company- and supply chain performance.

Managerial decision model highlights interdependence of key business processes in the company and provides business practitioners with specific instruments that can be used to receive input for OFP improvement taking into account typical managerial trade-offs such as a trade-off between customer satisfaction and costs. Therefore model contributes to the industry development. On the example of case study it was shown that valuable OFP improvement initiatives can be developed with help of the model. These improvement initiatives are based on customer importance for the company, customer service requirement and if implemented will improve OFP for important customers and increase customer satisfaction and, thus, company- and supply chain performance. Besides, improvement initiatives take company costs into consideration and make it possible to achieve the highest customer level possible under inventory costs and supply cost or service constraints and develop better inventory and supply policy that will comply with customer requirements.

However there are some weaknesses of a model the main one of which is that model considers only limited amount of key business processes as input for OFP improvement and such business process as for example demand management is only briefly analyzed within IM. Besides, possibility of application of the model was demonstrated by means of single case study and therefore it can not be concluded without any doubt that this model can be implemented by business practitioners.

To our knowledge there are no similar models for OFP or other key business process improvement developed before. This research concludes that in spite of some weaknesses managerial decision model can be used for OFP-, company- and supply chain performance improvement which was demonstrated with help of case study example of TOOLS Molde.

7.2. Further Research

The following paragraph provides some direction for future research which are mainly connected to two areas: limitations of the model and case study results.

First, it is recommended to do investigate and introduce more sophisticated instruments into the model in order to provide higher level of precision and greater range of improvement initiatives developed with help of managerial decision model.

Second, in order to conclude with higher degree of certainty that the model can be implemented in real life further research by means of multiple case study is recommended. It will allow to evaluate statistically whether the developed managerial decision model facilitates order fulfillment improvement and whether significant improvements might be achieved using the model.

In addition further research should focus on more thorough description of other key business processes that provide input information for OFP improvement. In particular it is necessary to describe demand management process and corresponding instruments that can be used in order fulfillment improvement. Other key business processes identified by Global Supply Chain Forum might also be included into model in order to provide greater precision and explore other areas where OFP can be improved.

Directions for further research based on the case study results are as follows:

- Study other branches of B&B TOOLS within developed managerial decision model framework and create a coordinated management policy (for SRM; IM and CRM) to realize synergy effects of B&B TOOLS Group.

- Study OFP improvement on operational level and develop program to implement improvements (including improvement of information flow with a help of ERP solutions).
- Study relationship of TOOLS Molde with suppliers and customers from the position of industrial buyer-supplier dependency theory and generalize conclusions for the case of B&B TOOLS.
- Develop a model of coordinated inventory management policies between different branches of B&B TOOLS.
- Optimize transportation routes and networks from suppliers to B&B TOOLS branches.
- Expand the simulation model of OFP (for example include inventories to the model, present a process on a map with possibilities to optimize geographical locations of facilities). Introduce system dynamics model and coordinate it with simulation model.

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Appendix

A. Survey for customers of TOOLS Molde

Undersøkelse for kunder av TOOLS AS

Vi vil gjerne stille deg og din bedrift noen spørsmål angående innkjøp av produkter som leveres av TOOLS AS. Vi tenker her på innkjøp av industrielle forbruksvarer og industrielle komponenter slik som verktøy, maskiner, personlig verneutstyr, festeelementer og arbeidsplassutstyr.

Bedriftens navn (valgfritt)

Stillingen til respondenten (valgfritt)

Bedriftens hovedbransje

Velg alternativ ▼

Ca antall ansatte?

- 1-10
- 11-20
- 21-50
- 51-100
- 101-300
- mer enn 300

Hvor lenge har TOOLS AS vært leverandør til din bedrift?

- Mer enn 10 år
 - 5 - 10 år
 - 3 - 4 år
 - 1-2 år
 - Mindre enn 1 år
 - Vet ikke
-

Hva er årlig beløp (totalt for alle leverandører) for kjøp av industrielle forbruksvarer (verktøy, maskiner, personlig verneutstyr, festelementer og arbeidsplassutstyr)?

