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The Impact of Customer Order Lead Time-Based Decisions on the Firm's Ability to Make Money

Case Study:
Build to Order Manufacturing of
Electrical Equipment and Appliances

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Tiivistelmä

Vuosikymmenten ajan tieteellisissä julkaisuissa on käsitelty toimitusnopeuden ja -joustavuuden tärkeyttä kilpailukyvyn ylläpitämisessä ja parantamisessa. Näiden tutkimusten ulkopuolelle ovat kuitenkin monesti jääneet toimialat, joissa valmistetaan tuotteita asiakastilauksille. Tästä syystä monilta teollisuuden osa-alueilta, kuten sähkölaitteita ja -kojeita valmistavalta teollisuuden alalta, ovat puuttuneet konkreettiset menetelmät varmentaa asiakastoimitusaikaa koskevien päätösten vaikutukset kannattavuuteen ja asiakastyytyväisyyteen.

Tämän tutkimuksen tavoitteena on todentaa toimitusaikojen ja niihin liittyvien toimitusaikajoustojen vaikutus kannattavuuteen ja asiakastyytyväisyyteen. Tutkimus on suoritettu tapaustutkimuksena kolmessa kansainvälisillä markkinoilla toimivassa, suomalaisessa sähkölaitteita ja -kojeita valmistavassa yrityksessä. Tutkimus suoritettiin haastattelemalla kyseisten yritysten avainhenkilöitä, analysoimalla yritysten tilaus-toimitusrekistereitä ja talouslukuja. Näiden pohjalta luotiin konkreettinen analysointimenetelmä, jonka avulla toimitusaikaan liittyvien joustopäätösten vaikutuksia pystytään vertaamaan kannattavuuteen ja asiakastyytyväisyyteen.

Tutkimuksen tulokset osoittavat, että toimitusaikapohjainen joustavuus vaikuttaa positiivisesti yrityksen kannattavuuteen ja asiakastyytyväisyyteen. Lisäksi tutkimuksessa nousee esille nopeiden toimitusten parempi kannattavuus. Tutkimus osoitti, että nopeat toimitukset voivat olla kannattavampia valmistavalle yritykselle kuin pidemmän ajan toimitukset huolimatta siitä, että nopeiden tilausten hankinta- ja tuotantokustannukset olivat yleisesti ottaen kalliimpia.

Asiasanat

Aikapohjainen, jousto, reagointi, kilpailu, strategia, kannattavuus, asiakastyytyväisyys, tapaustutkimus.

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The Impact of Customer Order Lead Time-Based Decisions on the Firm's Ability to Make Money – Case Study: Build to Order Manufacturing of Electrical Equipment and Appliances

Abstract

The importance of speed as one of the key dimensions for building competitive advantage has been studied for decades. However, the research on how customer order lead time-based decisions impact on competitive advantages, such as profitability and customer satisfaction in build-to order type of manufacturing, is limited. For this reason, many industrial niches lack the tangible methods for testing the actual impact of lead time-based decisions.

This research work addresses the identified gaps by conceptualizing a step-by-step approach and conducting a multi-case study on Finnish based case firms operating in the electrical equipment and appliances business. In this process, key managers and specialists are interviewed and nearly 2000 order delivery transactions from three case firms are analyzed by using correlation analysis.

The results of this study show that time-based flexibility exists and different ranges of time-based flexibility are offered to different customers and customer groups; order level prices can be time-dependent; and a firm gains better profits when it is able to provide shorter order lead times for customers and customer groups. It is also shown that a firm which is able to offer time-based flexibility for certain customers and customer groups without premium pricing the flexibility has the most satisfied customers. An interesting observation in the research is the improved profitability from shorter order lead times even when the firm has to pay price premiums to its sub-contractors for time-based flexibility. The reasons behind this irrational logic of increased purchase costs without increasing the price and still producing better profitability is briefly addressed in this study together with proposals for future research.

Keywords

Time-based, flexibility, responsiveness, competition, strategy, profitability, customer satisfaction, case study.

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Above all, I would like to thank my wife Satu for her support and great patience at all times. Our kids Sara and Patu, and my father Väinö for the understanding and encouragement you all have given me during the years. I cannot thank you enough. The dream has now come true and I want to dedicate this study to you Satu, Sara, Patu and to my father Väinö.

Merikaarto, December 2011

Petri Kärki

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List of abbreviations and definitions

AIDA	Attention, interest, desire, action (marketing approach)
ATO	Assembly to order
BTO	Build to Order
CODP	Customer order decoupling point
COLT	Customer order lead time
ETO	Engineer to order
JIT	Just in time
MTO	Make to order
NPV	Net present value
OTD	On time delivery
PLT	Production lead time
PMCC	Product momentum correlation coefficient (Pearson's)
POLT	Planned order lead time
PPILT	Production packing and invoicing lead time
QRM	Quick response manufacturing
S&OP	Sales and operations planning
TBC	Time-based competition
TOC	Theory of constraints
TPS	Toyota production system
TQM	Total quality management
TTPT	Total throughput time

1 INTRODUCTION

This dissertation studies the impact of time-based order lead time flexibility on profitability in the field of electronic equipment and the appliance manufacturing business sector. First, this chapter briefly introduces the evolution of competition in past decades and what the role of time-based competition in the process of this evolution has been. Second, the background of the study and motivation behind its selection is explained. Third, the research questions and objectives are presented. Fourth, the limitations and scope of the study are discussed. Fifth, the significance of the study is shown. Sixth, the main concepts of the study are described. Lastly, an overview of the structure of the rest of the dissertation is given.

1.1 Evolving complexity of competitiveness

Competition has intensified dramatically over the last decades, even in domains that, in the past, were considered as evolving only slowly. Firms have to compete to maintain their existing prosperity, and even more to enhance it (Porter 2008). They must deliver value to their customers to stay competitive. The firm's value in terms of the customers is to meet or exceed their needs. The value for the company is to do so efficiently. For this purpose every company has a strategy that is focused on competition (Porter 1980). This strategy may have been developed explicitly thorough a process, or it may have evolved through the performances of the various functional parts of the order delivery process (Porter 1980). Evidently, the pace of changes accelerated by globalization is reaching all forms of businesses (Hopp and Spearman 2000; Friedman 2005). More and more firms have found themselves competing in an environment where the traditional dimensions of competition are no longer self-evident (Stalk and Hout 1990; Suri 1998; Handfield 1995; Fine 1998; Hopp and Spearman 2000). As competitive advantage has become temporary, businesses have to evolve to meet the new challenges or they face extinction (Fine 1988). In this day and age, it is obvious that the efficient utilization of labor, material and equipment, together with increased focus on the internal and external quality activities are not enough to keep businesses ahead of the competition. As traditional dimensions like cost and quality have remained critical, time has evidently become one of the most relevant pillars of the competition in most business domains (Hopp and Spearman 2000). Rapid development of new products, together with fast customer order deliveries, are the pillars of time-based competition (TBC) (Stalk and Hout 1990; Blackburn, Elrod, Lindsley and Zahorik 1992; Stalk and Webber 1993; Hopp and Spearman 2000). Research on the creation of competitive advantage and value for customers has been the interest of many researchers in both the academic and manufacturing world. Re-

searchers like Stalk and Hout (1990), Blackburn et al. (1992), Suri (1998), Handfield (1995) and Fine (1998), have emphasized the essence of time in competition. Some researchers like Stalk and Webber (1993) and Fine (1998) have also underlined the negative effects of focusing intensively only on being fast.

1.2 Background and motivation

Background. On time delivery (OTD) along with profit have always been the key measurements ever since I started to work in the field of electrical equipment and appliance manufacturing in 1997. Throughout the years, different process improvement and optimization initiatives such as inventory, manufacturing, office, factory, and supply and value chains were conducted all over the global organization. These initiatives were based on different approaches like Theory of Constraints (TOC), Six Sigma (6σ), Toyota Production System (TPS), Lean manufacturing, and Sales and Operations Planning (S&OP). Despite the different approaches taken, all improvement projects have had two common targets. These targets have been the increasing of profits and decreasing the lead time.

In a time of economic boom many firms, including electrical equipment and appliance manufacturers, experience an increase in demand. When demand exceeds the available capacity many firms tend to increase the order backlog by selling with longer lead times. Increased order lead times can cause issues with on time deliveries and thus customers are more likely to try alternative suppliers, and in the worst case even change the preferred supplier for an alternative one. The loss of sales due to inadequate product or service delivery times is difficult to quantify with the existing system data. Even so, it is obvious that reduction of order lead times means fewer inventories, less rework, higher quality, and less overheads, which ultimately has impact on the bottom line, as less costs (Handfield 1995), the impact of time for a specific order line and item cannot be quantified with the rule of thumb. Despite the fact that the overall benefits of TBC and quick response manufacturing (QRM) have been documented, previous research on cost benefits is quite limited (Tubino & Suri 2000).

Motivation. During my time as a consultant in a corporate operational excellence group I needed to find concrete evidence on the impact of lead time. In order to get concrete evidence, I started to systematically collect project results from different projects on which our internal experts had been working. The focus was to collect the status of the customer order lead time (COLT), production lead time (PLT) and OTD before and after the project in order to indicate the changes. At the same time, I collected the calculated net present value (NPV) for the projects.

As a result, I was able to build a list of lead time improvement that contained results from 15 different projects from the years 2000-2007. The collected values were not available in all of these projects. Thus, all projects could not be analyzed at all levels. However, as shown in Figure 1, the analysis of the results in nine different projects indicates the possible connection between lead time reduction and improvement in OTD.

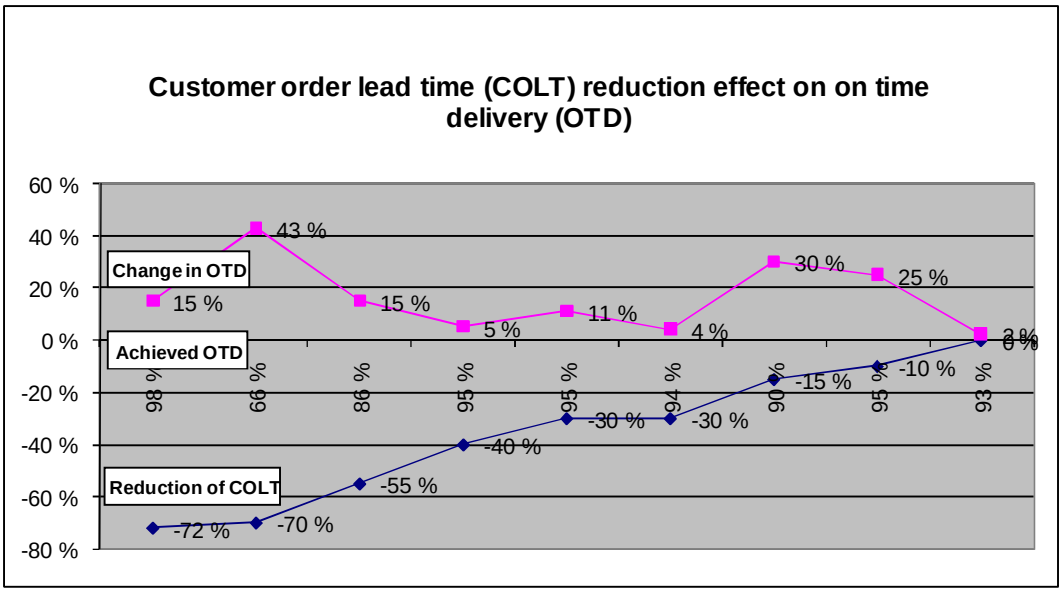

Figure 1. Project specific changes of COLTs, OTDs and achieved OTD levels.

Similarly, as in Figure 1, the PLT reduction appeared to have mostly positive impact on OTD figures in Figure 2.

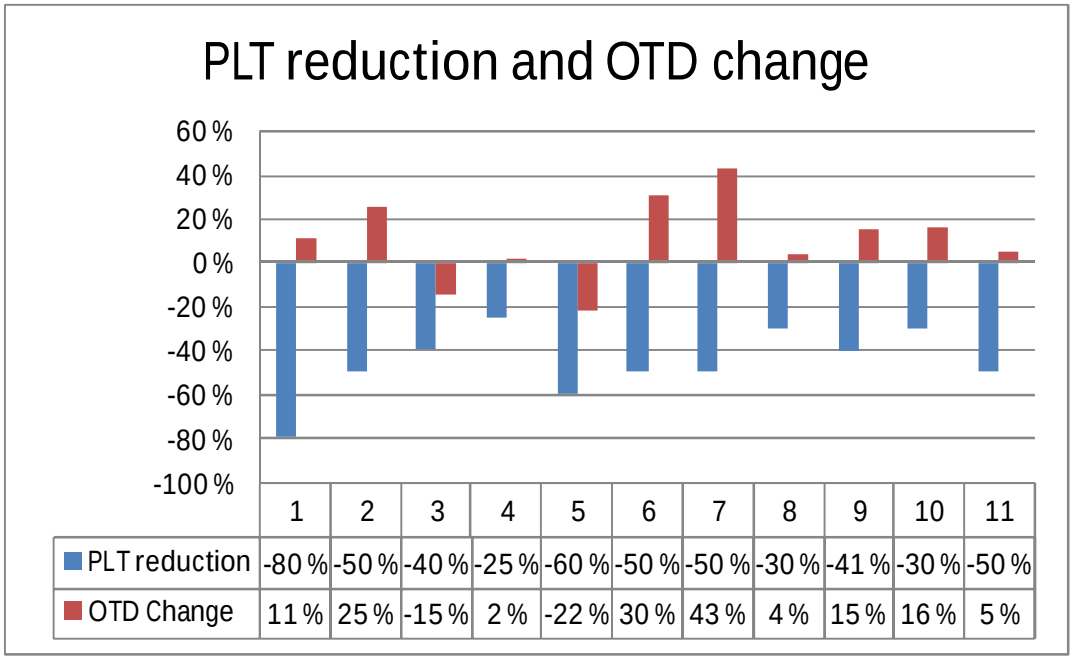

Figure 2. Project specific changes of PLTs and OTDs.

Also the lead time improvement in 15 different projects indicated that lead time reduction had positive impact on OTD (Figure 3).

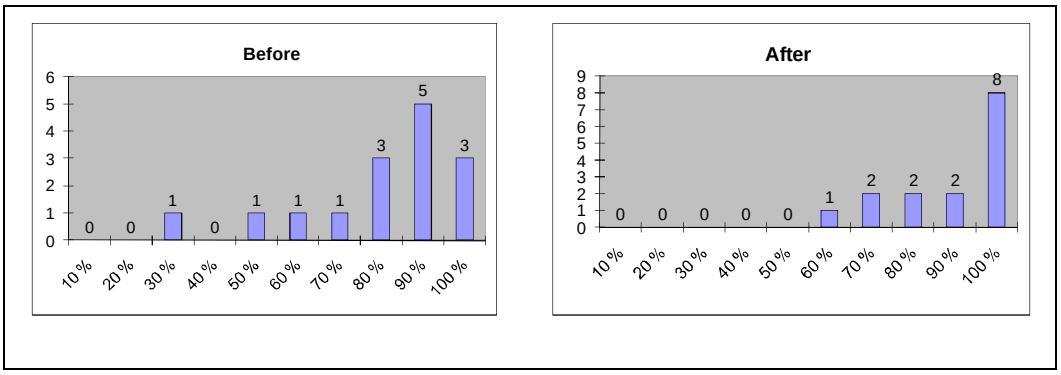

Figure 3. Impact of lead time improvements on OTD improvement.

If the lead time had impact on OTD, the monetary value of the lead time needed to be tested. Here, the focus was to test if the lead time reduction projects have had impact on the calculated NPVs for the projects. As shown in Figure 4, the lead time reduction was likely to impact on the projects´ NPV as to OTD.

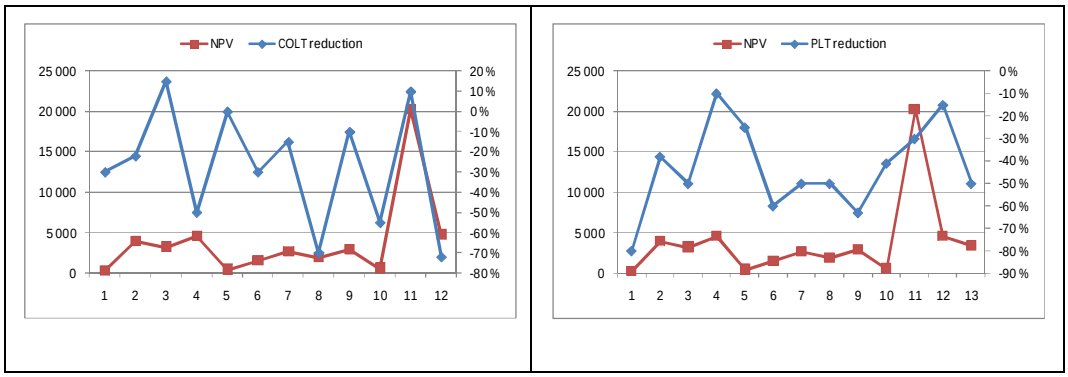

Figure 4. Impact of lead time improvements on OTD improvement.

The preliminary analyses on the lead time impacted OTD. In this industry, improvement in OTD does not only mean satisfied customers but also better profitability through less late delivery penalties. The lead time is also likely to impact on the profitability through less capital being tied up in inventories, less inventory holding costs and higher throughput. Even though the preliminary results were encouraging, the level of detailed information was limited. Also the cost savings and productivity improvement figures used for the NPV calculations were only indicative and calculated values. All this combined with the fact that during the years 2005-2007 firms operating in electrical equipment & appliance manufacturing experienced a significant peak in demand, motivated me to examine the lead time impact in more detail.

This economic boom definitely changed the balance in the scale of the three competitive characteristics, which according to Hopp and Spearman (2000) were cost, quality and speed. As part of manufacturing, quality and cost were emphasized a lot, but speed, also known as order lead time, has not been considered as measurable in the firms. The speed of the order lead time seemed to increase a notch as a competitive dimension during this period, for two reasons. First of all, quality was something that was self-evident for the customers in the electronic equipment and appliance business. Secondly, prices were very much determined by the competition and markets in the business sector. As such, the importance of speed in the order delivery process appeared to be much more needed as a competitive dimension than in the past.

During that period the pressure on order lead times became obvious through customer needs. Firms pushing their capacities to the limit had to build up a backlog of orders. Increased order lead times placed customer and supplier relationships under pressure. This period appeared to be a perfect opportunity to test whether speed in the order lead time was really essential. Many firms had already spent endless hours trying to benchmark the competition to achieve best practice com-

petitive strategy for their business, only to discover that they had only limited access to information on their competitors. Limited business intelligence on competitors´ order delivery processes and their profitability provided no further information on the competitive advantages of different order lead times. However, this dead-end turned the focus towards highly sensitive information that could be made available through existing business contacts. The available information was on order delivery and financial information within the global electronic equipment and appliance manufacturing firm. Here especially, the possibility to explore the speed of order delivery and profitability in detail raised interest in future research work.

1.3 Research objectives and questions

Objective. The objective of this dissertation is to create understanding on how time is used in everyday operations in the electrical equipment and appliance sector. It focuses also on what kind of impact time has had on the profitability of the case firms. This study approaches the objective by constructing a five step model that is followed throughout this research. These steps are to:

1. Conceptually analyze and define the main concepts of the study.
2. Analyze and integrate existing literature on time-base competition and quick response manufacturing to build understanding of the context area of the research and review the opportunity for research.
3. Select the research approach, build a theoretical framework and make hypotheses on the use of order lead time and its impact on profitability.
4. Conceptualize the method of analyzing and testing the hypotheses in the order delivery process of electrical equipment and appliances.
5. Test the concept on case units that meet the criteria set for the research in the field of electrical equipment and appliance manufacturing.

The objectives of this research aim predominantly at understanding the way in which the different case firms in the electrical equipment and appliance sector could benefit, as whole, from sharing best practice information on time-based strategy benefits in this focus area.

Research questions. Prior research on time-base competition and quick response manufacturing raised the first research issue in the field of electrical equipment and appliance manufacturing. The first thing that needed to be tested in one way or another was evidence of whether the selected case firms in the electrical

equipment and appliance sector were using time to provide competitive advantage over their competitors. This was followed by the need to understand whether the case firms were charging customers price premiums for faster order lead times. Finally, knowledge and understanding of the way the different case firms in the field of electrical equipment and appliance manufacturing were operating under the impact of time was tested from two perspectives: (1) profitability and time, and (2) customer satisfaction and time.

This research setup was explored with the following four research questions:

1. Do the case firms deliver similar products with significantly diverging order delivery lead times for different customers and customer groups?

2. Do the case firms ask for a price premium if the customer order lead time is shorter?

3. Is it more profitable for the electrical equipment and appliance case firms to handle order deliveries with a shorter lead time?

4. Are customers more satisfied with firms that can deliver similar products with significantly diverging order delivery lead times?

The first research question is focused purely on testing the use of lead time at the case firm level for selected customer levels. The purpose of this research question is to identify two lead time-related flexibilities. First, this research question is used to identify if individual case firms are offering significantly diverging lead times for different customers and customer segments. Secondly, it is used for showing if lead time flexibility is offered for selected customers. In other words, if a selected customer is offered significantly diverging lead times depending on the order.

The second research question focuses on the value side of the lead time. Here, the focus is on the price. Even though researchers like Suri (1998) disagree with premium pricing faster lead time orders, the temptation to do so exists. Today, more and more companies are able to change their prices in real time to capture the full possible value of goods and services (Sahay 2007). In this case study research, the price was a measurement of what customers were paying or charged by the case firm for the product delivery. In order to test the presence of premium pricing, the price's relation to the lead time was analyzed. The purpose of the second research question is really to see if price premiums were paid by the customer or charged by the case firms on faster product delivery lead times. With the help of the first and second research question the use and pricing of the lead time is studied,

whilst the third and fourth research questions focus on the second part of the research problem: What have the benefits of time been?

The third research question is used for testing the correlations between the speed of order lead time and profitability. This was done by testing the correlation of the order lead time and the reported profitability of the order. In this way, the study was able to scale the time and profit on the 2-axis plot and indicate the correlation with scatter plots and calculated correlation figures.

The fourth research question compares the connection of the strategies chosen by the case firms with measured overall customer satisfaction. A comparison of time-based strategies and customer satisfaction was made for the year 2007. This was the year when all the case firms recorded order deliveries for analysis.