- Mer enn 5 000 000 NOK
 - 1 000 001 – 5 000 000 NOK
 - 500 001 – 1 000 000 NOK
 - 100 001 – 500 000 NOK
 - 50 001 – 100 000 NOK
 - Mindre enn 50 000 NOK
-

Har din bedrift alternative leverandører til TOOLS AS (for produkter som ligner på hva du bestiller fra TOOLS)?

- TOOLS er vår eneste leverandør for en rekke produkter
- Vi kan velge mellom TOOLS og andre leverandører, men som regel foretrekker vi å bestille fra TOOLS
- Vi foretrekker å bestille fra andre leverandører, men noen ganger bestiller vi fra TOOLS
- Vi har ulike leverandører å velge mellom og vårt eneste kriterie er om leverandøren kan oppfylle vår bestilling i tide
- Vi kan ikke gi deg denne informasjonen
- Other

Undersøkelse for kunder av TOOLS AS

Hvor viktig er følgende faktorer for din bedrift når dere skal bestille industrielle forbruksvarer hos en leverandør? Evaluere det fra 1 til 7 for din bedrift (1 er Ikke viktig, 7 er Svært viktig):

	Ikke viktig						Svært viktig
	1	2	3	4	5	6	7
Leveringstid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: riktig produkt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: til avtalt tid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: korrekt og tidsriktig dokumentasjon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Komplett leveranse (en ordre leveres i én leveranse)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pris	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kvalitet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Høy produktvariasjon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muligheten til å ha en tilpasset tjeneste (som f.eks. merking)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Produktdesign	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fleksibilitet i bestillingen (mulig å endre betingelsene for bestillingen før endelig levering)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nivået av kundestøtte (rådgivning, informasjonsstøtte)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tjeneste etter kjøpet (Reklamasjon, service)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tilgjengelighet av produkt/merkevarer fra bestemte leverandører	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Punktlighet og vilje til å korrigere feil i leveranser	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Har du utfyllende kommentarer til noen av faktorene nevnt ovenfor?

Undersøkelse for kunder av TOOLS AS

Hvor godt mener du at TOOLS tilfredsstill disse kravene for din bedrift? Evaluere det fra 1 til 7 for din bedrift (1 er Ikke tilfreds, 7 er Svært tilfreds):

	Ikke tilfreds						Svært tilfreds
	1	2	3	4	5	6	7
Leveringstid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: riktig produkt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: til avtalt tid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveringspresisjon: korrekt og tidsriktig dokumentasjon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Komplett leveranse (en ordre leveres i én leveranse)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pris	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kvalitet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Høy produktvariasjon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muligheten til å ha en tilpasset tjeneste (som f.eks. merking)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Produktdesign	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flexibilitet i bestillingen (mulig å endre betingelsene for bestillingen før endelig levering)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nivået av kundestøtte (rådgivning, informasjonsstøtte)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tjeneste etter kjøpet (Reklamasjon, service)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tilgjengelighet av produkt/merkevarer fra bestemte leverandører	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Punktlighet og vilje til å korrigere feil i leveranser	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Har du utfyllende kommentarer til noen av faktorene nevnt ovenfor?

Undersøkelse for kunder av TOOLS AS

Vennligst anslå gjennomsnittlig ledetid for varer som din bedrift bestiller fra TOOLS (ledetid: fra det øyeblikk bestillingen er plassert til elementer er tilgjengelig for bruk).

- levering samme dag
 - 1 til 2 dager
 - 3 til 4 dager
 - 5 dager til 1 uke
 - 1 uke til 2 uker
 - mer enn 2 uker
 - Other
-

Hvis TOOLS reduserer prisen med 5%, vil din bedrift da øke innkjøpsmengden av produkter?

- Ja, men ikke mer enn 5%
 - Ja, vi vil kunne øke innkjøpet med 5% til 10%
 - Ja, vi vil kunne øke innkjøpet med mer enn 10%
 - Nei, det vil ikke ha noen innflytelse
-

Hvor fornøyd er du med tjenester og produkter som tilbys av TOOLS ?



Undersøkelse for kunder av TOOLS AS

Er din bedrift interessert i noen av disse integrasjonsløsningene og leveringsløsningene med TOOLS AS?

	Har det allerede	Er interessert	Er ikke interessert	Other	
Toolstrade	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
2 boks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Floorstock	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Ordre app	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Containerløsning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Annet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>

Hvilke tilleggstenester fra TOOLS kan være av interesse for din bedrift?

- Vi ønsker å vite nåværende leveringsstatus for vår bestilling
 - Vi ønsker å vite før bestilling forventet leveringtid for produkter vi er interessert i
 - Vi ønsker å ha prøveeksemplar av de produktene vi bestiller.
 - Vi ønsker å ha et standard bestillingskjema for å sende bestillinger til TOOLS.
 - Vi ønsker at ansatte i TOOLS hjelper oss å velge produkter som passer best for vår produksjonsprosess.
 - Vi ønsker å ha en mulighet til selv å hente bestillingen hos TOOLS.
 - Other
-

Har din bedrift et ERP-system?

- Ja
- Nei, men vi planlegger å ha et
- Nei, og vi trenger ikke det for øyeblikket

If “Ja”

Hva er navnet på bedriftens ERP-system:

If “Nei, men vi planlegger å ha et”:

Når planlegger din bedrift å få ERP?

- 2013-2014
- 2015-2017
- Senere enn 2017

Hva slags ERP-system planlegger din bedrift å anskaffe?

Planlegger din bedrift etterspørsel etter industrielle forbruksvarer?

- Ja, vi planlegger vår etterspørsel.
- Nei, vi planlegger det ikke, men vi har kapasitet/kompetanse til å gjøre det.
- Nei, vi har ikke kapasitet/kompetanse til å planlegge etterspørselen.
- Nei, etterspørselen er umulig å forutsi.
- Other

If «Ja, vi planlegger vår etterspørsel»:

For hvilket tidsperspektiv kan dere prognostisere med 90% sannsynlighet deres behov?

- Over 6 måneder
- 4 - 6 måneder
- 2 - 3 måneder
- 3 uker - 1 måned
- 1-2 uker
- 4-5 dager
- 2-3 dager
- 1 dag

Kan din bedrift dele etterspørselsprognoser med TOOLS (uten forpliktelser for din bedrift)?

- Ja, vi kan og vi gjør det i dag.
- Ja, vi kan, men vi gjør det ikke for øyeblikket.
- Nei, disse dataene er konfidensielle
- Other

If «Nei, vi planlegger det ikke, men vi har kapasitet/kompetanse til å gjøre det»:

Vær snill å forklare hvorfor din bedrift ikke planlegger etterspørselen?