These four research questions of the study were approached by developing a step by step model to collect and analyze the case firms' order delivery information. The focus of this approach was to identify opportunities among different customers and customer segments, recognize the potential of current operations and to point out the benefits.

Figure 5 illustrates the research questions and process for the study. In the main question column on the left are the main questions. In the second, data collection column, the first three approaches for building understanding of demand management strategies can be seen. The sub-questions in the third, sub-question column, were to build up understanding of the deviations in lead times, prices, and their impact on profitability. In the fourth, analysis column the approaches for answering the sub-questions are identified. The fifth, sub-implications column, summarizes the different demand management results. It enables linkage to the second, sub-questions column and to the last, implications column. This allows conclusions to be drawn about the overall implications of the conducted interviews and data analyses.

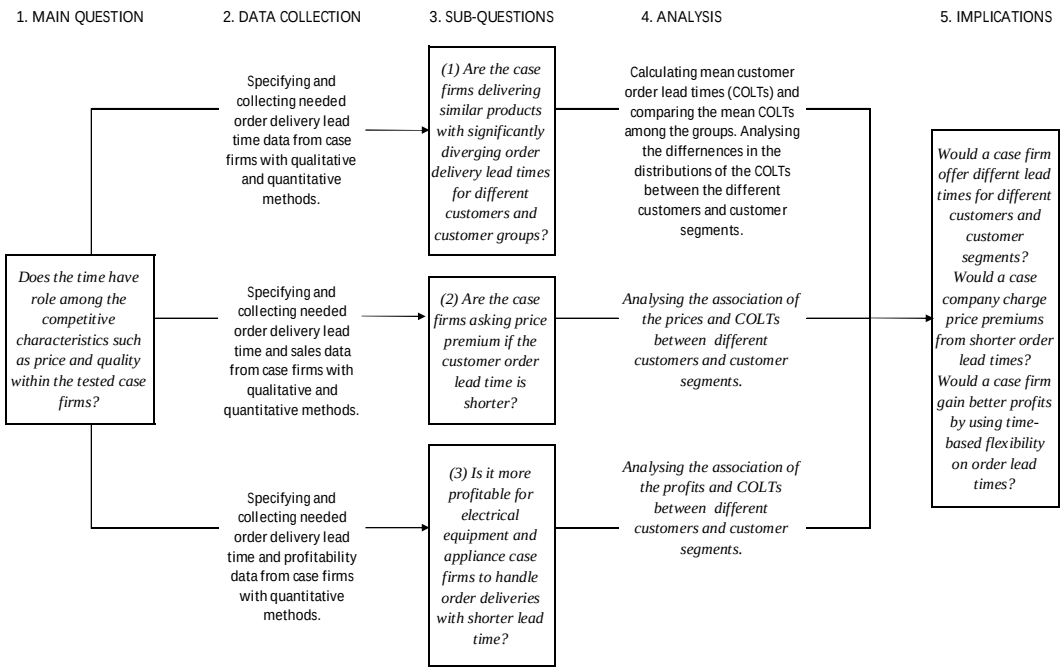

Figure 5. Research questions of the multi-case study.

1.4 Scope and limitations of the study

Scope. The scope of the study was to identify if the speed of order lead time could be the underpinning force of profitability and customer satisfaction. The scope was determined by the knowledge of previous research and by qualitative and quantitative analyses within selected case firms operating in the field of electrical equipment and the appliance manufacturing sector. The base for identifying if the speed of order lead time could be the underpinning force of profitability and customer satisfaction was done by answering two questions: Were different customers and customer groups offered different order lead time speed and if they were charged more for the faster order deliveries?

Even though the importance of the supply chain performance, including inbound and outbound logistics, can have, in some cases, critical impact on the customer order lead times, they are outside of the main scope of this study. This decision was made due to fact that different case firms had different kinds of procurement practices for the key components. As one had the key components in stock, the second one had part of the key components at supplier stock and the third had to make a purchase order for the supplier in order for them to start manufacturing of the key components. Clearly, the order penetration points for the key component orders were different between the case firms and thus could not be compared. Due

to this fact, two out of the three case firms were unable to connect component purchases on specific orders and order lines, which made the comparisons inconvenient.

In order to obtain an applicable framework to analyze the impact of speed of order delivery on profitability and customer satisfaction, the study scope had to be narrowed to firms operating with the same principles and in a similar environment. In order to do so, several limitations were needed.

Limitations. First, this study concentrates on global electrical equipment and appliance manufacturing. This means that the results are not necessarily generisable as true in other businesses. Second, the study focuses on firms based in the same country, Finland. Third, the study investigates firms operating only on a build to order basis. This leaves out all other firms that were operating on a make to stock basis and satisfying the customer demand directly from stocks. Fourth, the study focuses only on selected main products, product families and customers. This case study focuses on main volumes and customers and thus does not contain the entire offering of the case firms nor the complete customer base.

The study also has several case firm related limitations. First, the case firms should not have changed the operation basics for the selected products and product families during the analysis period. With this limitation all the major changes that could affect the results were limited, as well as the number of possible case firms, to an amount that could be handled in the study. Second, the analyzed products should have remained the same without any major changes to the product structures during the analyzed time horizon. This leaves out products with time-based manufacturability changes during the period of analysis. Third, all of the selected case firms had to be profitable during the period of the analyses. This means that the firms were focusing on growing profitable business instead of focusing purely on the cost saving initiatives. Third, all the case firms had to be able to deliver the requested data in a format whereby it could be analyzed.

The gathering of research data was limited to the period 2005 to 2008. However, the time horizon of three to five years, proposed by Porter (2008), was too long in the area of electrical equipment and appliance manufacturing. Three to five years was too long a horizon due to the fact that the life-cycle for many of the products in electrical equipment and appliance manufacturing changes in shorter cycles. First of all, in this focus industry, dynamic forces like market requirements and relentless competition produce several changes. Many of these firms were compelled to develop products in an ever shorter life-cycle time just to stay competitive. Frequently in this field of business the products are constantly changing, with new features, versions and components. Secondly, modules, parts and sub-

assemblies vary, depending on the supplier contracts and agreements. Thirdly, manufacturing methods, techniques, equipment and work schedules change, depending on the market maturity for specific products. Fourthly, the value offering points of the products tend to change with changing market demand and competition. Fifthly, the reporting and control systems change due to systemic changes, bureaucratic and organizational rigidities. For these reasons the selected time period needed to be limited to a time span where the selected product families and production lines had not undergone any major changes that would have significantly impacted on the research results. Thus, this study conducted analysis in case firms that had the same economic background and were operating in the same type of business environment.

1.5 Significance of the study

This study is of significance to the build-to-order (BTO) type of manufacturing domains as it extends the knowledge base that currently exists in that field. The opportunities of time-based competition (TBC) or quick response manufacturing (QRM) are relatively unexplored in the field of electrical equipment and appliance manufacturing, where most of the firms are operating on a BTO basis. Firms in the field of study have made successful efforts to tackle internal costs with Lean and Quality with Six Sigma principles. In this day and age, it is not necessarily enough to focus only on internal optimization. As customers are more aware of how fast they can get the product or service, it has become clear this will influence their buying decisions, together with the price and quality. Today, the focus ought to be satisfying customers in all three dimensions. Thus, if you are able to give the customers what they want (price and quality), when they want it (speed), with understanding of why they want it (business intelligence), you are likely to succeed.

This study provides the means for testing the current operation impact on profitability and customer satisfaction in the field of electronic equipment and appliance manufacturing, as well as for other fields. The study is needed to bring product delivery processes within electrical equipment and appliance manufacturing closer to the customer needs. As such, it enables the electrical equipment and appliance product delivery processes to meet or even challenge the growing competition in this field of operations.

1.6 Research structure

This research consists of six chapters. The first chapter introduces the subject of the research, describes the research problems and objectives of the research, presents the scope and limitations of the research, proves the significance of the research, shows the definition of the main concepts and clarifies the structure of the research. In the second chapter the competitive advantage for industries is presented, and time-based competition literature is reviewed. The third chapter reviews the business opportunity of time in fulfilling customer demand and proposes three main hypotheses for further testing. The fourth chapter describes the approach of the research, environment of the conducted research, sources of the acquired data, methodology of the data collection, methods of data analysis, data interpretation, and the validity and reliability of the analysis. The fifth chapter presents the results of the tested four hypotheses in three different case firms. The sixth, and last, chapter introduces the conclusions of the case study, compares the case firms with others, indicates the managerial implications and proposes future research areas.

2 TIME-BASED LITERATURE REVIEW

2.1 Literature review approach

This chapter concentrates on the conceptual context of time as a competitive characteristic, namely reviewing the literature on time-based competition and the impact of order delivery speed on the firm´s profitability. The chapter presents an overview of relevant previous research on how time has been used and what prior research has claimed in terms of the impact of time on businesses in general.

A review of existing literature in this study is divided into two parts. Section 2.2 discusses briefly the link between time and manufacturing processes with case examples and introduces some of the most known techniques and approaches that emphasize the importance of time in manufacturing. In Section 2.3 the literature review is taken deeper into time-based manufacturing and competition. This is done by using Harzing's Publish or Perish tool. Section 2.4 focuses on different literature approaches that try to quantify the benefits of time and the impact of time on other areas of performance. Section 2.5 introduces the basic requirements for building competitive advantage. In Section 2.6 the literature review studies different manufacturing strategies. Here, the focus is on how the re-balancing of the different manufacturing capabilities could build competitive advantage. Section 2.7 summarizes the literature review and presents research gaps in terms of this dissertation.

2.2 Time as an approach for creating competitive advantage

Time is often a common aspect in sources of advantage when firms continually search for the elusive combination of resources and capabilities that yield differential financial performance (Thomas 2008). A number of firms like AT&T, General Electric, Hewlett Packard, Northern Telecom, Toyota and Seiko have all recognized the importance of shorter delivery lead times in providing strategic advantage (Bowel et al. 1988). In 1986, Northern Telecom discovered something important about their company. They found that all the things that were vital to their long term competitiveness had one thing in common; time. Every improvement they wanted to make had something to do with squeezing time out of their processes. Suddenly, it was very clear that what they needed to do to satisfy their customer needs was the ability to do things faster. Ever since, the people at Northern Telecom did not ask the question: "How much will it cost to deliver a

quality product, and how long will it take?" Instead, the question they asked was: "How quickly can we deliver a quality product, and how much will it cost?" (Merrills 1989).

Time as strategic competitive dimension emerged from manufacturing that dates back to the late 19th century, when Frederick Taylor proposed the use of time study to improve productivity. In his approach each job was divided into smaller elements, and each element had standard time, which was determined by time study experts. (Niebel 1998). Later, Henry Ford successfully embedded these techniques into his automotive assembly lines and developed the world's most efficient and timely system for producing cars (Bockerstette and Shell 1993). In the early 1980s, Toyota developed a system for producing small quantity production that eliminated waste and reduced costs. The success of this system introduced a revolutionary just-in-time (JIT) and automation with human touch concepts for manufacturing practices (Ohno 1978, 1988).

In most business environments time can be argued to be one of the key characters and indicators of a company's success. It seems that companies need greater capabilities to respond more quickly to market dynamics and varying demand (Fernandes and Carmo-Silva 2006). Technological advances created the means for measuring the impact of time, and growing global competition and continuously changing customers' behavior have led manufacturing firms to the constant evolution of competitive paradigms. For this business environment, time-based competition has emerged as the basic competitive paradigm since 1990 (Porter 1980; Hum and Sim 1996; Alasoini 2007). However, time itself is not a new concept. Over two decades ago, in 1988, George Stalk Jr., stated in the article *"The Time Paradigm"* that: *"Time is a secret weapon of business"*. Although the statement is old and certainly no secret anymore, time and responding fast to customer needs is secretly used by some of the most successful businesses today. These firms provide leverage by means of speed. The growth rate of these businesses has been claimed to be at least three times as fast as their industries and earns profits of more than twice the average of their competitors (Stalk & Hout 1988).

2.2.1 Toyota Production System, lean and time

Researchers such as Liker (2004); Womak, Jones, Roos (1990); Shimokawa and Fujimoto (2009) have claimed that the time-based approach originates in mid-20th century Japan. Womack coined the term lean production to describe the approach which was initiated by Toyota Production System (TPS) in Japan (Womack, Jones and Roos 1990). Shimokawa and Fujimoto (2009) claimed that TPS was developed in the 1940s, 1950s and 1960s at the Toyota car manufacturing plant in

Japan. Several researchers have claimed the TPS was introduced to the western world as lean production, and that it started rapidly to partly replace the philosophy of mass production introduced earlier by Henry Ford (Womack, Jones and Roos 1990; Liker 1998; Shimokawa and Fujimoto 2009). However, Holweg (2007) sheds new light on the development of TPS and lean manufacturing. He has taken the research outside the comfort zone of previous western approaches and provided evidence which indicates that Toyota's production managers (e.g. Kiichiro Toyoda, Taiichi Ohno, and Eida Toyoda) have integrated elements of the Ford system in a Japanese environment, creating a hybrid system that was neither purely original nor totally imitative.

It was the 1970s and 1980s when Toyota caught the world's attention (Levinson and Rerick 2002; Liker 2004); however, it was not in terms of progressive car designs or performance, though the ride was smooth and design was often very refined. "It was the way that Toyota engineered and manufactured the autos that led to unbelievable consistency in the process and product…Toyota designed the autos faster, with more reliability, yet at competitive cost, even when paying the relatively high wages of Japanese workers." Despite the faster speed and higher wages, "Toyota is far more profitable than any other auto manufacturer." (Liker 2004). According to Holweg (2007), there are six critical points that will explain the blossoming of Toyota at that time:

1. Cost advantage: Japan was seen to have lower wage rates despite the claims from Liker (2004). The local currency rate against the dollar and lower cost of capital were the elements that created a relatively "unfair playing field".

2. Luck: Fuel efficient cars by Toyota during the energy crisis.

3. "Japan Inc.": Japan's Ministry of International Trade and Industry was suspected of setting a large-scale industrial policy.

4. Culture: The difference between Japanese culture and many others allowed for more efficient production.

5. Technology: The use of highly automated production.

6. Government policy: Trade barriers against the U.S., less strict labor laws, and a national health care program lowered the overall labor costs in Japan.

Whatever the reasons behind Toyota's success actually were, the foundation of the operational success of lean production was on the elimination of waste. It included elimination of all forms of waste in processes, including waste of work-in-process (WIP) and finished goods inventories, which are the earmark of mass production (Womack, Jones and Roos 1990; Liker 1998; Levinson and Rerick

2002). By the elimination of waste, lean production focused heavily on reducing the cycle time between customer order and shipping date. (Womack, Jones and Roos 1990; Liker 1998).TPS is the basis for much of the "lean production" movement, which has been one of the manufacturing trends dominating for the past 10 years or so (Liker 2004). The basic principles of lean production pointed out by Womack and Jones in their book "Lean Thinking" (2003) define it as a five step process: "Defining customer value, defining the value stream, making it "flow", "pulling" from the customer back, and striving for excellence." The five step process focus is on ensuring the product flow through value-adding processes without interruption. (Liker 2004). The same was said by the founder of TPS, Taiichi Ohno, even more succinctly: "All we are doing is looking at the time line, from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes." (Ohno 1988).

"Managing time has enabled top Japanese companies not only to reduce their costs, but also to offer broad product lines, cover more market segments, and upgrade the technological sophistication of their products" (Stalk 1988). Looking at the impact of the TPS and lean principles at Toyota, the advantages of the principles are clear. According to Womack et al. (1990), Toyota was not only faster in time among other compared car manufacturers, but had superior performance with fewer defects, used assembly space, inventory turn rate, and other related indicators in the past. However, in the past two to three years Toyota has had several quality related setbacks. They have recalled in total over eight and half million cars globally due to reasons like hybrid braking, accelerator pedals and slipping floor mats (Browning 2010).

2.2.2 Time-based competition

Stalk (1988) was the first to introduce the concept of time-based competition (TBC) in his article "Time – the next source of competitive advantage". In his Harvard Business Review article he highlighted the importance of time in creating competitive advantage. Later in 1990, Stalk and Hout published the book "Competing against Time". This was the first to exclusively focus on time-based competition. In 1993, Stalk and Webber were the first to warn about the dark side of time-based competition. According to Stalk and Webber (1993), the negative impact of time-based competition is inevitable when it is applied blindly without knowing how to make time a competitive advantage.

The main strategy of time-based competition (TBC) is to use speed for competitive advantage. The company uses this strategy to deliver product or services fast-

er than the competitors (Suri 1998). Time-based manufacturing has been proven to be a successful way of creating 'unfair' competitive advantage over competitors by companies like Wall Mart. Stalk and Hout (1990) claim that time-based competitors can offer greater varieties of products and services, at lower costs and in less time than their more pedestrian competitors. Lead-time has been shown to be an important factor for today's markets. Lead-time in product development and in delivering the product or service to the customer plays a significant role in competition. (Stalk & Hout 1990). Thus, a number of researchers have been trying to point out the benefits that time-based competition can have on the bottom line. Stalk & Hout (1990) argue that every quartering of time reduces costs as much as 20 percent. Either due to the confidentiality of the research cases or lack of research on real numbers, the number of benchmark cases on different kinds of electrical equipment and appliance manufacturing has been limited. One of the approaches to indicate numbers that the firm can expect when implementing a time-based approach has also been studied within an approach called Quick Response Manufacturing (QRM).

2.2.3 Quick response manufacturing

Other researchers such as Suri (1998) studied the competitive advantages of time at the end of the 1980s. Suri combined academic research on time-based competition and his own observations from various lead-time reduction projects. Although Suri's QRM is rooted in same principles as Stalk's time-based competition, QRM focuses on manufacturing operations, whereas time-based competition can be applied to any business, including banking, insurance, hospitals and food service.

QRM dates back to the 1980s. Its roots, as well as the roots of lean production and TBC, can be found in Total Quality Management (TQM). The main difference between TBC and QRM is that whereas TBC strategy can be applied to any businesses, QRM is most effective in manufacturing operations that make a large number of product specifications with low-volume and highly variable demand and (or) highly engineered products in small batches, or even one-of-a-kind products. QRM thus sharpens the focus of TBC. (Suri 1998)

"QRM is a companywide strategy that pursues the reduction of lead time in all aspects of a company's operations" (Suri 2004). The company's operations can be divided into external and internal lead time reduction operations. External lead time reduction focuses on customers' needs by rapidly designing and manufacturing products customized to customer specific needs. The advantage of short order lead time to produce and deliver the customer order not only refers to manufactur-

ing - it typically includes all steps from receiving the customer order until the customer receives the product or service (Suri 1998).

2.2.4 Summary of time

"Think about the time, all the time."

Conner 2001

Listening to the ways in which managers talk about what is important to the success of their firms, we hear response time, lead time, up time, quality and being on time. Sometimes time may be an even more important parameter than money. (Stalk and Hout 1990). These three approaches briefly discussed in this chapter are probably the most known approaches that focus on time. For all of them, time and time management are critical. In all approaches time was claimed to create competitive advantage for firms focusing on the described time-based practices. In the following section research on time-based impact is studied in more detail.

2.3 Time-based literature review

The time-base literature review was performed by reading relevant articles in the field of time-based manufacturing and time-based competition. A lot of the articles were linked to the researchers introduced in the previous section; however, the software tool, Publish or Perish, was used for retrieving and analyzing the most relevant literature. In conducting the analysis, Harzing's Publish or Perish tool uses Google Scholar to obtain the citation data and presents the following statistics:

- Total number of papers
- Total number of citations
- Average number of citations per paper
- Average number of citations per author
- Average number of papers per author
- Average number of citations per year
- Hirsch's h-index and related parameters
- Egghe's g-index

– The contemporary h-index

– The age-weighted citation rate

– Two variations of individual h-indices

– An analysis of the number of authors per paper.

The actual search in this study was conducted by using the search word "time-based competition". The search had three limitations. The first was to limit the search to the fields of business, administration, finance and economics. The second limited the search words to title words only. The third limited the searches to different time spans. The first search with no time restrictions on publication indicated that the most frequently cited researchers were quite few in number and mostly from the 1990s. Here, the dominant names were Stalk (2003), Blackburn (1991) and Blackburn (1992). A closer look at the fourth most cited article by Chris (1993) indicated that it was not from the area of this research. The fifth most frequently cited, Hum (1996), was actually a literature review of earlier research. As Table 1 indicates, the research area of time-based competition has really only been explored by a handful of acknowledged researchers with more than 50 citations.

Table 1. Top 20 cited "Time-based competition" publications.

Cites	Authors	Title	Year
749	G Stalk...	Competing against time: How time-based competition is reshaping global	2003
276	JD Blackburn	Time-based competition: the next battleground in American manufacturin	1991
168	JD Blackburn	Time-based competition: White-collar activities	1992
115	M Chris	The M2-competition: A real-time judgmentally based forecasting study	1993
83	SH Hum...	Time-based competition: literature review and implications for modelling	1996
76	N Rich...	Supply-chain management and time-based competition: the role of the su	1997
53	J Jayaram, SK Vickery...	An empirical study of time-based competition in the North American auto	1999
49	RB Handfield	The Role of Materials Management in Developing Time-Based Competitior	1993
41	C Bozarth...	A contingency view of time-based competition for manufacturers	1996
38	G Stalk Jr	Time-based competition and beyond: Competing on capabilities	1993
38	A De Toni...	Traditional and innovative paths towards time-based competition	2000
33	A De Palma, R Lindsey	Private roads, competition, and incentives to adopt time-based congestior	2002
32	RB Handfield	Re-engineering for Time-based Competition	1995
31	PL Carter, SA Melnyk...	Identifying the basic process strategies for time-based competition	1995
28	RT Hise	The implications of time-based competition on international logistics strat	1995
25	SK Vickery, CLM Dröge...	Time-based competition in the furniture industry	1995
23	S Dewan...	Information technology and time-based competition in financial markets	1998
18	JD Kasarda	Time-based competition & industrial location in the fast century	1999
18	CH Pragman	JIT II: a purchasing concept for reducing lead times in time-based competit	1996
17	R Stenbacka...	Time-based competition and the privatization of services	1995

The second search using Harzing's Publish or Perish software tool with time limitation for publications from 2006 to 2011 indicated quite meagre results. As seen in Table 2, the top 20 articles were cited in total 31 times. The two most cited publications, Askernazy et al. (2006) and Thomas (2008), focus on two different areas. Askernazy et al. focus on incentives of reactivity and why such complementarities happen at the industry level, while Thomas (2008) explores time-based pressure in supply relationships. Tammela et al. (2008) discuss cultural aspects and time-based management and compare logistics management practices between selected countries. It is noteworthy that there are very few case studies in real operational business niches such as electrical equipment and appliance manufacturing.