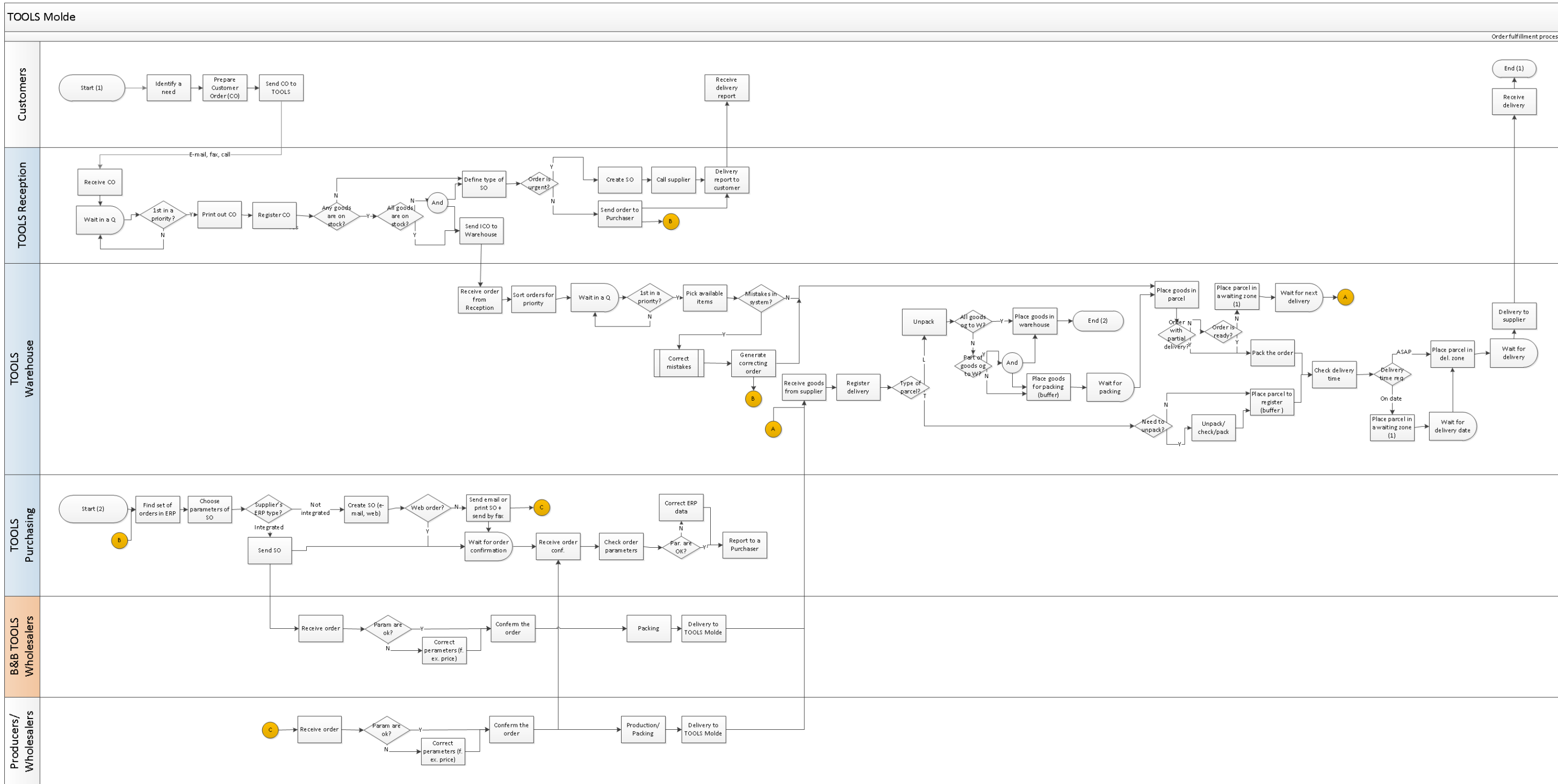
For hvilket tidsperspektiv kan dere prognostisere med 90% sannsynlighet deres behov?

- Over 6 måneder
 - 4 - 6 måneder
 - 2 - 3 måneder
 - 3 uker - 1 måned
 - 1-2 uker
 - 4-5 dager
 - 2-3 dager
 - 1 dag
-

Kan din bedrift dele etterspørselsprognoser med TOOLS (uten forpliktelser for din bedrift)?

- Ja, vi kan og vi gjør det i dag.
- Ja, vi kan, men vi gjør det ikke for øyeblikket.
- Nei, disse dataene er konfidensielle
- Other

B. Order fulfillment process map



C. Data for simulation model

Diversity of product groups in the order

number of groups	G1	G2	G3
1	40,55 %	58,93 %	79,77 %
2	22,76 %	24,36 %	15,87 %
3	15,84 %	10,53 %	3,78 %
4	10,61 %	4,23 %	0,33 %
5	6,64 %	1,52 %	0,00 %
6	2,44 %	0,43 %	0,25 %
7	0,85 %	0,00 %	0,00 %
8	0,26 %	0,00 %	0,00 %
9	0,03 %	0,00 %	0,00 %

Ordering frequency of different product groups

Probability for product group to be of N type	G1	G2	G3
AX	5,41 %	2,84 %	0,39 %
AY	13,92 %	9,23 %	0,98 %
AZ	29,69 %	32,78 %	19,37 %
BX	0,26 %	0,00 %	0,00 %
BY	4,94 %	1,66 %	0,26 %
BZ	24,17 %	27,98 %	31,15 %
CX	0,41 %	0,00 %	0,13 %
CY	1,32 %	0,10 %	0,20 %
CZ	19,88 %	25,41 %	47,51 %

Fill rate P2

Product group	Probability to be on stock
AX	80,0 %
AY	90,5 %
AZ	59,3 %
BX	75,0 %
BY	87,7 %
BZ	46,1 %
CX	90,9 %
CY	95,7 %
CZ	40,6 %

Probability that the order of of type T in “order processing block”:

Probability to have a T order	
AX	8,1 %
AY	9,2 %
AZ	28,7 %
BX	50,0 %
BY	13,7 %
BZ	35,8 %
CX	4,9 %
CY	9,2 %
CZ	47,7 %

Probability distribution for different orders to be purchased from specific supplier:

Order type	Leverage supplier	Preference supplier	Routine supplier	Strategic supplier
L orders	78 %	3 %	17 %	2 %
Orders from G1	71 %	1 %	27 %	1 %
Orders from G2	70 %	0 %	29 %	0 %
Orders from G3	67 %	3 %	29 %	0 %

Probability distribution for weekly demand within week days:

Week day	Orders from G1	Orders from G2	Orders from G3	L orders
1	16,40 %	17,38 %	23,77 %	20,42 %
2	20,77 %	19,19 %	20,27 %	16,75 %
3	21,42 %	18,91 %	20,81 %	19,76 %
4	25,79 %	23,53 %	17,22 %	24,48 %
5	15,30 %	20,82 %	17,58 %	18,57 %
6	0,04 %	0,06 %	0,00 %	0,00 %
7	0,29 %	0,11 %	0,36 %	0,02 %

Probability distribution for delivery duration from different suppliers:

Suppliers	Average delivery (days)	StdDev of delivery
Leverage	3,50	3,97
Preference	8,81	27,12
Routine	4,31	2,50
Strategic	5,63	4,95

D. Demand distribution analysis

Table 30. Results of the randomness test of demand for customer groups I, II and III. Minitab report tables.

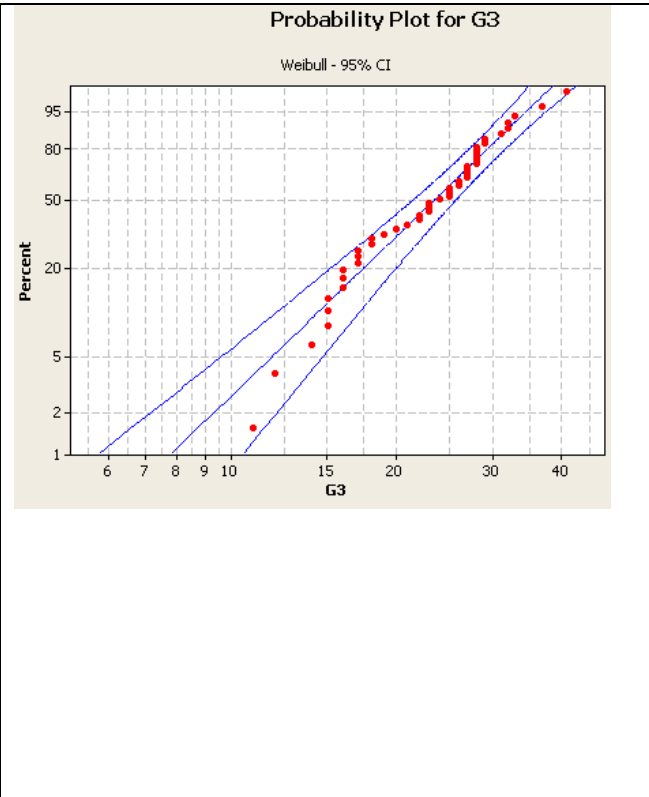
Demand from customers of Group 1	Probability plot																																																																																																																																																
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Goodness of Fit Test