Table 2. Top 20 cited "Time-based competition" publications from 2006 to 2011.

Cites	Authors	Title	Year
11	P Askenazy, D Thesmar...	On the Relation Between Organisational Practices and New Technolo	2006
4	R Thomas	Exploring relational aspects of time-based competition	2008
2	KE Da-gang	Theories and Methods of Management Accounting Based on Time-ba	2008
2	W Hua	Postponement Strategies of Cost Controlling in Supply Chain with Tin	2007
2	M Li...	Garment manufacturing process and organization mode oriented for	2007
2	I Tammela, AG Canen...	Time-based competition and multiculturalism: A comparative approa	2008
2	P Askenazy, D Thesmar...	Time based competition and innovation	2006
3	YAN Jun...	Study on Logistics Lead-Time Reduction Method Based on Time Comp	2006
2	YU An-ping	Re-engineering Strategy of Supply Chain based on Time Competition	2007
1	A Sapkauskiene...	The Concept of Time-Based Competition in the Context of Manageme	2010
0	HU Yan...	Analysis on the influence of time-based competition stratagem on th	2007
0	HU Yang...	Characteristics and configuration of organization mode for time-base	2007
0	J Gu...	Research on the Top Management Team Behavioral Integration, Strat	2009
0	S Zhou, Y Ding...	Time-Based Competition in Multistage Manufacturing	2009
0	W Shang...	Promised Delivery Time and Capacity Games in Time-Based Competit	2011
0	RW Thomas	Exploring Relational Aspects of Time-Based Competition in Supply Ch	2008
0	G Ji	Service value delivery system based on time-based competition	2008
0	XU Liang-pei, LI Shu-hua...	Research on China's Operation Model of Agricultural Product Supply C	2010
0	H Zhong-dong	New Product Development Strategies Based on the Competition ove	2007
0	X Guo-qiang...	Time Competition-Based Early-warning Model for Companies' Marke	2007

The results shown in Tables 1 and 2, as well as searches with words like "quick response manufacturing" and "Toyota production system" all indicated that the publications are relatively old. Only a handful of significant publications were from the 21st century. Looking more closely at the most cited publications in Figure 6, it appears that some of the most frequently cited literature focused on reviewing earlier research. Thus, it can be said that published research in this field has been fairly limited. As such, this indicates that research in this area would

require new investigation to conceptualize the role of time and the actual advantages of time-base approaches for today's business environments.

2.4 Quantifying the benefits of time

"Everyone knows that time is money, but time is actually a lot more money than most managers realize"

Suri 2010

In the information society of today, every business activity is eventually measured in terms of money. Top management loves to hear about savings like inventory reductions, scrap rate reduction and labor savings. These kinds of numbers can easily be traced back to the bottom line. Also the efficient use of time has been said to be one of the greatest indicators of competitiveness (Conner 2001). It has been even claimed that firms that cut the lead times from their value-delivery systems experience remarkable performance improvements like reductions in cost (Stalk and Hout 1990). Some have even shown that lead time is correlated with financial performance indicators, such as ROI or average profit (Christensen et al. 2007), which underscores the importance of managing lead time (Glock 2011). As such, it is obvious that the development of a methodology to measure time as a performance indicator is increasingly important for a firm to compete in terms of time (Blackburn 1992; Barker 1993; Kumar and Motwani 1995; Porter 2008). However, the criticism that time cannot be directly translated into a financial number is valid (Donovan 2010). Even though there are some time-based lean accounting techniques (e.g. Maskell & Baggaley 2004; Drickhamer 2004), so far they have received only limited acceptance in financial reporting (Donovan 2010).

There are some cases in which the impact of time on the financial figures has been indicated. The research by Stalk and Hout (1990) gives estimated figures on how time can be tracked on the bottom line. Stalk and Hout indicated that a 50 percent reduction in time results in a 20 percent reduction in costs. Blackburn, Elrod, Lindsley and Zahorik (1992) indicated that a one day faster delivery in the book industry brought a 0.5 percent price premium. Activities that shorten customer lead time may also have other beneficial effects for the firm. According to Blackburn et al. (1992), firms that can use shorter lead times often yield a flexible manufacturing system that gives the company the capability to produce a much wider variety of products at little increase in overall costs, which can give companies in certain business environments the advantage in competition over their ri-

vals. Stalk and Hout (1990) argue that time-based competitors can offer greater varieties of products at lower costs and in less time than their more pedestrian competitors. Handfield (1995) claimed that with time reduction firms are able to have greater cash flow, less inventory, quicker customer response, and ultimately greater profits. Meredith, McCutheon and Hartley (1994) performed a study which reveals that companies that reduced lead time by 50% produced on average a 25% reduction in overall product cost (2:1 lead time/cost ratio). Thomas (1989) showed that reducing response time by 50% resulted in a 20% cost reduction.

In order to create more concrete evidence than more or less rules of thumb, Tubino & Suri (2000) collected empirical data from 12 QRM projects. With this empirical data, a linear model to calculate the impact of time reduction on costs was created. This model indicated that managers would have to reduce 62 percent of the project lead time to achieve 15 percent savings. If we assumed that we could measure linearly (which certainly is not possible) the relationship between profits and order lead time in our case firms, we could approach the case with the formula:

$$y = f(x_1, x_2, x_3, \ldots x_n)$$

Where *y* would represent the reported price values of, *x* would represent the reported order lead times and *f* would denote the functional relationship. With the assumption that the relationship of price and lead time are linear, we could study the case results from the supplier to the customer or even study the cases at a functional level.

One such approach was studied by Schluter (1999). Schluter's research approaches the problem from a product cost perspective and he presents a framework for approaching cost accounting in lead time reduction projects. He states that companies usually calculate the cost of a product as:

Allocated Product Cost = f (Direct Labor, Direct Material Used, Machine Hours)

The problem in both of these approaches is that they are essentially linear formulas. However, manufacturing system dynamics that impact lead time are inherently nonlinear. In Schluter's framework study, he points out the challenge of establishing the magnitude of lead time and the magnitude of various direct or indirect costs. (Tubino and Suri 2000)

The fundamental idea behind Schluter's framework is to identify cost drivers for the products in the project. For identifying cost drivers his framework provides the following formula:

Allocated Product Cost = f (Amount used of each Cost Driver)

His approach is similar to activity-based costing (ABC); however, he indicates two key differences between his framework approach and ABC approach. The first key difference is in the metrics of measuring the change in product cost rather than calculation of the actual cost. (Tubino and Suri 2000) In his study, he also indicated two groups of metrics. The first group is Operating Metrics, which refer to activities that are directly related to the production process for the product under analysis. The second group is High-level Metrics. High-level Metrics refer to those activities that are not only related to the production process for the product under analysis, but to many or all products manufactured in a company (Tubino and Suri 2000). Many researchers before and after Schluter have provided contributions on how the relationship between lead time and cost could be calculated. One of the recent articles by Hayya, Harrison and He (2011) review research in this field in chronological order from the years 1991 to 2005 (Table 3) and they proposes yet another approach to this. Hayya et al. (2011) show the development of lead time and cost based calculation models and how the linear deterministic calculation models have developed. In the process, they propose yet another approach, that of using exponential distribution to characterize lead time. Despite the improvement of lead time and cost based calculations, they should only be considered as indicative rather than ones that can simulate real operations one-to-one.

Table 3. Lead time reduction chronology by Hayya et al. (2011).

Authors	Cost equation	Reduction cost per cycle
Liao and Shyu (1991)	$C(L) = hz_o\sigma_x + R(L)$, Q constant, and $C(L)$ concave in L	$R(L) = c_i(L_{i-1} - L) + \sum_{j=1}^{i-1} c_j(b_j - a_j)$ (a piecewise linear function).
Ben-Daya and Raouf (1994)	$C(Q,L) = \frac{AD}{Q} + h\left(\frac{Q}{2} + z_o\sigma_x\right) + \frac{D}{Q}\left(c_i(L_{i-1} - L) + \sum_{j=1}^{i-1} c_j(b_j - a_j)\right)$ Convex in Q for fixed L; concave in L for fixed Q	$R(L) = c_i(L_{i-1} - L) + \sum_{j=1}^{i-1} c_j(b_j - a_j)$ a piecewise linear function.
	$C(Q,L) = \frac{AD}{Q} + h\left(\frac{Q}{2} + z_o\sigma_x\right) + \alpha\frac{D}{Q}e^{-\beta L}$ Convexity or concavity depends on the Hessian	$R(L) = \alpha e^{-\beta L}$, α, β constants.
Ouyang et al. (1996)	For normally distributed LTD: $MinC(Q,L) = \frac{AD}{Q} + h\left[\frac{Q}{2} + z_o\sigma_x + (1-\beta)\sigma_x G(z_o)\right] + \frac{D}{Q}[\pi + \pi_o(1-\beta)G(z_o)] + \frac{D}{Q}R(L)$ Convex in Q for fixed L; concave in L for fixed Q	$R(L) = c_i(L_{i-1} - L) + \sum_{j=1}^{i-1} c_j(b_j - a_j)$ a piecewise linear function.
Ouyang and Wu (1997)	For normally distributed LTD: $Min\ C(Q,L) = \frac{AD}{Q} + h\left[\frac{Q}{2} + z_o\sigma_x + (1-\beta)\sigma_x G(z_o)\right] + \frac{D}{Q}R(L)$ s.t. $\frac{\sigma_x G(z_o)}{Q} \leqslant \alpha$ Does not satisfy the Kuhn–Tucker conditions	Same as in Ouyang et al. (1996).
Ouyang and Wu (1998)	Distribution-free: the same as in Ouyang et al. (1996), except that now the safety stock, $r - \mu L$ replaces $z_o\sigma_x$ and the ESPRC, $E[X-r]^+$, replaces $\sigma_x G(z_o)$	
Moon and Choi (1998)	They correct a redundancy flaw (service level and a unit shortage cost in the same formulation) in Ouyang et al. (1996)	
Hariga and Ben-Daya (1999)	Lead time reduction models as in the above, but with full and partial information about the *LTD*	
Lan et al. (1999)	Same as in Ouyang et al. (1996), but a 'refinement' of the solution	Same as in Ouyang et al. (1996).
Pan et al. (2002)	For normally distributed lead time demand, $C(Q,\pi_x,L) = \frac{AD}{Q} + h\left[\frac{Q}{2} + z_o\sigma_x + (1-\beta)\sigma_x G(z_o)\right] + \frac{D}{Q}R(L)$. The same as for Ouyang et al. (1996), except for the structure of $R(L)$. C is convex in Q, concave in L	$R(L) = (a_i + b_iQ)(L_{i-1} - L) + \sum_{j=1}^{i-1}(a_j + b_jQ)(T_j - t_j)$, $L_i \leqslant L \leqslant L_{i-1}$ The same as in Ouyang et al. (1996), except that $c_j = a_j + b_jQ$, $c_j = a_j + b_jQ$.
Hoque and Goyal (2004)	They argue that the formulas in Pan et al. (2002) are incorrect and they offer an alternative solution. The Pan et al. model is extended to include a constraint on Q. They extend the Pan et al. model to include a constraint on Q	
Pan and Hsiao (2005)	Backorder unit price discount, π_x, introduced. For normally distributed *LTD*: $C(Q,\pi_x,L) = \frac{AD}{Q} + h\left[\frac{Q}{2} + z_o\sigma_x + (1-\beta)\sigma_x G(z_o)\right] + \frac{D}{Q}[\pi_x\beta + \pi_o(1-\beta)]\sigma_x G(z_o) + \frac{D}{Q}R(L)$	The same as in Pan et al. (2002). The distribution-free case is on the lines in Ouyang and Wu (1998). An algorithm used to produce (Q^*, π_x^*, L^*).
Chang (2005)	A linear programming (objective function analogous to the one in Ben-Daya and Raouf (1994)) minimized subject to resource constraints	As in Ben-Daya and Raouf (1994), except that D/Q is an integer.

C: cost; D: demand stochastic; $G(z_o)$: unit normal loss integral; L, deterministic lead time, but "reducible," i.e., a deterministic piecewise step function; Q: order quantity; i: $1,2,\ldots,n$, index for lead time component; a_i: the minimum duration of lead time component i; b_j: the normal duration of lead time component i, $j = 1,2,\ldots,i$; c_i: the cost per unit time for reducing lead time component i; *LTD*: Lead time demand; α: a constant; β: a constant, also fraction backordered; σ_x: standard deviation of demand during lead time; π: cost per unit short; π_o: gross marginal profit per unit; π_x: backorder price discount.

In conclusion, time is an abstract measurement. Thus, the impact of time is difficult to quantify with commonly used business accounting systems. While the general importance and overall benefits of time have been documented in TBC and QRM, previous research on the cost benefit and quantitative impact on profitability measures are limited (Tubino & Suri 2000).

Stalk and Hout (1990) present data which support the impact of response time on the company's growth and profitability. The problem is that their data is based on industry-wide comparisons and cannot be applied directly to electrical equipment and appliance manufacturing businesses. However, most prior researchers have claimed that time has an impact on creating competitive advantage over competitors in the right environment.

2.5 Competitive advantage

In the literature on strategy a lot of definitions on the nature and causes of competitive advantage already exist. Definitions of competitive advantage range from

the industry positioning approach, the commitment explanation, to the resource based view and dynamic capacity approach (Mellahi and Sminia 2009). Competitive advantage could be defined as the extent to which an organization is able to create and maintain a defensible position over its competitors (Tracey et al. 1999). It grows when the firm is able to meet or exceed customer needs with profits (Porter 1985). Meeting or exceeding customer needs creates customer value, which then fundamentally increases the firm's competitive advantage. Customer value is created when the firm is able to meet or exceed customer expectations with lower prices or by providing unique benefits that more than offset a higher price (Porter 1985). A competitive advantage can be attained if the current strategy is value-creating, and not currently being implemented by present or possible future competitors (Barney 1991). Ma (1999) defines competitive advantage as the asymmetry or differential in any firm´s attribute or factor that allows the firm to serve its customers more effectively than others, thus creating better customer value and achieving superior performance. Alternatively, competitive advantage may be considered to refer to the capabilities which allow an organization to shape its competitive advantage and differentiate itself from its competitors (Li, Ragu-Nathan B., Ragu-Nathan T.S., and Rao 2006). Harrison and Hoek (2002) emphasize the importance of supply chains in creating competitive advantage. They suggest that competitive advantage is achieved by the competitiveness of the supply chain, which means "meeting end customer demand through supplying what is needed in the form it is needed, when it is needed, at a competitive cost" (Harrison and Hoek 2002). Competitive advantage has also been described to be an advantage over competitors gained by offering consumers greater value, by providing greater benefits and service that justify the prices. Then when a firm sustains profits that exceed the average for the industry, the company is said to possess competitive advantage. (Porter 1985).

Based on prior research, it appears that creating competitive advantage requires a focus on the factors that are likely to allow a firm to better position itself in relation to competitors in the marketplace. Here, the question arises: How to successfully define and implement strategies that will lift a firm to superior performance by facilitating this firm with competitive advantage to outperform current and future competitors?

2.5.1 Building competitive advantage

More than half century ago, Forrester (1958) expected us to gain a far better understanding of the dynamic, ever-changing forces which shape the destiny of the company. As competition has grown globally, the pace of the changes in market

and customer needs have accelerated and presented challenges to companies to remain competitive. As such, this phenomenon has created the need for a new management focus. Management has had to shift the emphasis from tactical decision-making (moment-by-moment decision) to strategic planning (preparing for possible eventualities, establishing policy, and determining in advance how tactical decisions will be made). At the same time, the management focus has had to switch from solving everyday problems to focusing more on strategic problems. Here, the importance of basic information is critical. "Without an awareness of basic information-flow principles, it is only through costly errors that managers can develop an effective intuitive judgment." (Forrester 1958).

Demsetz argues that some firms enjoy performance advantages either because they are lucky or because they are more competent than other firms. These firms may enjoy growth and a superior rate of return for some time because their rivals are ignorant about the same opportunity or because they cannot imitate quickly. Also information and technology can be obstacles to imitation, since information is costly to obtain and techniques are difficult to duplicate. (Demsetz 1973). Porter argues that the activities of a firm define their contribution to the firm's performance. Porter continues to claim that a firm in an attractive industry with a poor competitive position or a firm with an excellent competitive position in a poor industry may still not earn substantial profits (Porter 1985).

As has been emphasized by prior research, competition is at the core of the success or failure of firms. Commonly, the success or failure of a firm has been linked to the strategy it follows and the strategic decisions its management executes. Thus, understanding how to drive competitive strategy rather than drifting with a vague strategy appears to be the key for creating competitive advantage for businesses.

2.5.2 Demand and supply chain management in building competitive advantage

Responsiveness has received increasing attention in operations management literature, and it has been recognized as one of the key themes in supply chain research (Reichhart and Holweg 2007). As a result of that, a number of researchers have pointed out the importance of supply chain management (SCM) concept adoption has helped firms to gain a competitive advantage. Not only has it been recognized by the academic researchers. Many firms such as Proctor and Gamble, Chrysler (Shin et al. 1999), Dell Computers, Cambell Soup, Hewlett-Packard, Cisco Systems, Digital Equipment Corp., Volvo, Lucent Technologies, Kmart Mexico, American Consolidation (Motwani et al. 1998), and fashion textile dis-

tributor Zara (Lopez and Fan 2009) have all focused on SCM responsiveness. However, it is not easy. "Managing supply chain effectively is a complex and challenging task, due to the current business trends of expanding product variety, short product life cycle, increasing outsourcing, globalization of businesses, and continuous advances in information technology" (Lee 2002: 105). Certainly, even the above listed companies do not have equal competitive advantage from the supply chain models they have deployed. The challenge that many of the firms are facing today is that their SCM models have been built in a relatively stable period in the past, and thus may not be enough for the purpose of creating competitive advantage today (Christopher and Holweg 2011).

Today it can be argued that manufacturing and supply chain strategies focus on responsiveness. These strategies aim to capture customers' needs and to provide the right product or service within an acceptable time frame. Capturing customers' needs and providing the right product or service within an acceptable time frame is claimed to be an essential cornerstone of sustained competitiveness. (Holweg 2005).

2.5.3 Building competitive strategy

"Every firm competing in an industry has a competitive strategy, whether explicit or implicit" (Porter 1980). According to Porter, competitive strategy is the search for a favorable competitive position in an industry. Competitive strategy aims to establish a profitable and sustainable position against the forces that determine industry competition. The purpose of competitive strategy is not only to respond to market needs but to shape the markets in a firm's favor. (Porter 1985).

Porter categorizes competitive strategies in three general types: *Segmentation, differentiation* and *cost leadership* strategy (Figure 6). These three strategies can commonly be applied by different businesses to achieve or maintain competitive advantage. According to Porter, market segmentation is narrow in scope, while both cost leadership and differentiation are relatively broad in market scope. (Porter 1980).

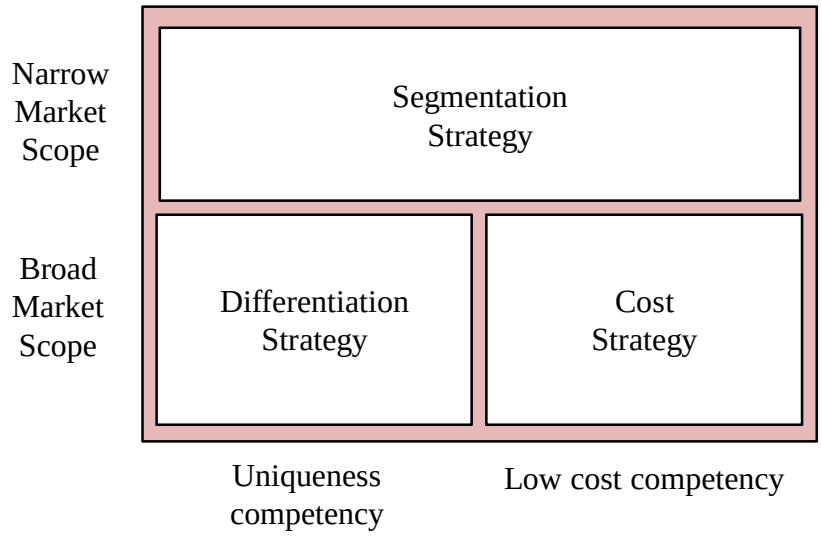

Figure 6. Three different competitive strategies and their dimensions (Porter 1980).

Empirical research on the impact of segmentation strategy indicated that firms with big and small market share were often quite profitable, whilst firms with mediocre market share were the least profitable. Porter's explanation of profitability was that firms with high market share were profitable because they focused on cost leadership, firms with low market share focused on profitable niches, and firms with mediocre market share did not have a viable generic strategy (Porter 1980).

Cost leadership based strategy involves a firm winning market share by appealing to cost-conscious and price sensitive customers. This is achieved by offering the lowest prices or best price to value ratio to customers. In order to do this with profit and a high return of investment, a firm has to operate at lower cost than its rivals. Achieving a low overall cost position often requires relatively high market share or other advantages such as lower procurement costs for needed materials than competing firms. It can also mean better design of products for easier manufacturing or a wide line of related products to spread the costs (Porter 1980). According to Tubino and Suri, often the greatest impact on cost benefits is the reduction of lead time. Lead time drives business understanding, decision-making and supportive measurements and thus reduces lead time, and many dysfunctional dynamics and their management costs disappear (Tubino & Suri 2000).

Differentiation strategy is something that is defined industry-wide as being unique. Differentiation can be done in many ways, such as brand image, design, technology, features, dealer networks, or other dimensions. Differentiation is a

viable strategy for earning above average profits. Differentiation provides insulation against competitors because of brand loyalty by customers and resulting in lower sensitivity to price (Porter 1980). In the competitive environment, where effective barriers to entry are absent, it would seem that differentiation of the firm's success could only be derived from its superiority in the producing and marketing of products or in the superiority of a structure of industry in which there are only a few firms (Demsetz 1973).

A firm can shape its industry attractiveness and its competitive position within the industry. Even so, the factors reflecting industry attractiveness are something that a firm has little influence on, and competitive strategy is something that has the power to make the industry more, or less, attractive. Porter emphasizes that two central questions underlie competitive strategy. The first one is the attractiveness of an industry for long-term profitability and the factors that determine it. The second is the determinants of relative competitive position within an industry. Neither of the approaches would be sufficient in itself to determine the competitive position (Porter 1985).