Distribution	AD	P	LRT	P
Normal	0,475	0,229		
Box-Cox Transformation	0,548	0,150		
Lognormal	0,742	0,049		
3-Parameter Lognormal	0,557	*	0,273	
Exponential	10,623	<0,003		
2-Parameter Exponential	4,091	<0,010	0,000	
Weibull	0,441	>0,250		
3-Parameter Weibull	0,521	0,174	0,138	
Smallest Extreme Value	0,927	0,018		
Largest Extreme Value	0,782	0,040		
Gamma	0,618	0,114		
3-Parameter Gamma	0,572	*	0,775	
Logistic	0,571	0,094		
Loglogistic	0,805	0,021		
3-Parameter Loglogistic	0,610	*	0,311	

ML Estimates of Distribution Parameters

Distribution	Location	Shape	Scale	Threshold
Normal*	23,40000		6,75008	
Box-Cox Transformation*	4,78665		0,70645	
Lognormal*	3,10964		0,30315	
3-Parameter Lognormal	4,01426		0,11970	-32,37993
Exponential			23,40000	
2-Parameter Exponential			12,68182	10,71818
Weibull		3,82859	25,88041	
3-Parameter Weibull		2,33659	16,48795	8,79084
Smallest Extreme Value	26,80002		6,90560	
Largest Extreme Value	20,13279		5,98179	
Gamma		11,76570	1,98883	
3-Parameter Gamma		21,15855	1,46260	-7,54645
Logistic	23,35829		3,90464	
Loglogistic	3,12700		0,17601	
3-Parameter Loglogistic	4,54505		0,04152	-70,93480



Internal demand for TOOLS Molde "L orders"

Goodness of Fit Test

Distribution	AD	P	LRT	P
Normal	0,448	0,267		
Box-Cox Transformation	0,448	0,267		
Lognormal	0,519	0,178		
3-Parameter Lognormal	0,422	*	0,204	
Exponential	15,145	<0,003		
2-Parameter Exponential	8,391	<0,010	0,000	
Weibull	0,799	0,036		
3-Parameter Weibull	0,541	0,119	0,111	
Smallest Extreme Value	1,390	<0,010		
Largest Extreme Value	0,990	0,012		
Gamma	0,447	>0,250		
3-Parameter Gamma	0,425	*	0,474	
Logistic	0,323	>0,250		
Loglogistic	0,345	>0,250		
3-Parameter Loglogistic	0,311	*	0,401	

ML Estimates of Distribution Parameters

Distribution	Location	Shape	Scale	Threshold
Normal*	715,67391		116,35999	
Box-Cox Transformation*	715,67391		116,35999	
Lognormal*	6,55986		0,16750	
3-Parameter Lognormal	8,13027		0,03386	-2681,98263
Exponential			715,67391	
2-Parameter Exponential			306,33017	409,34065
Weibull		6,55100	764,70807	
3-Parameter Weibull		3,61497	425,63433	331,09994
Smallest Extreme Value	774,15698		120,00108	
Largest Extreme Value	658,58193		115,06494	
Gamma		37,57323	19,04744	