Strategic choices made without considering the long-term consequences for industry are often made by firms. They see a gain in competitive position, but fail to anticipate the consequences of competitive reaction. In the worst cases these choices can destroy the industry structure, and as a result everyone is worse off. The ability of firms to shape industry structures places a particular burden on industry leaders. The actions of industry leaders can have influence over buyers, suppliers, and other competitors and thus leaders have to balance their own competitive positions against of the health of the industry as a whole. (Porter 1985).

2.5.4 Characteristics shaping the competition

David Rothkopf, a former senior Department of Commerce official in the Clinton administration and now a private strategic consultant, said that "Globalization is the word we came up with to describe the changing relationships between governments and big businesses. But what is going on today is a much broader, much more profound phenomenon." (Friedman 2005). Globalization signifies the development of an increasingly integrated global economy marked especially by free trade, free flow of capital, and the tapping of cheaper foreign labor markets (Merriam-Webster Online). The phenomenon "globalization" has been shrinking the world from a small to tiny size and flattening the playing field at the same time. The thing that gives it its unique character is the newfound power for individuals to collaborate and compete globally. Development of fiber-optic networks and computer software make us next door neighbors and at the same time close

competitors in the same markets. We have to face the fact that today companies are operating in a challenging and fast changing business environment, where the competition is truly global and fiercer that ever (Friedman 2005). "Global competitors are challenging not only the large, international markets but also limited, specialized, and regional markets" (Meredith et. al. 1994:7).

According to Hopp & Spearman (2000), global competition comprises three main competitive dimensions: Cost, quality and speed. "These three competitive dimensions are broadly applicable to most manufacturing industries, but their relative importance obviously varies from one firm to another" (Hopp and Spearman 2000:5). All the three competitive characteristics are important for markets, but not equally so. Some industries depend on efficiency, some on quality and some on speed to meet the market requirements. It is the right balance between the three competitive dimensions that needs to be optimized to meet the value customers are willing to pay. The right balance gives the firm competitive advantage (Hopp and Spearman 2000).

2.5.5 Constantly outperforming

The word competition can be seen as negative or positive. Competition has been the way for species to evolve and develop into their current form. In the evolution process strong and smart individuals have survived better and been able to pass their genes to future generations, and individuals with restricted abilities to survive changes have been eliminated from the evolution process (Fine 1998).

In today's business, competition should be seen as a positive driver. It has been, and still is, the ultimate driver for firms to enhance the development of new technologies. New technologies have improved the standard of living, lowered the consumption of non-renewable resources and enabled people to have the opportunity to bring the latest technology into their everyday lives at affordable price levels. Competition and technology together have united competition into a worldwide phenomenon, known as globalization. (Friedman 2005).

Understanding the dimensions of competitive advantage for firms has been a major area of research in the field of strategic management (Rumelt 1984; Porter 1985). In this search for understanding in strategic management, one question has been raised above the rest. That question is: "Why do some firms persistently outperform others?" (Barney & Clark 2007:3). Sometimes firms outperform others; sometimes the performance differences last only a limited time. What this question suggests is that sometimes, in some situations, persistent performance differences will exist between different firms. "It is these differences in firm per-

formance that strategic management scholars seek to understand. (Barney & Clark 2007:3).

Two broad level explanations as to why some firms persistently outperform others have been developed in prior research on strategic management. The first one was articulated by Porter (1979, 1981). This explanation focuses on the impact of a firm's market power on creating competitive advantage over the competition and thus outperforming others (Porter 1981). Bain (1956) argued that if the entry into industry is restricted by various barriers, then performance differences can persist. The second explanation of why some firms persistently outperform others focuses on the differing ability of firms to respond to customer needs more effectively and efficiently (Demsetz 1973).

2.6 Competitive manufacturing strategy

"Manufacturing is part of the strategic concept that relates a company's strengths and resources to opportunities in the market"

Skinner 1969

Roughly 30 years ago, Skinner (1969) argued that too often top managers overlook the manufacturing's potential to strengthen or weaken a firm's competitive ability. Skinner's argument was that the firm's competitive goals and strategy should be aligned with the firm's manufacturing strategy. In his research Skinner has stated that if firms fail to recognize the trade-offs and relationships between manufacturing decisions and corporate strategies, they may end up with production systems that are noncompetitive. This can easily happen if firms are making the mistake of considering typical manufacturing criteria such as low cost, high efficiencies and productivity as the key manufacturing objectives. (Skinner 1969).

Some manufacturers seem to provide better quality, be more dependable, respond faster to changing market requirements, and while doing so achieve lower costs. Many researchers have implied that this should not be possible by stating that achieving competitive strength along with one of these indicators should come at the expense of the rest (Ferdows and Meyers 1990). Many researchers like Crosby (1979) and Juran and Blaton (1998) have offered explanations of how and for what reason this occurs. What they have shown is that different improvements in areas like quality performance and cost efficiency can be a consequence of investment quality improvement programs. Interestingly, this does not seem to work in reverse. In other words, increasing cost efficiency does not appear to improve quality. Here, the trade-off seems to work only in one way. Jaikumar

(1986) offered an indication that was a relationship between flexibility and dependability of the production process. His comparisons revealed that higher flexibility was associated with greater dependability. Those companies that had made their production systems reliable could run their machines with more flexibility. Also here the reverse does not appears to true. In other words, increasing flexibility does not seem to make the process more dependable.

Ferdows and Meyer have developed and provided evidence for a "sand cone" model. In this model, they have researched the needed sequence for the four building blocks (cost efficiency, flexibility (=speed), dependability and quality) on building a cumulative and lasting manufacturing capability. Their model indicated that the first thing to focus efforts on is quality. When quality efforts get underway way, the focus should be on making the system more dependable. When these two are underway, it would be time to concentrate on flexibility, which is also considered as speed. Only after these three steps should efforts be directed towards cost drivers. (Ferdows and Meyer 1990)

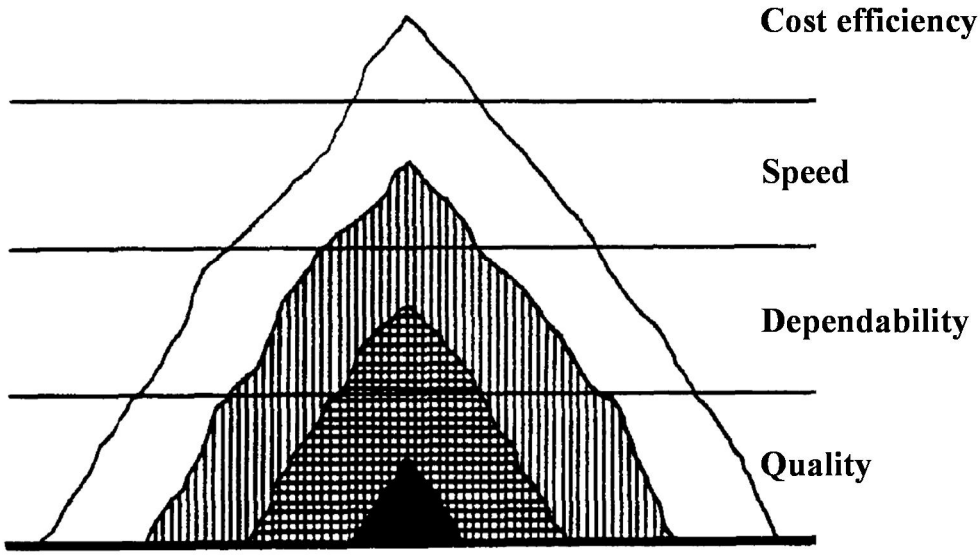

Figure 7. The sand cone model (Ferdows and Meyer 1990).

In the sand cone model, Ferdows and Meyer are proposing that traditional trade-off theory would not apply in all cases. Rather, what they are proposing is that certain approaches change the trade-off relationship into a cumulative one, where one capacity is built upon another and not in its place. (Ferdows and Meyer 1990). Also more recent research has provided evidence on the positive association between manufacturing strategy and competitive strategy. For example, Amoako-Gyampah and Acquaah (2007) have shown that competitive strategy

components have positive and significant correlation at the 0.01 level with manufacturing strategies such as delivery, flexibility, low cost and quality.

2.7 Summary, conclusions, and applicability of the approach

With respect to time as a competitive advantage, the undisputable fact is that time is money. The more challenging question is: How much money time is? When asked questions about the impact of time on the profitability of their businesses, most managers cannot answer, because they do not know the answer. As a metric, time is something that the management typically has not been able to conceptualize in their day-to-day operations. If the value of time is not known, most likely it is not measured. And when it is not measured, it cannot be managed. This is one of the main reasons why many managers do not know the power of time and thus cannot use time as a competitive advantage. However, it has been recognized by several researchers that different manufacturing capabilities and strategies can in the right combination and sequence provide competitive advantage for firms.

Despite the known challenges, different firms are in increasing numbers focusing on time and speed when working to create competitive advantage over their competitors. For example, apparel firms like Hennes & Mauritz, Zara and Nike have all based their competitive advantages somehow on speed. With being faster than their direct competitors they have tried to stand ahead, and according to resent research they have succeeded in that. Hennes & Mauritz and Zara have specialized in bringing the latest designs to users with low costs and with speed that overseas competitors like GAP can only dream of (Ballinger 2001 and Wahlgren 2005). Nike has built its computer systems in a way that it can get the right number of sneakers to more places in the world more quickly (Holmes and Bernstein 2004). Firms like Apple can be argued to have several focus areas in which they create competitive advantage. Among them is speed to the customer. A good example is iTunes that can be downloaded anytime, from anywhere and by anyone at reasonable cost. Apple has also specialized in providing people with simple products with experiences that contain a high level of “cool” factor instead of technology jargon (Khan 2010). In this way Apple has brought the latest technology like iTunes closer to end users, who have been able to do their music shopping online with the convenience of 24 hours a day, 7 days a week, without traffic, parking, crowded stores, or waiting in long checkout lines (Vaccaro and Cohn 2004).

It should be remembered that here we are discussing complex, large enterprises; many larger (and more productive) than entire nations. One such enterprise happens to "click" for some time, while others do not. It may be very difficult for these firms to understand the reasons for this difference in performance or to know to which inputs affect the performance of a successful firm (Demsetz 1973). The complexity of these organizations does not allow easy analysis that would identify the characteristics enabling competitive advantage. The characteristics enabling competitive advantage can be undervalued by the competition for long periods of time. These characteristics can also be overvalued by successful firms for too long. Rapid change in competitive advantage is likely to happen when market needs are suddenly changed, e.g. by economic recession or boom.

3 THEORETICAL FRAMEWORK AND HYPOTHESES

In this chapter, the following concepts are introduced: Business opportunity recognition (3.1), how time is connected to ways of doing business (3.1.1), how customer needs have been evolving (3.1.2), why customer needs are increasingly challenging, and where to focus on fulfilling customer needs based on the literature review. The chapter also describes the set of hypotheses (3.2) for the study and justifies the selection of hypotheses from the managerial perspective in the field of electrical equipment and appliance manufacturing and from the literature perspective.

3.1 Business opportunity recognition

Business opportunity recognition provides a justification for the research, a brief overview on how time and speed of delivery are connected in doing business and how the importance of time has been underlined by the main researchers in the field of time-based competition. This chapter also introduces changing customer needs in today's business and in doing so indicates the importance of customer focus in being successful in the area of operations. Briefly describing the three aspects of time, changing customer needs and building competitive advantage highlights the importance of conducting the study in the field of electronic equipment and appliance manufacturing and why this work looks at the competitive advantage of speed of delivery from two angles: 1) the profitability of the firm and 2) results of the overall customer satisfaction survey.

3.1.1 What does time have to do with business?

Stalk and Hout (1990) claim that sometimes time may be a more important performance parameter than money. However, time is not critical in itself, "it is the benefits achieved through time reduction, in the form of greater cash flow, less inventory, quicker customer response, and ultimately, greater profits" (Handfield 1995). When looking at the longer perspective of time, competing in terms of time creates a closer feedback loop between firms' customers and employees. This gives employees the opportunity to learn about customer needs and to create value for them faster than the competition. (Stalk & Webber 1993). It is not uncommon to say that customers feel increasingly time-starved. This time-starvation of customers provides a major opportunity for those firms that learn how to ex-

ploit it (Tucker 1991). And there are a lot of firms which have done it successfully, but first the firm has to know where to start from.

3.1.2 What does a customer want?

> *"Let us tell you what all customers want. Any customer, in any industry, in any market wants stuff that is both cheaper and better, and they want it yesterday"*
>
> Ridderstråle and Nordström 2000

Today, customers are not only aware of what is available in the markets and with what cost. They are also increasingly aware how fast their needs can be satisfied. Due to the transparency of the available selection and prices, many companies feel a pressure to deliver complex customer orders with faster lead times than ever. The importance of time and speed of operations has certainly increased as one of the customer requirements in many businesses during the past decade. As the speed of delivering customer orders has decreased, the demand for more time-based flexibility has increased. The speed of the customer order delivery process has become increasingly important for satisfying customers with increased bargaining power.

3.1.3 Why should we focus on what customers want?

In this day and age, profitability in all businesses, regardless of the size or sector, is strongly dependent on customer satisfaction. This satisfaction is created by distinguishable competitive characteristics. These characteristics enable companies to create added value for customers and thus create competitive advantage over rival businesses. (Porter 2008). If a firm has a strong competitive advantage in an attractive market, it can enjoy profitable sales growth (Alexander 2007). However, competitive advantage is temporary, as may be seen in the examples of the Roman Empire, Henry Ford's Model T, IBM and Dell. Thus, firms have to exploit their current capabilities and competitive advantages, while also consciously and purposefully building new capabilities for the moment when the old ones no longer provide an advantage. In order to stay competitive the right advantage must be chosen again and again. If a firm fails to change to meet new emerging challenges it will stop existing. (Fine 1998)

3.1.4 Where to focus on fulfilling customer needs?

Several studies and publications have clearly indicated the impact of time on other critical attributes that create benefits for product and service providers. The impact of time has commonly been acknowledged as one of the dimensions of competitive advantage ever since the term time-based competition (TBC) was introduced to the western world by Stalk & Hout in the late 1980s. The introduction of the new term "TBC" resulted in a lot of discussion on how time really impacts the firm´s critical measurements such as costs and customer satisfaction. The criticality of time has been studied in several industrial sectors like the automotive, aerospace, appliance and electronics industries.

Many researchers have tried to indicate how time impacts on other competitive characteristics. Some have approached the subject with "rules of thumb" like Stalk and Hout (1990), who claimed that "for every quartering of the time interval required to provide a service or product, the productivity of labor and of working capital can often double. These productivity gains result in as much as a 20 percent reduction in costs". Others have built a framework to approach cost accounting for lead time reduction projects (Schluter 1999), developed algebraic model for benefits (Tubino & Suri 2000), or even made math-based predictions of the potential impact of time (Ceglarek, Huang, Zhou, Ding, Kumar & Zhou 2004). While there has been previous research on calculation based impact of lead time on, for example, inventory cost reductions from researchers like Liao and Shyu (1991); Ben-Daya and Raouf (1994); Ouyang; Yeh and Wu (1996); Ouyang and Wu (1997 and 1998); Moon and Choi (1998); Hariga and Ben-Daya (1999); Lan, Chu, Chung, Wan and Lo (1999); Pan, Hsiao and Lee (2002); Hoque and Goyal (2004); Pan and Hsiao (2005); Chan (2005), they have only dealt with deterministic lead times, where the authors portray costs piecewise as a linear function of lead time. Even the two staged stochastic lead time model introduced by Hayya, Harrison and He (2011) that was claimed to give more accurate results when comparing lead times and costs, will not indicate the "as is" stage of the firm's current status when it comes to lead time impact on different key performance indicators such as profitability and customer satisfaction. I do not want to claim that they would not be useful. Instead, I would indicate that using such calculation models or even the "thumb rules" mentioned earlier, would not provide the outcome of this research.

For the reasons indicated in the literature review and in this section, this research has a unique approach that has not been used, as such, in the field of build-to order manufacturing of electrical equipment and appliances. The reason that makes the contribution of this research so valuable is the combination of the case study

research approach with extensive statistical analysis of operational data. Despite reviewing tens of articles from this specific area of research, nothing even similar could be found. The reason that makes the contribution here unique is that this research focuses on analyzing the relationship between time-based flexibility and premium pricing on profitability and at the same time their multiplicative impact on customer satisfaction. It is not only a unique approach in the field of electrical equipment and appliance manufacturing niche, but also unique in responding to the real demand from the manufacturing side with a high level of statistical detail as well as closing many gaps between academic research and real business needs and goals.

3.1.5 What is the goal of a business?

Ultimately, the goal of any business is to make money; everything else is a means to achieving the goal (Goldratt 1986). This goal of profitability can be illustrated with a sample hierarchy of objectives from the fundamental goal of making money to various supporting subordinate objectives as illustrated in Figure 8. In Figure 8, *high profitability* requires *low cost* and *high throughput*. The branch on the left hand side, *low costs,* requires low unit costs, which are dependent in one way or another on *high throughput, high utilization, and low inventory*. The key for having *high throughput* is *less variability* when the ability to hold *low inventory* and still serve customer needs requires *short cycle times* together with *less variability*. Having *high sales* requires quality products, good customer service, fast response, many products (all that the customer needs), low utilization, and/or high inventory, more variability (all that the customer wants), and short cycle times. Looking at the right hand side branch of Figure 8, *high sales* needs supporting subordinate objectives like *quality products* and *high customer service* in order to work. *Quality product* requires *low inventories, less variability* and *short cycle times. High customer* service, on the other hand, requires *fast response* and a range of *many products*. In order to deliver *fast response, short cycle times, low utilization* and/or *high inventory* are needed. To offer customers *many products, high inventory* and *more variability* are needed.

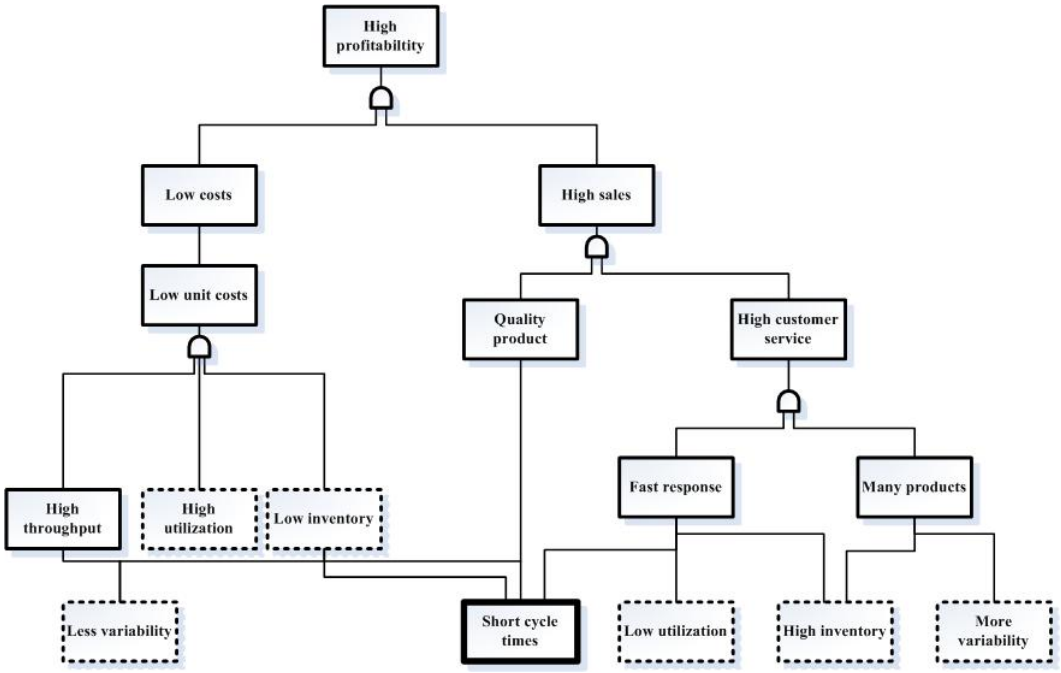

Figure 8. A hierarchy of objectives from a fundamental objective to various supporting subordinate objectives (Hopp & Spearman 2000).

This hierarchy of objectives contains some conflicts. These conflicting subordinates are indicated with a dotted frame in Figure 8. For instance, keeping many products available requires high inventory and more variability. However, to obtain high quality, we need less variability, low inventory and short cycle times. These kinds of conflicts prevent the usability of the model as such, and therefore there is no choice but to make some tradeoffs to resolve the overlaying conflicts. (Hopp & Spearman 2000). Despite the conflicts, the main observation in the Figure 8 is that *short cycle times* (with thick frame) support both low costs and high sales which are the high level objectives supporting the ultimate goal of making money. As such, the impact of short cycle times needs to be tested in this research.

3.2 Hypotheses of the study

The research questions on this doctoral dissertation are based on the six research hypotheses that have been formulated through four procedures. First, literature on the subject was read and key managers from potential case firms were interviewed to construct an overview of the researched subject. Second, the literature and practical perceptions of the key managers were reviewed in detail to identify the concepts related to the research subject. Third, the literature and practical

issues supporting and conflicting with the research variables were reviewed. Fourth, the hypotheses and their direction (positive versus negative) were formulated on the basis of what seemed to be the mainstream view of the key managers. If the perception from key managers was not even close to being unanimous, the hypotheses were based purely on the literature perspective.

The research problem: *"Does the lead time of the order delivery process have impact on the profitability?"*, is answered through four individual research questions which have close connection with each other:

1. Do the case firms deliver similar products with significantly diverging order delivery lead times for different customers and customer groups?

2. Do the case firms ask for a price premium if the customer order lead time is shorter?

3. Is it more profitable for the electrical equipment and appliance case firms to handle order deliveries with a shorter lead time?

4. Are customers more satisfied with firms that can deliver similar products with significantly diverging order delivery lead times?

From the four research questions, questions 1 and 2 need to be answered before questions 3 and 4 can be tested. Due to the close connectivity of the research questions, the sequence of answering them is crucial in this study.

3.2.1 Hypothesis for the first research question

Research question 1 tests the flexibility of the lead time given by the firms to different customers and the lead time flexibility within the customer groups. This research question indicates whether firms offer significantly diverging order lead times for different customer groups and if they offer significantly diverging order lead times for different orders by the same customer group. This research question is hypothesized from the manufacturing literature perspective, where processing and manufacturing lead times determine the order lead time in a first-in first-out perspective, and thus no significant time differences between different customer groups or within customer groups should be identified.

H_a: $\rho = 0$ (The case firm is not offering different COLTs for different customers)

H_0: $\rho = 0$ (Different customer groups are served with similar COLTs)

H_{10}: $\rho = 0$ (No significant time-based flexibility exists within the analyzed group)

H_{20}: $\rho = 0$ (There are no differences in the distributions of the COLTs for different groups)

Hypothesis testing for H_a was done through interviews, while hypotheses H_0, H_{10} and H_{20} were tested with the help of order delivery data analysis. Here, hypotheses H_0 and H_{10} were used for testing research question 1 with cases that had an adequate number for statistically relevant analysis and H_{20} for cases where there were an inadequate number of valid cases for statistically relevant analysis.

3.2.2 Hypotheses for the second research question

The second research question identifies whether firms were offering significantly diverging order lead times for different customer groups or within customer groups and premium pricing these orders. Based on different time-based approaches in the literature, flexibility on the order lead time could allow firms to ask for price premiums. However, profitability should be gained through the savings that time-based strategy enables and not through premium pricing. For this reason, the hypotheses for the second research question were hypothesized as follows:

H_b: $\rho = 0$ (The case firm is not using time-based dynamic pricing)

H_{30}: $\rho = 0$ (The case firm is not using time-based dynamic pricing)

In hypotheses H_b and H_{30} dynamic pricing means that the firm charges different prices for the same product delivered to customer(s) with significantly diverging lead times. Here, H_b was tested with interviews, whilst H_{30} was tested through order delivery data analysis.

3.2.3 Hypotheses for the third research question

Research question 3 tests the profitability aspect of delivering customer orders faster. This research question tests the correlation between increasing the lead time and profitability. The purpose of the correlation test is to indicate if time and profitability have a correlation, and if the correlation exists, also to indicate if the correlation is significantly positive or negative. For this research question the unanimous opinion from the key managers was that lead time has no significant impact on the firm's profitability, even though the time-based literature indicated differently. Thus, the hypotheses for the third research question were set as follows:

H_c: Customer order lead time does not have positive impact on profitability

H_{40}: Customer order lead time does not have positive impact on profitability

Hypotheses H_c and H_{40} are used for testing whether the correlation exists and if it is significantly positive or negative. Here, H_c tested if managerial perception on the impact of time on profitability was correct. H_{40} was used for analyzing the actual order delivery data and testing if time had had an actual impact on the profitability of the case firms.

3.2.4 Hypotheses for the fourth research question

The fourth research question tests the overall customer satisfaction level for a single year within a time period when order delivery data was available from all the case firms. The purpose of this approach was to test the significance of time along with the quality and price on customer satisfaction. In this field of operations quality is not considered a competitive advantage; instead, it is self-evident that without proper quality you will have no business. Also the price was claimed to be market driven and thus not really creating any competitive advantage for these case firms. Thus, the assumption here was that the time-based flexibility offered to customers could impact significantly if the customers in the field of electrical equipment and the appliance market sector saw time as a critical measure in the process of conducting business. For the above reasons the hypotheses was formulated as follows:

H_{50}: Customers that were served according to their time-based needs were more satisfied overall

Hypotheses H_{50} is used to rank and indicate the overall customer satisfaction level between the different case firms during the period from which all the case firms were able to deliver adequate data for analysis.

4 METHODOLOGY AND CASE DATA GATHERING

This chapter introduces the methods used in this research, describes the approach (4.1), population, delimits (4.2), data gathering process (4.3), data analysis process (4.4), and statistical methods used (4.5), and summarizes these sections (4.6). Section 4.7 examines the reliability and validity of the contribution to the field of study. In so doing, the chapter discusses the reasons why these methods were applied for this particular research.

4.1 The research approach

In this study the choice was to use a *multicase-study*. A multicase-study will have its plan as a whole, but will focus on each single case almost as it were the only one in the study. In a multicase-study, an investigator works vigorously to understand each particular case one by one (Stage 2006). This type of approach makes it possible to handle each selected firm as unique and considered as individual which could have been analyzed as *single-case study* (Eckstein 1975; Yin 1994; Stake 1995; Merriam 1998).

This study is considered to be case-study research, even though a large amount of statistical operations data was analyzed and used for establishing the needed evidence to test hypotheses and finally answer the research questions. The purpose of the study was to provide means for in-depth investigation of selected firms. The targeted firms of the study were operating in the same geographical location, delivering customer orders on a build-to-order basis and operating within the same electrical equipment and appliance business niche. Other approaches, including experiments, surveys, interviews, histories and the analysis of archival records, could have been possible choices for the study. The above choice made it possible to focus on the overall field while concentrating on each single case, almost as if it were the only one (Stake 2006). In this environment the facts could not be pulled directly from surveys, interviews, or existing key performance indicator reports, they needed to be collected piece by piece in order to solve the puzzle. The situation in the focus area of the study could be described by saying that very limited reliable information was available for addressing the research question with confidence. In fact, the firms' management had no key performance indicators available to directly answer the research question. As such, there was a high risk of manipulation. Manipulation could have also happened unwittingly by false observations by the investigator or addressing the wrong target group for study.

This does not mean that other approaches are not usable or important; on the contrary, analysis of archival records, histories, surveys and interviews play a major role when creating multiple sources of evidence. Overall, it is not suggested that the approach taken was either better or worse, but that the choice of combining different approaches within a multicase-study approach supported the target of the study. Closing the knowledge gap and reaching the study objectives required collecting, presenting and analyzing data fairly in a way that the research question could be answered.

The inductive (Observations → Pattern → Tentative hypotheses → Theory) and deductive (Theory → Hypotheses → Observations → Confirmation) reasoning approaches are the two broad methods often used for reasoning (Trochim 2006). In this research both inductive (bottom-up) and deductive (top-down) approaches were used. Inductive reasoning was applied because different case firms had very different profitability figures. They had different profitability figures, even though they were operating in the same markets, were using similar or the same channels to markets and were dealing with very similar or the same end customers. For this reason, these specific observations and measurements were formulated into tentative hypotheses that could be further explored. A deductive reasoning approach is applied to support the formulation of the tentative hypotheses and further reflect the previous research results into the contribution of the study (Trochim 2006). The main role of deductive reasoning was to confirm the tentative hypotheses formulated while applying inductive reasoning. This was done by studying the existing research in this research area and by comparing the indicated results with tentative hypotheses.

The research approach was built around a marketing approach called AIDA. The AIDA model has been claimed to be first introduced by an American advertising advocate, E. St. Elmo Luis (Strong 1925). The acronym AIDA is used in marketing and it describes a sequential list of events that may be undergone by a person selling a product or service. These events are *attention, interest, desire* and *action.* In this multi-case study research the purpose of *attention* was to attract the attention of the potential case firms by raising a question that was widely discussed but not tangibly addressed: “How does order lead time impact on firms’ profitability?” The attention was raised by actively approaching selected key managers in the business and by challenging them to discuss and elaborate the subject further. As such, this raised the needed *attention* and establishing the needed *interest* by the key managers in the area of the electrical equipment and appliances business. *Interest* was further promoted by introducing the forthcoming research approach with the high level vision, mission, and expected values of the research along with deliverables. The *interest* creation was done with face to face discussions

with steering committee members and by one firm at a time. Articulation of the key management inputs around the subject and presenting a simplified approach were used to create the *desire* to participate in this research. In this way the key management of the firms was convinced about the potential benefits of the research for them and also for their corporation as whole. When commitment on the managerial level was achieved, non-disclosure agreements made and the needed contacts agreed on, then the needed actions to operation level contacts were communicated, thus reaching the final event of the AIDA, *action.*

4.2 Population and delimits

The multicase-study was conducted within selected firms of a multinational corporation. This corporation and its firms operated within global electrical equipment and appliance manufacturing and service businesses. Different firms in the corporation had adjusted their strategies according to four main order delivery principles. They served the internal and end customer needs with all four customer order decoupling points (CODP), depending on the market needs, competition and existing strategy. Despite serving customers also from stock (make-to-stock), the value of the stock of the yearly revenues in 2005 was only 2 percent. As such, the assumption was that from this kind of environment the required number of case firms would be found in order to study and answer the research questions.

The purpose of setting delimits for the case research was to establish a research environment that was constructed with firms that were experiencing similar issues in similar environments:

1. The case study participants had to be located in the western part of Finland
2. All case firms had to serve customers via similar operation models
3. The case firms had to show profitable growth during the study and 2 years prior to the study on the selected product families
4. The case firms could not have implemented any major changes in the production principles or product structures during the studied period

The first delimit was to focus the study cases on a selected geographical location. The possibility to conduct a case study with firms that were closely located was considered an advantage. These firms experienced similar location benefits and problems, and thus the study did not have to address the issue of the firms' location. Also the close location of the case firms enabled close collaboration and thus the gathering of more detailed information needed for understanding the cases.

The second delimit was to make sure that the general customer serving processes were alike. The purpose was to ensure the comparability of the case firms on some level. The third delimit was to select only cases that were not struggling with financial crisis. The purpose here was to eliminate cases which had higher risk of changing their operational principles due to financial difficulties. In a global corporation like this, there could be a lot of high level management decisions behind these issues. Thus, in order not to bring dispersion among the selected cases, these kinds of firms were rejected from the study. The fourth delimit was to prevent the data being skewed by extraordinary selection of the data. Data distortion could happen if major changes of production principles or in product structure had taken place during the research period. The main requirement for the selected case firms was that they needed to be able to deliver the needed data between the years 2006 and 2008. Not necessarily from the entire time span, but data from more than one year was required. Investigating firms over a long period of time and using a multicase-study were considered mandatory. In this way, the approach would provide a systematic way of looking at events, collecting data, analyzing information and reporting results (Yin 2003). As a result, the investigator gained a heightened understanding of what impacted on what, why, and vice versa. As the study progressed, this approach enabled testing and adjusting of the research questions and hypotheses (Flyvbjerg 2006). First, all the selected firms had to be operating in international markets and located nearby, geographically. In this way, the study tried to minimize the competitive advantage or disadvantage created by geographical location. This eliminated potential case firms from other countries as well as other cities than the selected city of Vaasa, Finland. Second, the firms had to operate with the same kind of operational principle. This was the build-to-order type of customer order delivery process; thus, potential case firms and their product families served from stock were left out of this study. In this way, the response time of the order delivery process became visible instead of focusing only on warehouse management and logistics. Third, the firms needed to have a stable and profitable order delivery process one year prior to the study period of 2006–2008 and during this period. In the potential population, this was considered a precaution during the time of economic boom in the field of study. However, the fourth delimit really limited the potential choices. Not necessarily entire firms, but in many cases some of their production families and production lines. In any case, the studied population was chosen among the product families and production lines that met the previously indicated criteria.

Constructing a population in this way made it possible to collect data evidence of real cases operating in real situations. A small number of cases were chosen in order to build a deeper understanding of them. A deeper understanding was critical when interpreting the business data into information, building the business

knowledge by analyzing the information and exploring the knowledge in order to propose future strategic decisions for the case firms. If the studied sample population had been larger, the risk of failure of building a deeper knowledge of the cases would have been significantly higher due to limited resources.

4.3 Data gathering process

In order to test the identified four research questions, a specific field of study had to be chosen. For this particular purpose the electrical equipment and appliances industry was chosen, for two reasons. First of all, the electrical equipment and appliances field of operations was well known by the author of this doctoral dissertation work. As the author had worked for several years in this business and had been in operation related projects in more than 20 different manufacturing firms in the field of the electrical equipment and appliances business sector, the basic know-how on operations was expected to provide a very solid base for the research. Secondly, during his work in more than 20 different firms, the author had built a large organizational relationship network of key contacts in which mutual trust and co-operation existed. Thus, the acquired data through interviews, discussions and data mining was expected to be much more valuable and reliable than, for example, sending questionnaires to people and industries not known by the author. In this way the first objective of the case-study, that is to understand the case (Stake 2006), was much more mature at the beginning of the process. Of course, this was supported with case firm focused interviews, for which a set of questions was prepared. This set consisted of questions on selected supply and procurement strategies, office and production processes, warehousing, shipping and logistics arrangements. With the set of questions asked from the interviewed persons, a rough picture of the operations was drafted as a high level value stream map (VSM).

While the interviews built an understanding of the cases and operational environment of electrical equipment and appliances, it made it easier to choose potential firms from the interviewed population. Knowing the background of the current and past business of the possible case firms was critical in making the final selection. The interviews enabled an explanation of the background, targets of the research and the benefits of the study to the recipient firms, thus raising the interest of the firms to participate, as well as building direct links between the key people of the firms and the investigator.

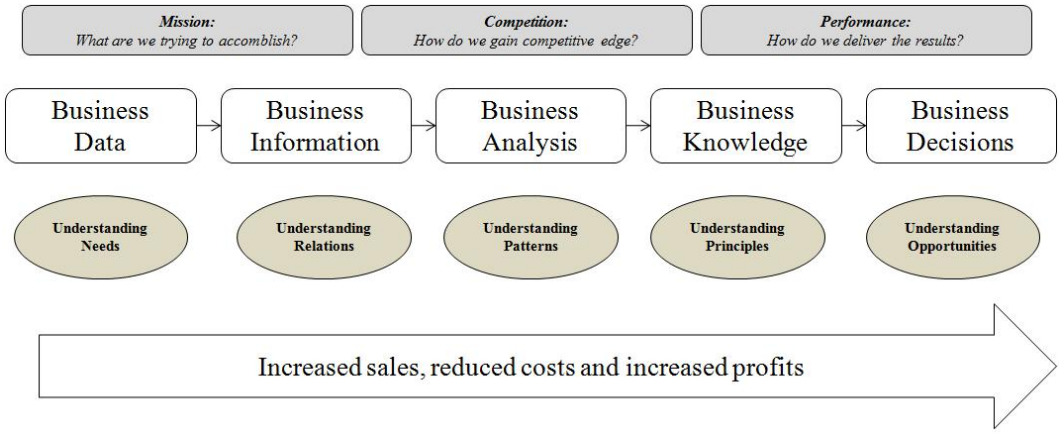

Figure 9. Research approach to answer research questions and test hypotheses.

During the interviews, it became increasingly clear that the management did not have the information available to answer the question: *Does the order lead time of the order delivery process have an impact on profitability?* Conflicting information from the management interviews confirmed the need to examine the functioning and activities in more detail. Thus, the decision was to start retrieving real-life archival order delivery process and profitability data from existing systems. This confirmed the assumption that the research question would be too difficult to approach only through a more traditional qualitative case-study based on interviews.

First, a pilot firm was selected among the case firms and taken under closer examination. The purpose of the pilot case was to create understanding of what kinds of data details were available and what kind of data could be expected from the other participating cases. In this way, the approach could be adjusted case by case. Creating the list of available data included screening the order delivery and financial data, together with several key persons in the firm. The screening consisted of going through different sources of order delivery, supplier performance and financial data. After screening, the available data was listed with explanations about what each particular data contained.

Second, a list of collected data was created. The list included roughly 130 different order delivery and financial performance details, such as selected customer names, customer numbers, customer origins, customer order received dates, customer order shipped dates, requested delivery dates by the customer, prices paid by the customer, key component material costs from different suppliers on selected customer orders, suppliers, supply lead times, supplier names, supplier numbers, supplied key components, order based profits, selected product families, production lines, different time stamps from the office, manufacturing, packing

and shipping processes. A more elaborated list of the collected delivery and performance details can be found in Appendix 2. This list was reviewed together with the firm's key person(s), and modified if needed. The purpose for collecting extensive process, delivery and financial data was to be able to provide multiple angles on explaining, interpreting and backing up the results and evidence observed from the case firms. When the content of the list and the time frame were agreed, the data was extracted and collected. This was done by the nominated person in the case firm, who was also responsible for delivering the data.

Third, the extracted order delivery and financial data were reviewed by the investigator. The purpose of the first review was to confirm that all the needed data was extracted and in a usable format. The second review of the data was conducted by using MS Excel. The purpose of the second review was to eliminate clearly visible false data. In this review, the data was shortened and filtered several times in order to indentify false inputs from the sheets, columns, rows and cells. If a lot of missing or inconsistent data was identified, the person responsible for the case-firm's data extraction was contacted in order to make a partial or full re-run of the data collection process.

Based on the pilot case, the main process for the data gathering was identified and used for gathering the data from the rest of the selected cases. The target was to have from one to three different product families which would have enough order delivery transactions during the predefined time frame and would thus fulfill the criteria for the study. From the selected product families, two to four different products were selected. The aim of selecting the products from the product families was to have products that could be considered as high runners. High runners had the advantage of being served across most of the customer segments, and involving most of the customer segments enabled the study to explore the research questions better, especially the first two research questions: Are different customer segments paying more, and are different customer segments served with significantly diverging order lead times?

A number of potential case firms failed to deliver the agreed data for analysis. Nearly all of them had difficulties in delivering the needed data from their systems. For most, the data was there, but creating the connection with the financial and operational data on the order level appeared to be very difficult. Financial and operational data stored in several different and independent systems, and the lack of experience in extracting and combining this kind of data, made the task laborious. This was because the data was often in different formats and because it was difficult to find data keys that could be used for connecting the needed data on specific orders. Laborious manual work also increased the risk of making mis-

takes when connecting the financial and operational data. This laborious process was conducted with one of the case firms. After performing this process of data gathering, a decision to avoid similar process in future cases was made. Thus, only case firms with data that could be gathered directly from the system and with adequate data keys would be used when moving on to the next case firm. In this case study, these firms did their in-house operation stage acknowledgements by scanning the barcodes into the firm's operation system. The used barcodes were either stickers on the products or prints in the different work orders that travelled with the product through the processes. In some cases the work orders were batched in manufacturing and scanned in the systems when the entire order was completed. This observation was done when creating the high level value stream maps for the case firms. Thus, this bias that happened for some products was avoided by using the time when the shipping department received the product. In this way the product manufacturing times for certain products could be handled as times that were closer to the real manufacturing lead times.

Data gathering to test the fourth research question: "Are customers more satisfied with firms that can deliver similar products with significantly diverging order delivery lead times?", was more straightforward. This particular case organization had been conducting customer satisfaction surveys for years and using the same set questions throughout different case firms. Thus, this already existing and applicable information from the different case firms was collectively acquired from different case firms. Even though the questions and measurements were one-to-one, they needed to be translated into comparable format for analysis. Also the free text comments from the customer responses were reviewed in order to build understanding around the business opportunities (Figure 9).

4.4 Data analysis

Three case firms were able to deliver the set of data in the agreed time. After receiving the data, it was screened for missing information and abnormalities. Missing data was easy to spot with plain spreadsheet applications, whereas abnormalities were much more difficult to pinpoint. For identifying abnormalities in lead times and profits, the data was sorted according to selected customers with ascending order delivery lead times and attained profits. In this way, data was grouped into customer groups, and after identification abnormally short or long lead times were removed from the acquired data. Also abnormal profits were questioned and discarded if they were found to be out of line with other order deliveries due to abnormal procedures like warranty replacements.

As the case data had passed the two above reviews, the format of the data was adjusted in a way that made it processable in a statistical analysis program. The program for statistical analysis of the study was called SPSS. The majority of the data adjustments changed the data types (numeric, string or date) and measures (scale, nominal or ordinal). Also adjustment of the cell widths, number of decimals and re-labeling were needed.

When the data was suitable for statistical analysis with SPSS, first analyses were conducted. The first data review was made by the investigator. The purpose of the first review was to indicate remaining errors in the data, record data outliers and test whether the data was large enough for statistically valid analysis. The limit for statistically valid sample size analysis was set for 30 valid order deliveries. The limit of the sample size was not set according to any required sample size calculations for hypothesis testing, but on a generally accepted sample size according to statistical research professionals. This was done due to the nature of the research approach and research questions in the study.

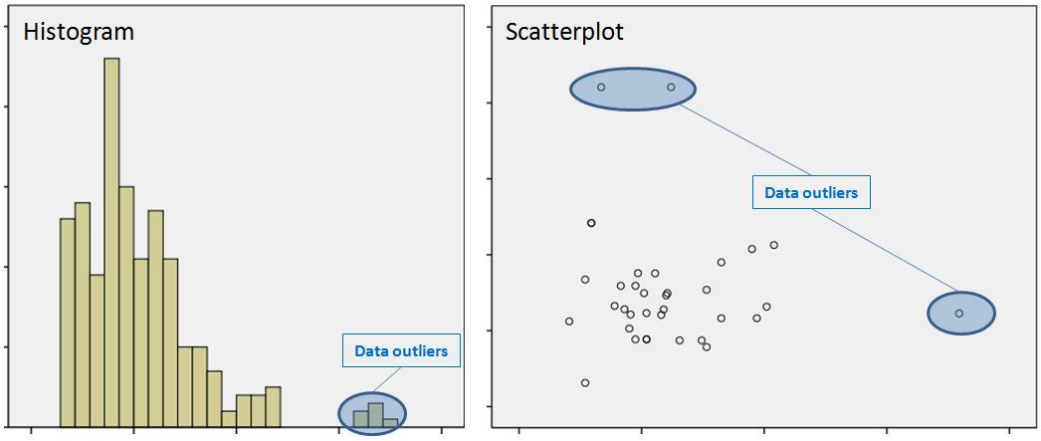

Figure 10. Eliminating data outliers.

"All researchers have great privilege and obligation: The privilege to pay attention to what they consider worthy of attention and obligation to make conclusions drawn from those choices meaningful to colleagues and clients." (Stake 1995: 49). One of the main qualifications in qualitative research is the researcher's experience, which comes largely through reflective practice. The experience of the qualitative researcher is likely to lead to significant understanding of and recognizing good sources of data. According to Stake, an experienced researcher consciously and unconsciously tests the veracity of their eyes and robustness of their interpretations (Stake 1995:49–50).

When the sample sizes were confirmed, the first data analyses were done. The first analyses enabled a comparison of the results from the interviews against the real order delivery data. As the interviews with the key persons in the case firms had indicated, the variation between the answers and actual data was high in many cases. These deviations were documented for later use in the process.

Some flexibility and adapting of the analysis process was needed due the fact that the participating companies had very different kinds of product family structures and product portfolios. Despite the differences between the case units, the acquired data was divided into different groups as much as possible. These groups helped to create an understanding of the operation of the order delivery process to the end customers from different group-specific perspectives.

The second step of the analyses was to present the first analysis and observations to key persons in the firm. The first target was to eliminate false assumptions made by the investigator and key persons involved. The second target was to raise the question of data outliers. Raising the data outliers for discussion enabled the process for building a more reliable set of data for analyzing the research questions. Outliers that were caused by force majeure or a change in customer needs were eliminated from the data used in the analysis. Review sessions with the key persons of the case firm appeared to be an excellent source of tacit knowledge. For this reason, these review sessions were conducted two to four times with each firm, depending on the number of questions raised during the data analysis. With the help of these review sessions and issue clarifications, the study was able to avoid several pitfalls that would have affected the results negatively.

4.5 Statistical methods

The statistical methods used in this study focused on correlation analyses. Correlation analyses are used for testing the strength of relationships between several pairs of selected variables. They varies from 0 (random relationship) to 1 (perfect linear relationship) or -1 (perfect negative linear relationship). The following section presents the main principles of the statistical correlation analysis used in this study.

4.5.1 Scatter plot

The scatter plot, also known as scatter diagram, or X-Y graph, or scatter graph, was used for providing useful information about the data patterns. In this study, a scatter plot was used for two purposes. First, it was used for eliminating data out-

liers. This was done at the stage when the data was prepared for analysis. Second, a scatter plot was used for confirming the linear nature of the correlation and determining whether there is a correlation between the two variables. The second examination was needed because sometimes even when the correlation coefficient appears important, examination of the data with a scatter plot can suggest otherwise (Elliot and Woodward 2007).

The purpose of the scatter plot in the analysis process was to display what happens to one variable when another is changed (Bauer, Duffy and Westcott 2006). Scatter plots are useful in rapid screening for a potential relationship between two variables. Answering the first research question, for example, required the observing of the order lead times and price. As this study is about time and how it impacts other critical KPI's, the customer order lead time is considered as a cause variable and plotted on the horizontal X-axis. For the first research question, another variable is the price. This variable is considered as an effect variable and plotted on the vertical Y-axis. Plotting the cause and effect variables made it possible to get a rough picture of the possible correlations and direction of the correlation slope.

4.5.2 Histogram

The histogram is a graphic summary of variation in a set of data (Bauer et al. 2006). In this study a histogram was used for two purposes: First, for graphical visualization of data outliers; second, in visualizing the nature of the data distribution. When a histogram shape looks approximately like a bell curve, it suggests that the data may have come from a normal population (Elliot et al. 2007). Once the normality of the data was confirmed, it opened up the possibilities of using several statistics such as means, standard deviations, and so on, to describe the data.

4.5.3 Correlation analyses

The dependencies of quantitative (numeric) and independently collected observations from operational and financial performance needed to be tested in order to test the hypotheses and answer the research questions. For this purpose, Pearson's product moment correlation coefficient (PMCC) was used. PMCC is more generally known as Pearson's correlation coefficient (ρ), which is estimated from a set of data usually denoted by r (Elliot et al. 2007). PMCC is generally used for testing the strength of a linear relationship between two normally distributed numerical values (Elliot et al. 2007; Saunder 2008). It measures how closely two points

(X and Y) in a scatter plot are to a straight line. If the two tested variables are not related, then the PMCC is not able to detect the correlation as hypothesized (H_0). Also, if the two tested variables are related but the relationship is not linear, then the PMCC may not be able to detect the relationship (H_0). If two variables are related and the relationship is linear, then Pearson's moment correlation coefficient is able to detect the correlation as hypothesized (H_1).

The hypotheses for the study with PMCC were presented as follows:

$$H_0: \rho = 0 \text{ (there is no linear relationship between the two variables)}$$

$$H_1: \rho \neq 0 \text{ (there is linear relationship between the two variables)}$$

In the correlation tests where $\rho \neq 0$, the two tested variables can have either positive or negative correlation. However, the visualization with histograms and scatter graphs or testing the correlation with PMCC might not be enough in all studies. For this reason, there are a few alternative methods presented briefly in the following section, some of which are also used in the research to confirm the results achieved with Pearson's correlation coefficient analysis.

Other correlations used to confirm the results were Spearman's rho and Kendall's tau. Spearman's rho and Kendall's tau measure the same as Pearsons' correlation coefficient analysis, except that they do not require the increase or decrease to be represented by a linear relationship. The main idea of using Spearman's rho and Kendall's tau was to make the coefficient less sensitive to non-normality in distributions. (Elliot and Woodward 2007).

The hypotheses for the study with Spearman's rho and Kendall's tau were presented as follows:

$$H_0: \rho = 0 \text{ (there is no monotonic relationship between the two variables)}$$

$$H_1: \rho \neq 0 \text{ (there is monotonic relationship between the two variables)}$$

Here, monotonic relationship suggests that the relationship between the two variables would be either increasing or decreasing.

A common method of validating a measure is to see if it correlates with some objective measures or already-validated other measures. This study, for instance, wishes to validate a measure of "time" by showing that it correlates with an objective measure of "money", on the assumption that faster order lead time should be well correlated with the amount paid by the customer. Even though this may or

may not be a valid assumption, methods of establishing the reliability and validity of measures rely heavily on correlation.

Observing only correlation is not enough. Also the variance should be taken into account in validation. Two proposed measures may have identical correlations with the validation measure (with the amount paid by the customer in the example above), but this does not mean the two proposed measures are equal. It is possible for the two measures to differ, even substantially, in variance. Here, the correlation only shows that the proposed measure and the validation measure go up and down together to a degree that is reflected by the correlation coefficient. Correlation does not say that the spread up and down will be the same for equal correlations. Thus, variance is needed.

4.6 Summary of analyses

There are a number of other special types of correlation analysis to handle the special characteristics of variables. There are also other measures of association for nominal and ordinal variables. Multiple regression, to name one, produces multiple correlation, R, which is the correlation of multiple independent variables with a single dependent. It is based on linear combinations of interval, dichotomous, or dummy independent variables. Dummy independent variables, for example, were used for validating the correlation analysis done for research question 3.

Ultimately, all types of statistical analyses are based on calculations that use predefined and assumed formulas. In best cases, these calculations will give results that indicate the direction of the actual events. Without underestimating the usability of statistical correlation analyses in any way, in this study they are considered only as supportive and indicate the analysis in determining the answers for the research questions. The main source for the conclusions will be based on the visual information from the data, such as scatter plot graphs.

4.7 Reliability and validity analysis

The purpose of this doctoral dissertation work is to make a contribution to the field of study. In order to do so, the study should be concerned with reliability and validity analysis. This should be attempted, even when there is no coherent set of reliability and validity tests for each research phase in the case study (Riege 2003).

4.7.1 Reliability

The empirical data for the study was collected by the researcher as a sample of opportunity. This empirical data consisted of both qualitative and quantitative data. Since the qualitative (interview based) data was based only on one person's view, there was a possibility that the acquired data could be biased. Avoiding the risk of acquiring biased data, the interview questions were divided into different parts of the order delivery process. In this way procurement related questions could be focused on professionals in different functions of the order delivery process. Reliability of the data was also ensured by collecting the data from interviews instead of questionnaires. The interview situation enabled the investigator to explain the questions, relate them to the processes and adjust them to the current order delivery strategies used in the case firms. This required previous knowledge of the case firms, but since the investigator had been acquainted with the case firms during his formal working experience, this opportunity was grasped. Also the piloting of one case firm and conducting from two to four separate interviews and reviews in pre-analysis enabled a fine-tuning of the questions.

The reliability of the quantitative data was ensured by using different approaches. First, the data collection principles and guidelines for the needed data were defined. In practice, this meant that sources for the quantitative data were defined, and both obligatory and supporting performance indicators were defined for the study. Obligatory performance indicators were required from all the participating units. The idea was to ensure the testing of the research questions. Supporting performance indicators, on the other hand, defined the depth of the analysis. When the case firm was able to deliver more supporting performance indicators, the study was provided with more knowledge and evidence on the case and thus also on the results of the analysis. Second, the acquired data was sieved with different methods discussed in Section 4.5. In this way data outliers, and missing and wrong values, could be eliminated and the reliability of the data for analysis confirmed.

4.7.2 Validity

Validating a measure refers to the extent which the measure really measures what it was intended to measure. A common method of validating a measure is to test if it correlates with some objective measures or already-validated other measures. However, Cohen (1988) states that interpretation of a correlation coefficient depends on the context and the purpose of the study. A correlation of 0.9 may be too low if one is verifying a physical law using high-quality instruments, but may be

regarded as very high in the social sciences, where there may be a greater contribution from complicating factors (Cohen 1988).

Due to the nature of the data and its distribution, this study could not rely purely on the correlation analysis. Instead, graphical analyses of the data were conducted in order to build evidence for the research questions. Important from the validity perspective was also the decision to make analysis only of sample sizes that had enough cases to be considered statistically relevant. In practice, this meant 30 or more order deliveries with pre-defined obligatory data indicating the performance of the entire process.

5 CASE FIRMS, ANALYSIS AND RESULTS

This chapter presents the analysis conducted to test the research hypotheses. In this process, the results of the conducted hypotheses analysis and the answers to the research questions are presented. The chapter is constructed such that first the case firms and their order of penetration points are presented. Second, the level of analyzed order delivery data from the case firms is indicated. Third, all the hypotheses are tested and the hypothesis results summarized. Finally, all the case study hypotheses and research question findings are summarized and the results are presented.

5.1 Describing the cases

The list of interested and potential case firms was eight. Out of these eight, altogether five case firms had to be disqualified. Three of them did not pass the set criteria described in Section 4.2. The other two did pass the set criteria but failed to deliver data accurate enough before the set data delivery deadline. With the ones which did qualify, applicable non-disclosure agreements (NDA) were made due the nature of the sensitive discussions and data. It was agreed that neither actual figures nor firm or product names would be shown in the case study. Instead, names would be changed and sensitive figures indexed. Thus, the names and figures in this case study are disguised to protect sensitive data and the names of the case firms.

5.1.1 Mighty Machines

The first case firm, **Mighty Machines**, fit the set criteria perfectly. For the selected products and product families, Mighty Machines was operating on an engineer-to-order (ETO) basis. It had been profitable consistently for the past several years. It also had not made any major changes to the products, production lines or to the order delivery process of the selected product and product lines during the scope set for the study. Thus, all the prerequisites for acquiring the needed order delivery related data for statistically relevant analysis existed.

The acquired data from Mighty Machines contained a little more than 360 order delivery transactions from two production lines and from four customer segments. The structure of the Mighty Machines order delivery and financial data was used as the pilot. The template for acquiring data from other case firms was based on the data structure from Mighty Machines. The studied products at Mighty Ma-

chines consisted of similar components which were produced in two similar production lines, Alfa and Beta. Alfa had 266 order delivery transactions and Beta had 95. Overall, these two production lines produced very similar products for two different customer segments.

5.1.2 Power Control

The second case firm, **Power Control**, was also found suitable for the criteria set for the research. Power Control was operating on a make-to-order (MTO) basis. It had been profitable long enough to be part of the study. The product family chosen for the research had remained the same and the order delivery process for the concerned product family had not been changed radically. Some minor modifications had been conducted to the manufacturing processes, which limited the time scope slightly.

The acquired data from Power Control included close to 300 order delivery transactions from three customer segments. Segments A, B and C all purchased the same product. Typically, the product type in the study had a lot of variations. These variations were mainly made with different key component setups and configurations. Thus, a significant share of the engineering was done by key component suppliers, which in many cases had to engineer the key component to fit the customer specification.

Unfortunately, the case firm Power Control was rather more challenging than the other case firms in the sense that there were not enough order delivery cases for all levels of analysis to conduct statistically relevant analysis. Power Control had gone through a renewal process with the selected product. In practice, this meant that the study had to work with a fraction of the data available. Naturally, this decision limited the number of orders to be studied from this case firm. For instance, the limited number of cases prevented statistically relevant analyses for testing the third research question. Secondly, a deeper analysis of the processing times in different processes and functions was limited. This was due to fact that the data had only the order and received dates. Nevertheless, this case firm was able to provide the obligatory data and had enough reported order deliveries for a high level analysis.

5.1.3 Agile Grid

The third case unit, **Agile Grid**, was the last firm that delivered the required data on time and met the qualification criteria set for the research. Agile Grid fit the research criteria perfectly. At the same time, it fulfilled the whole spectrum of build-to-order (BTO) manufacturing strategies with assembly-to-order (ATO). The products and product families, together with production practices, had remained the same long enough for Agile Grid to qualify for the case study.

The acquired data from the Agile Grid had more than 1400 reported order delivery transactions. These orders covered a two year period of order delivery transactions for selected countries. Due to the high number of transactions reported, the data could be divided and analyzed at several levels. The data included three different countries, nine different customers and seven customer segments. This allowed closer and more reliable statistical analyses among different groups providing valuable information for the study.

Another positive aspect of the extensive number of reported order delivery transactions over the two year period was the possibility to split the data into two time periods. Splitting the data in this way enabled the internal and external changes to be studied in more detail. These periods are later in the doctoral dissertation referred to as the first period and second period.

5.1.4 Summary of description of the case firms

Although all the case firms fit the selection criteria, still they were all different in many perspectives. All the products produced and analyzed in the selected firms were different. Physically, the product sizes varied from the size of an elephant to the size of a cat. Prices for the products varied from a few hundred to several thousand. Customer order delivery lead times varied from a few weeks to several months. One of the main differences was that each one of the case firms and their product families operated with different strategic order penetration points.

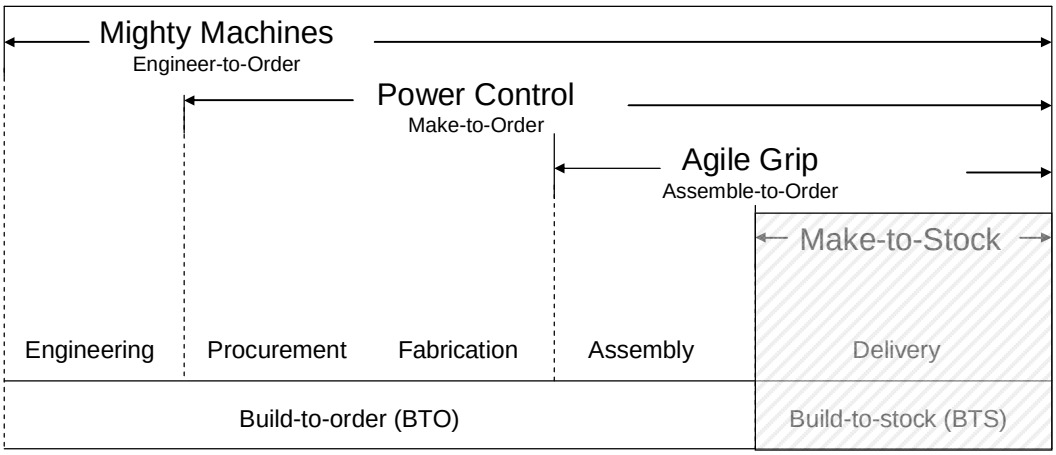

Figure 11. Customer order penetration points (COPPs) for the case firms (modified from Tersine 1994).

All the case firms were considered to be manufacturing firms that were selling both directly and indirectly to end customers. For a large global enterprise like the one in this case study, a lot of business activities of the individual firms can be also focused in parallel or in a competitive matter on the same customers. This means that these firms can offer their products through several channels and directly to the end customers. Figure 12 presents a generic model of how the case firms can offer their products directly or via different channels to end customers. These channels include players like internal system integrators, local sales units, original equipment manufacturers (OEM), external (competing) system integrators or several combinations of them.

Despite the differences, these products can be found next to each other on the customers' final applications. These products are present in power plants, pulp and paper plants, oil & gas rigs, luxury cruisers, mining sites, metal smelters and in several other business oriented applications. Ignoring the variety in size, price range, order delivery lead time, final destination, or customer order penetration point, they were all customized for individual customers who had diverging needs.

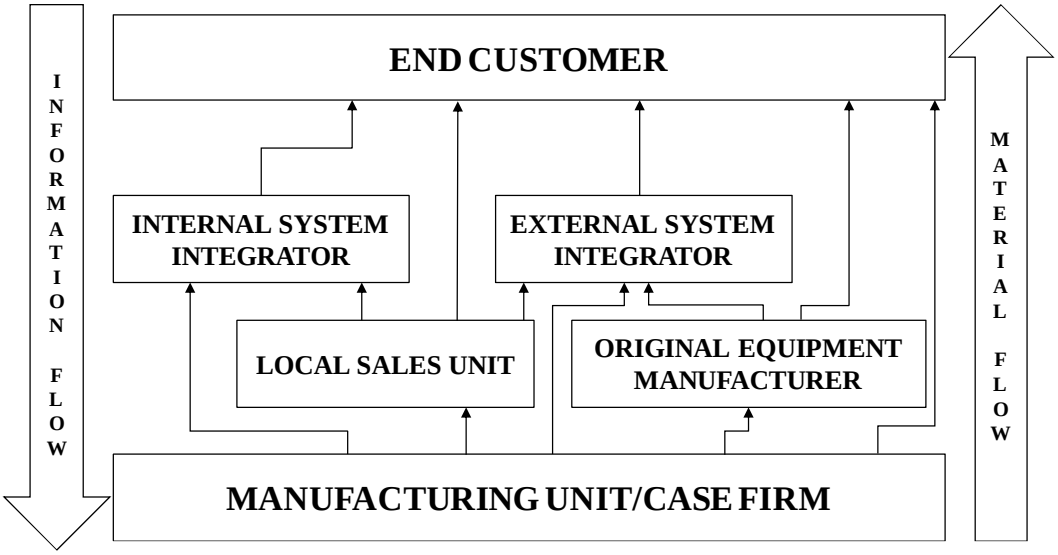

Figure 12. Generic model for alternative paths for case unit products to end customers.

5.2 Approach for overall analysis

The **qualitative** part of the research was conducted face-to-face with the selected persons from the case firms. With the key person(s), the purpose and the focus of the study were reviewed. This was done in order to confirm understanding of the targets of the study. As such, the role of the case firm was explained and the way confidential data would be presented. The product families involved in the study were discussed in more detail and selected products within product families were highlighted. The purpose of the pre-interview discussion was to ensure that the focus was on the selected product families.

The actual interview focused on creating knowledge on how different functions and processes operated. This was done with a series of questions focusing on the flexibility of the lead time. Understanding of the different functions and processes was developed by focusing on the flexibility of the customer order delivery and the order delivery process perspective. Here, the focus was on answering a series of question like:

– Was flexibility needed from the sales point or not?

– What is time-based strategy from the sales department point of view and is there one?

– How is flexibility created?

– Does time-based flexibility add internal costs?

– What are the reasons for offering shorter order lead times?

These high level questions were followed by supporting questions. The supporting questions were individual questions based on the answers of the key person(s) from the case firm. The logic that the questions followed was based on the "5Why" methodology.

A **quantitative** approach was employed with statistical data analysis. Statistical analyses were conducted on the acquired data with the help of statistical analysis tools like Microsoft Excel and Statistical Package for Social Sciences (SPSS). Both tools were used to conduct statistical analyses and graphical visualizations. The purpose of the quantitative approach was to provide less biased evidence for testing the research hypotheses than what was available with a qualitative approach. Value comparisons were made mainly by using Microsoft Excel when correlation analyses were carried out with SPSS. Correlation analyses were conducted by using Pearson's, Spearman's and Kendall's two-tailed (2-tailed) bivariate analysis. Two-tailed analyses were performed in order to test both directions (positive and negative) of the correlation. Correlation analyses were conducted in two groups:

1. Customer

2. Customer segment

In this research the limit of quantifying the level of statistical relevant analysis was set at 30 or more relevant samples. The limit of 30 or more samples was chosen based on the generally applied rule of thumb in statistical analysis. Thus, sample populations of less than 30 were not considered as hard evidence when testing the hypotheses and answering the research questions.

5.3 Approach for time-based flexibility analysis

In the coming analyses different lead time terms will be used. Certain time stamps from the order delivery process were recorded and used for indicating the used

lead time in this multi-case study. The time measurements started from the point when the customer order was recorded into order system (order entry date). This time was used for the reason that it was now up to the manufacturing firm to start the needed actions like engineering, procurement, production planning and production. The second and third time stamps were used for indicating the production lead time (production started and production finished). The fourth and fifth time indicated the time needed for preparing the product and documents for shipping (packing and invoicing started and packing and invoicing finished). The sixth time stamp was the date when the product was shipped (shipping date). The shipping date was used to indicate the end of the customer order lead time. These different time stamps and order lead times used in defining different lead times used in this multi-case study are shown in Figure 13.

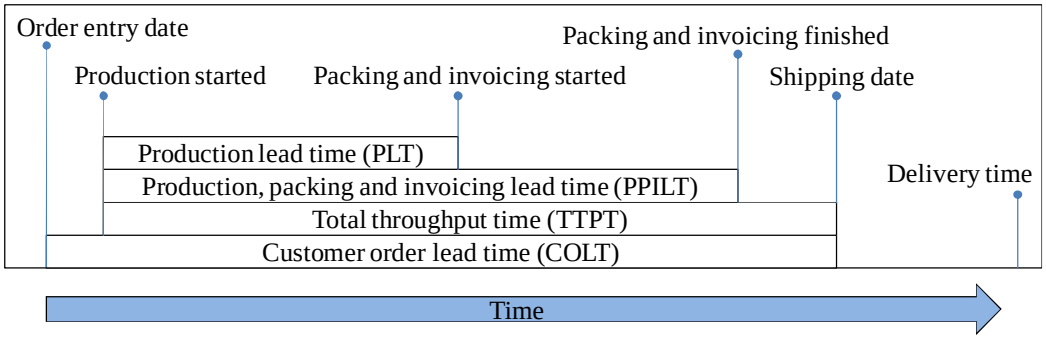

Figure 13. Lead time "time stamps" for different lead time terms.

Here, the shipping date was used instead of, for example, the customer order received date because different customers had different needs and requirements for their choice of transportation. Transportation was normally customer specific, meaning that the delivery terms were fixed for different customers. Similarly, different customer segments were using segment specific delivery terms in most cases. Times handled without dependency on transport enabled a comparison of the lead times within and between different customers and customer segments in this multi-case study.

In these analyses the most important time to focus on is the COLT. COLT represents the time closest to the time that the customer actually experienced. Also the possibilities to influence the COLT other than manufacturing times by expediting were much greater. The possibility for expediting selected orders were mostly done, for example, via dual sourcing, re-planning production, working overtime, building safety around bottlenecks or expediting the critical component delivery times from suppliers. Here, dual sourcing means that the same components or sub-assemblies could be purchased from different suppliers which had different capacities to offer, lead times and prices for the components and sub-assemblies.

Re-planning of the production means re-arranging the production release orders or reserving empty production slots for certain customers before the order is received. Expediting critical lead time components means increasing the delivery frequency, for example, from once per week to three times per week. This would thus shorten the average waiting time from three and half days to close to one day. Focusing on bottlenecks would mean, for example, ensuring the maximum up-time in the identified bottleneck, increasing capacity in the bottle neck or outsourcing certain bottleneck related sub-assemblies to increase the bottleneck process throughput.

5.4 Testing research question one and hypotheses

The purpose of the first research question was to test if the case firms were using time-based flexibility as part of their customer order strategy. From the customer perspective, time-based flexibility meant the adjustment of COLT (customer order lead time) according to customer needs. For this, it was hypothesized in the first hypothesis that the case firms in the field of electrical equipment and appliances were not offering different COLTs for customers. In other words, the case firms did not have the flexibility to offer significantly different COLTs for customers. Instead, the order delivery process operated purely with first-in-first-out principles with close to standard process and delivery times.

$H_0: \rho = 0$ (The case firm did not offer different COLTs for different customers)

$H_1: \rho \neq 0$ (The case firm did offer different COLTs for different customers)

The first approach was to interview different key people from different parts of the overall order delivery process that impacts the COLT. The questions focused on understanding how the processes were managed and if there was a possibility to adjust the COLT if needed. Interestingly, different time-based approaches were indicated by each of the case firms. For two of them the ability to respond to customer needs with the time-based flexibility of COLT was acknowledged. This was done through their commonly known processes. One of the case firms argued that time-based flexibility did not exist or was very rare. For them there was no commonly identified process, and it was handled case by case.

The second approach was to statistically test the hypothesis by analyzing the acquired order delivery data from the case firms. Analyses of the quantitative variables were condensed as mean values and standard deviations before conducting the tests. Here, this study explored the mean COLT values and standard devia-

tions of COLTs between and within earlier identified customer and customer segment groups. Testing the differences between mean COLTs was done by splitting the data into different customer groups. Each of these groups consisted of a different number of samples that could be identified within the group. Next, the unwanted groups were removed from the source data. The purpose of removing sample groups with less than 30 order delivery transactions was to create statistically valid analysis for the study. When the data contained only the statistically relevant sample groups, they were indexed according to mean COLTs. The purpose of indexing mean COLTs was to indicate the dimensions of the differences between mean COLTs in selected interest groups. The analyzed data also consisted of lead times other than COLT. These lead times were used for supporting the analyses and for building a deeper understanding of the firm's processes.

The aim of the second approach was to test two hypotheses that would provide more quantitative evidence for testing the first research question. These hypotheses were stated as follows:

$H_0: \rho = 0$ (Different customer groups were served with similar COLTs)

$H_1: \rho \neq 0$ (Different customer groups were served with variable COLTs)

and

$H_0: \rho = 0$ (No significant time-based flexibility existed within the analyzed group)

$H_1: \rho \neq 0$ (Significant time-based flexibility existed within the analyzed group)

The third approach was to confirm the second approach with a test for several independent samples. Testing several independent samples from the entire population was done by using the Kruskal-Wallis test. This test was used for two purposes. First, Kruskal-Wallis procedure was used for identifying the mean rank values. Here, the smallest COLT value is assigned Rank 1 (fastest customer order lead time), the second smallest COLT value is assigned Rank 2, and so on, until the largest value in the list is signed with the largest rank. The smallest Mean Rank value indicates the group with the fastest mean COLT value. Second, Kruskal-Wallis was used for testing that the samples did not differ in mean rank for the criterion variable. The first test was to indicate if the hypothesis was true. This test was to verify the observation from the first test and confirm the hypothesis test.

The test was done with SPSS by recoding the numeric sample groups (1,2,3,…,N) into "dummy" output variables using SPSS's "Transform" function. After recoding the numeric variables into output variables, non-parametric tests for several

independent samples within the customer and customer segment groups were conducted. These tests were hypothesized as follows:

$H_0: \rho = 0$ (There were no differences in the distributions of the COLTs for different groups)

$H_1: \rho \neq 0$ (There were differences in the distributions of the COLTs for different groups)

The hypothesis with the Kruskal-Wallis was evaluated by testing the chi-square value. Kruskal-Wallis H is calculated on the basis of sums of ranks for combined groups. Here, the H is computed as:

$$H = \frac{12}{N(N+1)} * SUM(T^2 i/ni) - 3(N+1)$$

H is computed as above and then a chi-square value is checked from the chi-square table with (k - 1) degrees of freedom, where k is the number of groups. If the tested critical chi-square value for the desired significance level (typically 0.05) is equal to or less than the computed H value, then the observer should reject the null hypothesis. Kruskal-Wallis was used to test for differences among feeds, because the normality of the data among different case firms was questionable and sample sizes within some selected groups were small. It is also more powerful and preferable because it takes rank size into account rather than just the above-below dichotomy of the median test (Hollander and Wolfe 1999).

The above described qualitative and quantitative analyses performed in three different electrical equipment and appliance manufacturing case firms were used to test the different hypotheses. The following three sections will cover the research question 1 analyses conducted in the case firms in more detail. Each case firm's results will be summarized at the end of each section and there is an overall summary in Section 5.3.4.

5.4.1 Mighty Machines

5.4.1.1 Interviews

Based on the interviews, it appeared that there was the flexibility to offer different COLTs to key customers. It was stated in the interviews that this kind of time-based flexibility was limited and could not be offered for all customers. The customers to whom this possibility was offered were mainly key customers with considerably high yearly volumes. It was very seldom that customers with smaller volumes were offered or received COLTs. Typically, smaller customers had to be satisfied with the COLTs promised. These promises were mostly based on the

process lead times from standard operations. However, it was also seldom that these customers even wanted or requested shorter COLTs than the ones offered in the first place.

5.4.1.2 Data analyses

A quantitative approach was used for validating the claims from the interviews. This was done by analyzing the order delivery data from the case firm Mighty Machines. In the collected data, Mighty Machines had 34 different customers, from which four had more than 30 qualified order samples. Four customers, Kisu, Misu, Sisu and Visu, had placed 218 product orders for specified products during the studied timeframe. This was more than 60 percent of the overall orders for this product.

Table 4. Order frequencies from customers Kisu, Misu, Sisu and Visu.

Customer

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Kisu	46	21.1	21.1	21.1
	Misu	30	13.8	13.8	34.9
	Sisu	107	49.1	49.1	83.9
	Visu	35	16.1	16.1	100.0
	Total	218	100.0	100.0	

The acquired data could be further divided into different customer segments. From the existing four customer segments, three qualified for hypothesis testing. These segments were A, B and D.

Table 5. Order frequencies from customer segments A, B, C and D.

Customer segment

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	A	88	24.4	24.4	24.4
	B	178	49.3	49.3	73.7
	C	7	1.9	1.9	75.6
	D	88	24.4	24.4	100.0
	Total	361	100.0	100.0	

Products for different customers and customer segments were made in two individual lines, Alfa and Beta. Since customer segments were served by two different production lines, Alfa and Beta, the decision was to extend the analysis. The purpose was to identify the difference of the lines and thus to understand the environment better.

Table 6. Order frequencies from production lines Alfa and Beta.

		Production line			
		Frequency	Percent	Valid Percentage	Cumulative Percentage
Valid	Alfa	266	73.7	73.7	73.7
	Beta	95	26.3	26.3	100.0
	Total	361	100.0	100.0	

The Alpha and Beta lines were specialized in producing very similar products with different levels of customization, which depended on the customer needs. Splitting the incoming orders into two production lines according to the level of product customization enabled a closer study of the use of COLT in different customer segments. Although the studied end-products were more or less similar, the separation of lines for the analysis made a comparison of similar products from the Alfa line possible. Production line Alpha served customers with slightly less customized products than production line Beta. Alfa had the higher numerical throughput of these two production lines. According to the research data from the past two years, close to 74 percent of the orders were produced by production line Alpha.

Table 7. Order frequencies from customer segments A, B, C and D by production lines Alfa and Beta.

			Customer segment			
Production line			Frequency	Percentage	Valid Percentage	Cumulative Percentage
Alfa	Valid	B	178	66.9	66.9	66.9
		D	88	33.1	33.1	100.0
		Total	266	100.0	100.0	
Beta	Valid	A	88	92.6	92.6	92.6
		C	7	7.4	7.4	100.0
		Total	95	100.0	100.0	

Alpha also produced for two main customer segments in the research. These customer segments were B and D. From these two customer segments, segment B was the biggest from the studied customer segments at Mighty Machines. Customer segment B had nearly half of the total orders. Customer segment D was the smaller of the customer segments produced in production line Alpha. Overall, D was the second biggest customer segment, together with customer segment A from production line Beta. D segment comprises slightly over 24 percent of the total orders studied.

Beta served customers with a slightly higher customization level than production line Alpha. Beta represented the remaining 26 percent of the production orders studied. Like Alpha, Beta also fulfilled orders for two of the main four customer segments. These segments were A and C. Customer segment A shared the second biggest customer segment, together with customer segment D from production line Beta, with slightly over 24 percent. The smallest customer segment for Beta was customer segment C, which had less than two percent of the total orders, and because of the small number of orders it did not qualify for statistically relevant analysis. For this reason, customer segment C has no statistically relevant value for the later analysis. However, customer segment C was part of production line Beta and also served different individual customers. Thus, it was not completely removed from the data, but used for adding valuable samples for customer and production line level analyses.

Four different mean order lead times were used for indexing the COLTs for four customers, three different customer segments and two production lines. They were indexed in a way that the smallest mean COLT value was used as a divider for the other mean values of the COLTs. The base figure 1.00 indicated the fastest mean for COLT value. In other words, 1.00 indicated the fastest COLT mean among the studied group, and as the index number increased, so the mean COLT also increased. The indexed mean COLTs were then compared between the customers, customer segments and production lines.

Due to fact that Mighty Machines had data available from in-house processing times from several stages of the process, supporting measurements for COLT were used. These were total throughput time (TTPT), production, packing and invoicing lead time (PPILT), and production lead time (PLT). TTPT was a measure between the order received date and production finished date. PPILT was a measure between production started date and ready for shipping date. PLT was a measured time between the production start date and production finish date. The purpose for also analyzing TTPT, PPILT and PLT was to identify where the time-based flexibility was created.

5.4.1.3 Customers

Customer orders from Kisu, Misu, Sisu and Visu were distributed to production lines Alfa and Beta. The only exception was Misu, which did not have any deliveries from production line Beta. Orders from Kisu, Sisu and Visu were distributed among the different production lines as indicated in the frequency column in Table 8.

Table 8. Distribution of orders to production lines Alfa and Beta.

Customer

Production line			Frequency	Percentage	Valid Percentage	Cumulative Percentage
Alfa	Valid	Kisu	43	24.7	24.7	24.7
		Misu	30	17.2	17.2	42.0
		Sisu	100	57.5	57.5	99.4
		Visu	1	.6	.6	100.0
		Total	174	100.0	100.0	
Beta	Valid	Kisu	3	6.8	6.8	6.8
		Sisu	7	15.9	15.9	22.7
		Visu	34	77.3	77.3	100.0
		Total	44	100.0	100.0	

First, different customers had to be selected from the data by using the SPSS function “Select cases”. Then, different mean values of the lead time were analyzed by using descriptive statistics. When mean values for the different lead times were calculated by the statistical analysis tool, SPSS, they were indexed and entered into a Microsoft Excel worksheet.

Table 9. Mean lead times indexed for different customers.

Customers	**Kisu**	**Misu**	**Sisu**	**Visu**
Number of orders	*46*	*30*	*107*	*35*
Customer order lead time (COLT)	**1.00**	**1.30**	**1.03**	**1.04**
Std. Deviation of COLT	*1.01*	*1.13*	*2.64*	*1.00*
Total throughput time (TTPT)	**1.00**	**1.21**	**1.08**	**1.13**
Std. Deviation of TTPT	*1.34*	*1.00*	*3.18*	*1.15*
Production, packing and invoicing lead time (PPILT)	**1.03**	**1.74**	**1.00**	**1.11**
Std. Deviation of PPILT	*1.61*	*1.76*	*1.00*	*1.40*
Production lead time (PLT)	**1.00**	**1.42**	**1.15**	**1.47**
Std. Deviation of PLT	*1.58*	*1.00*	*1.92*	*1.27*

Looking at the results from the customer perspective would mean looking at the customer order lead times (COLTs). When answering the first research question, the focus ought to be on the standard deviation of the COLTs. Three customers, Kisu, Sisu and Visu, had very similar COLT indexes. However, the standard deviation index for the COLT was significantly higher with Sisu than with Kisu, Visu, or even Misu. This indicated that the scale of variation of customer order lead times was much higher than with others. This supported the information from the interviews, where it was claimed that higher volume customers were offered time-based flexibility when possible.

According to the interviews and statistical analysis, Mighty Machines offered significantly different order lead times for their customers. As it appeared, the customer to whom this time-based flexibility was offered the most was Sisu, which had the highest number of orders during the studied time period. Thus, the interview and analysis confirmed that the case firms were delivering similar products with significantly diverging order delivery lead times for different customers.

Kruskal-Wallis test on customers

The Kruskal-Wallis ranks in Table 10 confirmed the claim indicated in the interviews that high volume key customers are given time-based flexibility in COLTs. The earlier approach of testing the mean COLTs between different customers could not indicate accurately enough if the claimed flexibility was really given to the high volume customers. That was because the mean COLTs of the three highest volume customers, Kisu (1), Misu (2) and Visu (4), were ranked quite close to each other (see Table 9 for more details). Instead, the Kruskal-Wallis test statistics in Table 10 indicate that there is a statistically significant difference in the distribution of COLTs between different customers, chi-square = 19.766 and ρ=0.000. Since ρ equaled zero, there is no change in obtaining the rank-difference chi-square equal or greater than the observed (19.766) by change.

Table 10. Nonparametric Kruskal-Wallis test results from selected customers.

Ranks

	Customer		N	Mean Rank	Rank
COLT		Kisu (1)	46	113.16	2
		Misu (2)	30	148.80	4
		Sisu (3)	107	93.42	1
		Visu (4)	35	120.16	3
		Total	218		

Test Statistics[a,b]

	COLT
Chi-square	19.766
df	3
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer

Thus, the Kruskal-Wallis test indicated that the COLT ranking on the customer level correlated with the numbers of the order in such a way that when the number of orders was high the COLT was low. In other words, high volume customers were offered the fastest COLTs.

5.4.1.4 Customer segments

Second, data was analyzed from the customer segment perspective. From the data, different customer segments A, B, C and D were selected. Then mean order and process lead times were calculated in the same way as for individual customers Kisu, Misu, Sisu and Visu. Earlier shortening of the data according to the cus-

tomer segments indicated how the two production lines were actually divided to serve different customer segments. The descriptive analysis in Table 10 indicates that production line Alfa serves customer segments B and D, and Beta serves A and C. In the following analysis the customer segments and production lines are studied together. In this way, the study was able to compare not only the difference between the customer segments, but also between customer segments that are produced in the same and in different production lines.

Table 11. Mean lead times indexed for different customer segments.

Customer segments	**B**	**D**	**A**
Number of orders	*178*	*88*	*88*
Customer order lead time (COLT)	**1.00**	**1.23**	**1.04**
Std. Deviation of COLT	*1.97*	*1.33*	*1.00*
Total throughput time (TTPT)	**1.00**	**1.14**	**1.15**
Std. Deviation of TTPT	*1.59*	*1.01*	*1.00*
Production, packing and invoicing lead time (PPILT)	**1.00**	**1.50**	**1.12**
Std. Deviation of PPILT	*1.00*	*1.64*	*1.11*
Production lead time (PLT)	**1.00**	**1.20**	**1.54**
Std. Deviation of PLT	*1.82*	*1.00*	*2.46*
Production line	**Alfa**	**Alfa**	**Beta**

As Table 11 shows, customer segment B had the fastest lead time means in all the areas measured. Having the smallest COLT index indicated that customer segment B was offered the fastest lead time among all the customer segments measured. Customer segment B also had the most orders delivered, with nearly 50 percent of the studied orders, and almost 67 percent of all the orders for production line Alpha. These issues were also confirmed in the interviews, where it was claimed that shorter lead times were offered to high volume key customers. Here, the high volume was coming from a certain customer segment, but the expected outcome was the same as from the individual customer.

Surprisingly, the second fastest customer segment was not produced on production line Alpha. Instead, it was assembled on production line Beta for customer segment A. Customer segment A had the highest order volume on production line Beta. It had nearly 93 percent of the analyzed orders on Beta, and around 24 percent of overall orders. It was interesting that the second fastest customer segment A was indexed as notably slower on TTPT, PPILT and PLT than customer segment B, but had only a slightly bigger COLT index value. All in all, the measured lead time indexes for customer segment A were ranked as the second fastest, except for PLT. PLT for customer segment A was the slowest of the three tested segments. In practice, this meant that products produced for customer segment A took the longest mean time to be assembled on the production line, indicating that

time-based flexibility was present in earlier processes like engineering and procurement.

Customer segment D was served with the longest COLT. Products for customer segment D were assembled on production line Alpha. The number of orders from customer segment D was equal to customer segment A. With 88 orders, customer segment D had slightly more than 33 percent of the overall volume produced on production line Alpha. From the three customer segments, customer segment D had the highest COLT index, indicating that it had the highest mean COLT. Customer segment D was also the slowest on PPILT, but slightly faster on TTPT and notable faster with PLT than customer segment A. PLT was indexed at 0.20 units slower than the fastest segment B, but 0.34 units faster than the second fastest customer segment A.

The difference between the two fastest mean COLT values for customer segments B and A was not that significant. Interestingly, the case firm representatives in the interview also argued that these two production lines were distinguished by a fast and slow category. This seemed to be the case. Production lead time (PLT) had a significantly higher mean COLT value for customer segment A assembled on line Beta than for customer segments B or D assembled on line Alfa. Despite the longer PLT, the mean COLT for customer segment A was nearly as fast as it was for customer segment B. This indicated that the time-based flexibility had been created in processes other than physical production such as engineering and procurement.

The ranking based on the mean COLT index values indicated that different customer segments were served with significantly diverging lead times. As for individual customers, the flexibility of offering different COLTs was tested with the standard deviation variation of the COLT values. These indexed standard deviation values in Table 11 indicate the same as in the analyses for individual customers. Here, customers with the highest volumes were offered the most time-based flexibility for the COLTs. Similarly, customer segments with the highest volumes were offered the most time-based flexibility on COLTs. The indexed mean COLT variation was nearly double compared with customer segment A, which had the second smallest mean COLT index. Thus, it can be argued that the case firms delivered similar products with significantly diverging order delivery lead times for different customer segments.

Kruskal-Wallis test on customer segments

The Kruskal-Wallis rankings in Table 12 gave more weight to the interview based claim that high volume customers had more flexibility on COLTs. The highest volume customer segment B from production line Alfa had the smallest mean rank, indicating the fastest COLTs. The second highest volume was divided between customer segments A and D. Customer segment A was produced on production line Beta and D was produced on the same production line as B. In Table 11, customer segment A was ranked with the second smallest mean rank value, indicating it to be the second fastest customer segment. Customer segment D was third, and C fourth.

The Kruskal-Wallis test statistics table indicates a significance level of 0.000, which means that there is a 0.0% chance of obtaining a rank-difference chi-square equal to or greater than that observed (30.575) by chance. This means that the ratings of the referendum issue do differ significantly by media.

Table 12. Nonparametric Kruskal-Wallis test results on selected customer segments.

Ranks

	Customer segment		N	Mean Rank	Rank
COLT		A (1)	88	186.65	2
		B (2)	178	153.85	1
		C (3)	7	238.71	4
		D (4)	88	225.67	3
		Total	361		

Test Statistics[a,b]

	COLT
Chi-square	30.575
df	3
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer segment

Thus, this provides sufficient evidence to reject the null hypothesis on customer segment level and conclude that there is a statistically significant difference in distribution of the COLTs between different customer segments.

5.4.1.5 Summary of the analysis at Mighty Machines

The interviews indicated that Mighty Machines was offering different customers time-based flexibility. The first analysis, made for order delivery data among selected customers, verified that the mean COLTs offered for different customers had significant variation. This supported the information from the interviews. Testing the standard deviations on the lead times also indicated that time-base flexibility exists between different orders within the selected customer group. With some customers it was higher than for others, just as claimed by the key persons interviewed. Similar results were achieved in the analysis of selected customer segments. COLTs for different customer segments had significant vari-

ances. Similarly, the standard deviations of certain customer segments were higher than others, indicating that certain customer segments had more flexibility on the COLTs than others. Finally, the Kruskal-Wallis tests provided sufficient evidence that there was difference in the distribution of the COLT values among the tested sample groups.

Table 13. Summarizing the RQ1 results for Mighty Machines.

		Statistical analysis 1		***Statistical analysis 2***	
	Interview	**Customers**	**Customer segments**	**Customers**	**Customer segments**
Research question 1	Yes	Yes	Yes	Yes	Yes

The interviews, together with the statistical analyses, provided enough evidence to reject both of the stated null hypotheses on research question 1 (Table 13). The interviews indicated that there was time-based flexibility on COLTs. The statistical analyses confirmed the variation of mean COLTs between different groups and that there was statistically significant difference between the actual COLTs within the different groups analyzed. Rejecting null hypotheses with enough qualitative and quantitative evidence concluded that Mighty Machines had a time-based strategy to serve customers, and the ability to offer diverging COLTs for different groups. Mighty Machines also provided more flexibility on COLTs within certain groups than others. Thus, all the evidence indicated that Mighty Machines was able to use time-based flexibility when offering products to their customers.

5.4.2 Power Control

5.4.2.1 Interviews

Interviews at Power Control indicated that the process for time-based flexibility for the COLT was not utilized, or utilized rarely. The process or strategy for time-based flexibility itself was not well-specified. It was claimed that the implementation of time-based flexibility for specific orders was problematic to manage. Thus, the general point of view was that Power Control does not offer different lead times for different customers or customer segments. The COLTs offered would be dependent on key component availability from suppliers and manufacturing capacity rather than customer needs or requirements.

5.4.2.2 Data analyses

The amount of qualified data was limited due to changes in production that affected the lead times in such a way that they were not comparable. Thus, only 6 months of order delivery data could be used in this case study. Second, order delivery data was quite limited in lead time details. The only available dates were the date when the order was registered in the order system, the promised and actual delivery date. Even though only COLTs were required for the final analyses, other time stamps from the processes could have opened up the case even more. A third issue was the quality of the data. Unfortunately, this placed certain limitations for data analysis, and many reported order delivery lines had to be disregarded. Despite these issues mentioned, the acquired data from Power Control could be used for testing the hypothesis for the first research question.

5.4.2.3 Customers

First, the order delivery data was split into eight different customers (see Table 14). Out of the eight customers, only customer 7 had enough cases for conducting statistically relevant analysis. Since there was only one customer group for the comparison, a reliable comparison among the other customer groups could not be conducted with the first statistical analysis approach. Despite that, customer level time-based flexibility analyses were conducted. There were two reasons why customer based analyses were conducted. The first was to obtain more insights into how the case firm's operation models responded to the time-based flexibility test. The second was to test the validity of the interview results.

Table 14. Order frequencies of product A from eight customers.

Customer

		Frequency	Percent	Valid Percentage	Cumulative Percentage
Valid	Customer 1	6	6.5	6.5	6.5
	Customer 2	3	3.3	3.3	9.8
	Customer 3	7	7.6	7.6	17.4
	Customer 4	20	21.7	21.7	39.1
	Customer 5	7	7.6	7.6	46.7
	Customer 6	1	1.1	1.1	47.8
	Customer 7	39	42.4	42.4	90.2
	Customer 8	9	9.8	9.8	100.0
	Total	92	100.0	100.0	

When the customers were listed, the second step was to index customer based mean COLTs and their standard deviations (Table 15). The indexed variances between the mean COLTs were reasonably small considering the small population and sample sizes. This analysis approach indicated that the clear pattern of

favoring high volume customers did not exist in this case firm. The fastest mean COLTs were with customer 5, which was one of the medium volume customers. The highest volume customer 7 had the second fastest mean COLT values, but customer 4 with the second highest volumes had nearly double the mean COLT values of customer 5. Also, the standard deviations of the COLTs had no recognizable pattern, maybe due to the small sample size, or simply that there was none as stated in the interviews.

Table 15. Mean lead times indexed for different customers.

Customers	**Customer 1**	**Customer 2**	**Customer 3**	**Customer 4**	**Customer 5**	**Customer 6**	**Customer 7**	**Customer 8**
Number of orders	*6*	*3*	*7*	*20*	*7*	*1*	*39*	*9*
Customer order lead time (COLT)	**1.51**	**1.92**	**1.41**	**1.93**	**1.00**	**1.59**	**1.08**	**1.53**
Std. Deviation of COLT	*1.00*	*12.19*	*5.60*	*14.49*	*5.87*	*-*	*3.93*	*3.92*

Kruskal-Wallis tests on customers

Testing the customer segments with Kruskal-Wallis can be, and is, recommended when the sample sizes in each group are small (Hollander and Wolfe 1999; Woodward 2007). Because of the limited population sample, the Kruskal-Wallis analysis fitted well in analyzing Power Control's order delivery data on both the customer and customer segment levels. The output for the Kruskal-Wallis analysis on selected customers in Table 16 is divided into two separate tables. The table "Ranks" shows the mean rank for each customer group, and the table "Test Statistics" reports the chi-square test statistic and associated ρ-value.

Table 16. Nonparametric Kruskal-Wallis test results for selected customers.

Ranks

	Customer	N	Mean Rank	Rank
COLT	Customer 1	7	56.64	4
	Customer 2	2	86.00	8
	Customer 3	7	52.86	3
	Customer 4	20	68.10	6
	Customer 5	7	25.71	1
	Customer 6	1	71.00	7
	Customer 7	39	30.14	2
	Customer 8	9	61.22	5
	Total	92		

Test Statistics[a,b]

	COLT
Chi-square	41.407
df	7
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Customer

The Kruskal-Wallis test for comparison of COLTs indicates that there was a statistically significant difference between the COLTs among different customers. Even though the population of samples was very limited, the analyses indicated that there was likely to be evidence for rejecting the null hypothesis on the customer level.

5.4.2.4 Customer segments

After completing the customer level analysis, the order delivery data was divided into customer segments. Dividing the data into two customer segments, A and B, enabled testing of the first hypothesis for the second research question. The difference between the two first case firms was that in Power Control all the products were assembled on the same production line. This ruled out the need to compare different production lines. Other than that, the hypothesis tests were conducted as for Mighty Machines.

Table 17. Order frequencies from customer segments A and B

Customer Segment

		Frequency	Percent	Valid Percentage	Cumulative Percentage
Valid	A	42	45.7	45.7	45.7
	B	35	38.0	38.0	83.7
	C	*15*	*16.3*	*16.3*	*100.0*
	Total	92	100.0	100.0	

Customer segment A had the highest volume of orders from the two tested segments. Customer segment A had 42 order delivery transactions, whilst customer segment B had 35 reported order delivery transactions (see Table 17 for more details). The analysis in Table 18 indicates that customer segment B had a significantly longer mean COLT. The difference between customer segment A and B was as high as 0.54. It was interesting that these two customer segments had such a big difference between COLTs, although both of them were ordering the same product, which was manufactured from the same key components, on the same production line, and by the same persons. The difference between the slowest and fastest served customer segments was even greater than with Mighty Machines. Thus, the difference can be regarded as significantly diverging and would thus confirm the hypothesis on the customer segment level. Also, the time-based flexibility measured with standard deviation of COLTs indicated the same. Thus, this contradictory situation required further analysis in order to obtain more evidence for rejecting the null hypotheses.

Table 18. Mean lead times indexed for different customers.

Customer segments	**A**	**B**
Number of orders	*42*	*35*
Customer order lead time (COLT)	**1.00**	**1.54**
Std. Deviation of COLT	*1.00*	*1.98*

Kruskal-Wallis tests on customer segments

The advantage of analyzing small sample populations with Kruskal-Wallis was exploited again on the customer segment level by including customer segment C (3) into analysis. The analyses in Table 19 were divided similarly into two separate tables: "Ranks" and "Test Statistics", just as for the customer level Kruskal-Wallis analysis.

Table 19. Nonparametric Kruskal-Wallis test results for selected customer segments.

Ranks

	Customer Segment		N	Mean Rank	Rank
COLT		A (1)	42	32.89	1
		B (2)	35	65.01	3
		C (3)	15	41.40	2
		Total	92		

Test Statistics[a,b]

	COLT
Chi-square	28.335
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer Segment

The Kruskal-Wallis test results shown in Table 19 indicate that there was a statistically significant difference in the distribution of COLTs between the different customer segments, chi-square 28.335 and ρ=0.000. Thus, the analyses indicated sufficient evidence to reject the null hypothesis, also on the customer segment level.

5.4.2.5 Summary of analysis at Power Control

The use of time-based flexibility was clearly denied in the case firm interviews, yet the data analysis showed a different indication. There can be a contradiction between qualitative and quantitative analysis for several reasons, and it is likely that the qualitative data was true and the quantitative data analysis indicated differences between COLTs for other reasons. Theses can also be customer or customer segment related. For example, different customers or customer segments could have needs for additional services for the products. One example of these kinds of needs or requests was the factory acceptance tests (FATs) that had to be arranged for end customers at the factory site. Scheduling the test facilities to meet the customer schedules could be the reason for extended COLTs. The same

principle would also apply to customer segments because the use of FATs was more common in certain customer segments than others. However, this was just one of the reasons that could explain the difference between the qualitative and quantitative data analysis. Thus, further investigation on what caused the differences between COLTs could be helpful to create a deeper process understanding of the case firm.

5.4.3 Agile Grid

The case firm Agile Grid was chosen to further investigate two very similar products in a product family that had been manufactured for few years without any major changes in processes. These two similar products were considered as one due to very similar technical characteristics and processes that they undergo within the manufacturing processes. In this way, the case study was able to build an extensive sample population of recorded order deliveries.

5.4.3.1 Interviews

Interviews at Agile Grid indicated that there was the possibility to offer shorter COLTs to customers. However, this probably could not be done through their normal capacity and processes. Instead, a shorter COLT would require special arrangements and overtime work. On the other hand, working overtime to complete customer orders faster would create additional manufacturing costs for the product itself. Thus, it was not the preferred way to operate but used in order to serve customers better.

5.4.3.2 Data analyses

Data analyses for Agile Grid were conducted using the two approaches already introduced earlier, though some modifications were needed due to the changes that took place in the customer field. A merger that occurred during the middle of the studied time period changed the customer field among key customers. For this reason, the data was split into two time periods. The first part involves data before the change, and the second part data after it. From now on these time periods will be referred to as the first and second periods. In other words, the indexing of COLTS and standard deviations were made in the same way as for the other case firms, but in two separate parts. In both parts the focus remained on mean COLTs. This data was also divided into two different products and into three different market regions as requested by the case firm.

5.4.3.3 Customers

In the first period, customer orders had been received from seven different customers. Out of these, six had enough data for statistically valid analysis. These six customers were analyzed by using the second approach, which compared the indexed COLTs among different customers.

Table 20. Mean lead times from the first period indexed for different customers.

Customers	**Customer 1**	**Customer 2**	**Customer 4**	**Customer 5**	**Customer 6**	**Customer 9**
Number of orders	*260*	*34*	*284*	*133*	*33*	*34*
Customer order lead time (COLT)	**1.41**	**1.30**	**1.09**	**1.24**	**1.00**	**1.13**
Std. Deviation of COLT	*1.56*	*1.86*	*1.00*	*1.73*	*1.34*	*1.26*
Total throughput time (TTPT)	**1.40**	**1.28**	**1.02**	**1.26**	**1.04**	**1.00**
Std. Deviation of TTPT	*2.37*	*2.63*	*1.52*	*2.58*	*2.05*	*1.00*

In Table 20, different customers are indexed based on their mean COLT values and standard deviations of COLTs. Customer 4 had the highest volume during the analysis period. It was indexed to have the second fastest mean COLT value. In fact, it was so close to customer 6 that elimination of one outlier from the customer 6 data made customer 6 have the smallest mean COLT value. The smallest volume customer (customer 6) had the fastest mean COLT values, while the customer with second highest volumes (customer 1) had the slowest COLT values. This could indicate that the volume sizes made no difference to the speed of customer deliveries. Despite that, analysis clearly indicated that different customers were served with significantly diverging mean COLTs. Similarly, the standard deviations indicated no clear dependencies on the volumes. Studying the standard deviation figures from Table 20 also indicated that there was a different amount of COLT deviation with different customers. Based on this result, it could be inferred that time-based COLT flexibility existed between and in the sample groups. As such, significantly diverging COLTs substantiated that a null hypothesis could be rejected. Rejecting the null hypothesis meant that different customers were served with significantly diverging mean COLTs.

Second period

The second period of the data contained order delivery data from seven customers. From the seven, five had the required minimum amount of 30 or more order delivery transactions during this period. In this period the new customer through the merger was customer 7.

Table 21. Mean lead times from the second period indexed for different customers.

Customers	Customer 1	Customer 4	Customer 7	Customer 8	Customer 9
Number of orders	*165*	*199*	*146*	*30*	*66*
Customer order lead time (COLT)	**1.19**	**1.12**	**1.00**	**1.31**	**1.24**
Std. Deviation of COLT	*1.00*	*1.89*	*2.31*	*1.74*	*1.24*
Total throughput time (TTPT)	**1.00**	**1.05**	**1.06**	**1.23**	**1.16**
Std. Deviation of TTPT	*1.00*	*1.89*	*2.15*	*1.86*	*1.22*

The results shown in Table 21 indicate that the differences between the indexed mean COLT values were not as big as during the first period. Despite the fact that the mean COLT values were closer to each other, the values still significantly diverged between different customers. An interesting observation from Table 20 is that the new customer (customer 7) had the smallest mean COLT value. This indicated that customer 7 had the orders delivered fastest on average. Another observation on the deliveries to customer 7 was that it had the biggest standard deviation of COLTs, which could indicate also the highest time-based flexibility in order lead times.

Another interesting observation is the differences between mean TTPT and COLT values for customers 1, 4 and 7. The differences between the mean TTPT values of the fastest top three customers were very small (0.06), but the differences between the mean COLTs at the customer level were much bigger (0.19). This could indicate that time-based flexibility for customer orders could have been produced before the actual manufacturing, most likely in the office and procurement processes or even after the manufacturing process in shipping and logistics. A significant time gain after the manufacturing seems unlikely, since packing operates on the basis of first in first out and shipment pickups were done on a daily basis regardless of the customer or destination. Thus, it is most likely that it happened in office processes such as order handling and production planning.

The first and second periods also differed from each other in two notable ways. First, the mean order intake from the studied three countries was 65 orders per month during the first period and 69 orders per month during the second. As such, there is nothing extraordinary in that. The interesting part was the difference of overall mean COLT values between the first and second period. The overall mean COLT values dropped by more than 30 percent during the second period. This indicates that significant time-based changes had happened to the lead times offered to customers.

Kruskal-Wallis tests on customers

The results of the Kruskal-Wallis analysis for the first period for the selected customers are shown in Table 22. The table "Ranks" on the left shows the mean rank for each customer group, and the table "Test Statistics" reports the chi-square test statistic and associated ρ-value.

Table 22. Nonparametric Kruskal-Wallis test results from the first period for selected customers.

Ranks

	Customer	N	Mean Rank	Rank
COLT	1	260	477.84	7
	2	34	400.31	6
	3	4	112.00	1
	4	284	337.04	3
	5	133	371.01	5
	6	33	323.77	2
	9	34	356.13	4
	Total	782		

Test Statistics[a,b]

	COLT
Chi-square	65.676
df	6
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer

The Kruskal-Wallis test statistics table (Table 22) indicates a significance level of 0.000 (ρ=0.000), which means that there is a 0.0% chance of obtaining a rank-difference chi-square equal to or greater than that observed (65.676) by chance. This means that the ratings of the referendum issue do differ significantly by media and thus a null hypothesis can be rejected.

Table 23. Nonparametric Kruskal-Wallis test results from the second period for selected customers.

Ranks

	Customer	N	Mean Rank	Rank
COLT	1	165	365.49	4
	4	199	293.23	3
	5	10	423.10	7
	6	7	223.79	2
	7	146	233.23	1
	8	30	380.75	6
	9	66	370.38	5
	Total	623		

Test Statistics[a,b]

	COLT
Chi-square	61.618
df	6
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer

The Kruskal-Wallis test statistics table (Table 23) indicates a significance level of 0.000 (ρ=0.000), which means that there is a 0.0% chance of obtaining a rank-difference chi-square equal to or greater than that observed (61.618) by chance. This indicates that there is sufficient evidence to reject the null hypothesis on the customer level.

5.4.3.4 Customer segments

As with customer analyses, orders from customer segments were split into a first and second period. The data from three different countries included six different customer segments. From these six, three customer segments had enough order delivery transactions for statistically relevant analysis. In addition, the overall order delivery transactions were also analyzed. This was done in order to compare the changes in order volume balances and whether that had impact on the COLT values at the customer segment level.

Table 24. Indexed mean lead times and standard deviations from the first, second and overall periods for different customer segments.

Period I: Customer segments	**A**	**B**	**C**
Number of orders	*104*	*280*	*390*
Customer order lead time (COLT)	**1.00**	**1.00**	**1.23**
Std. Deviation of COLT	*1.38*	*1.00*	*1.55*
Total throughput time (TTPT)	**1.00**	**1.00**	**1.30**
Std. Deviation of TTPT	*1.16*	*1.00*	*1.53*
Period II: Customer segments	**A**	**B**	**C**
Number of orders	*77*	*347*	*180*
Customer order lead time (COLT)	**1.26**	**1.00**	**1.16**
Std. Deviation of COLT	*1.10*	*1.61*	*1.00*
Total throughput time (TTPT)	**1.22**	**1.00**	**1.03**
Std. Deviation of TTPT	*1.16*	*1.55*	*1.00*
Overall: Customer segments	**A**	**B**	**C**
Number of orders	*181*	*627*	*570*
Customer order lead time (COLT)	**1.14**	**1.00**	**1.31**
Std. Deviation of COLT	*1.00*	*1.08*	*1.19*
Total throughput time (TTPT)	**1.13**	**1.00**	**1.37**
Std. Deviation of TTPT	*1.00*	*1.14*	*1.34*

The first period in Table 24 shows no clear sign of the dependencies between order volumes and COLTs. The two customer segments, A and B, with the smallest volumes had smaller mean COLT index values than customer segment C with the highest volume during the first period. This indicated that they were served faster on average than customer segment C, which had the highest volume during the first period. However, the two fastest served customers segments, A and B, had the same indexed COLTs, and customer segment A had significantly higher standard deviation for COLT. This strongly suggested that customer segment A had significantly more time-based flexibility in COLTs. What is also worth pointing out from Table 24 is the mean total throughput time (TTPT) index. The in-

dexed value for TTPT was the same for customer segments A and B, but 0.30 units higher for customer segment C.

During the second period the situation had changed. Table 25 indicates the changes of the rankings from the first period to the second. In Table 25, the arrow up symbol (↑) indicates an increase in position, the arrow down symbol (↓) indicates a decrease in position, and no change is indicated with the symbol (-). The number in front of the symbol indicates how many positions the change from the first to second period has represented.

Table 25. Customer segment lead times ranked for comparing changes between the first and second period.

Period II: Customer segments	**A**	**B**	**C**
Number of orders	*3* (-)	*1* (↑)	*2* (↓)
Customer order lead time (COLT)	**3** (2↓)	**1** (-)	**2** (↑)
Total throughput time (TTPT)	**3** (2↓)	**1** (-)	**2** (↑)

The most drastic change occurred for the smallest volume customer segment A. Customer segment A was served with the longest mean COLTs and TTPTs. Customer segment B had gained the highest volumes and had the shortest mean COLT and TTPT values. Customer segment C dropped to second position in volume, but at the same time reached the second fastest position in mean COLT and TTPT values. This change indicated that the volumes could be dependent on COLTs.

Analyses of the first and second period data indicated significant differences between the customer segment mean COLT values. This indicates that different COLTs were offered for different customer segments. The significant differences between standard deviations between mean COLTs, on the other hand, did not rule out the existence of time-based flexibility.

Kruskal-Wallis tests on customer segments

The Kruskal-Wallis test shown in Table 26 for the first period order delivery data indicated a significance level of 0.000. This significance level meant that there was a 0.0% chance of obtaining a rank-difference chi-square equal to or greater than that observed (49.208) by chance. As such, the ratings of the referendum issue do differ significantly by media and thus the null hypothesis can be rejected. Rejecting the null hypothesis meant that there were differences in the distribution of the customer segment COLTs.

Table 26. Nonparametric Kruskal-Wallis test results from the second period for selected customer segments.

Ranks

	Customer segment	N	Mean Rank	Rank
COLT	1	104	324.54	2
	2	280	350.07	3
	3	390	439.45	5
	4	3	732.50	6
	5	1	350.50	4
	6	4	112.00	1
	Total	782		

Test Statistics[a,b]

	COLT
Chi-square	49.208
df	5
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer segment

As with the first period of customer segment order delivery data analysis, the Kruskal-Wallis test statistics (Table 27) indicated a 0.0% chance of obtaining a rank-difference chi-square equal or greater than that observed (65.895). Similarly, the null hypothesis could be rejected.

Table 27. Nonparametric Kruskal-Wallis test results from the second period for selected customer segments.

Ranks

	Customer segment	N	Mean Rank	Rank
COLT	1	77	399.85	4
	2	347	263.23	1
	3	180	373.16	3
	5	19	267.32	2
	Total	623		

Test Statistics[a,b]

	COLT
Chi-square	65.895
df	3
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Customer segment

5.4.3.5 Summary of analysis at Agile Grid

The analysis done for the different customers and customer segments indicated strongly that different customers and customer segments were offered significantly diverging COLTs. Also, the standard deviations between the COLTs in customers and customer segments indicated that time-based flexibility could be offered. Based on the interviews and two different approaches to analyze the order delivery data, this study can suggest the rejection of the null hypothesis set for the first research question.

5.4.4 Summary of research question 1 and its hypotheses

Four hypotheses were tested in order to answer the first research question: "Do the case firms deliver similar products with significantly diverging order delivery lead times for different customers and customer groups?" In the first, it was hypothesized that the case firm was not offering different customer order lead times (COLTs) for different customers or customer groups. This hypothesis was answered by using a qualitative, interview-based approach. The second approach was to use quantitative, statistical tests to analyze the order delivery data from the case firms. For the statistical test two hypotheses were set. The second and third hypotheses for the first research question were hypothesized in such a way that the null hypothesis stated that all customer groups were served with similar COLTs and there was no time-based flexibility within the analyzed groups. In the third hypothesis, it was hypothesized that there were no differences in the distributions of the COLTs between different customers or customer segments. For testing this hypothesis, the statistical Kruskal-Wallis test was used.

Table 28. Summary of testing of the hypotheses for the first research question.

	Mighty Machines	Power Control	Agile Grid
RQ1: *Were the case firms delivering similar products with significantly diverging order delivery lead times for different customers and customer groups?*	YES	YES	YES
$H_0: p = 0$ (The case firm did not offer different COLTs for different customers)	FALSE	TRUE	FALSE
$H_0: p = 0$ (Different customer groups were served with similar COLTs)	FALSE	FALSE	FALSE
$H_0: p = 0$ (No significant time-based flexibility existed within the analyzed group)	FALSE	FALSE	FALSE
$H_0: p = 0$ (There were no differences in the distributions of the COLTS for different customer groups)	FALSE	FALSE	FALSE

In the analyses, all three studied case firms indicated evidence for rejecting the null hypothesis. Therefore, the first research question analysis could be summarized as follows: The three individual case firms were delivering products to their customers with times that were not standard. Even if time-based flexibility was not used to meet customer needs, different customers and customer segments were quoted with diverging COLTs, which varied even within the customer and customer segment. Other potential reasons for different COLTs could have been, for example, capacity and material availability. Both of these play a major role in defining the COLTs that the firm can offer to their customers. However, the purpose of the first research question was to build understanding of how time was used, and why. The first research question was intended to provide a basis for the

second research question analyses. In the second research question the relationship between time and price paid by the customer was analyzed.

5.5 Approach for pricing and lead time analysis

The second research question analysis tested the price and COLT correlation. In this research the need for price and COLT correlation analysis was for two main reasons. First, during the time of the research the case firms were operating at their peak capacities. This meant that order backlogs were increasing and as a result of that COLTs increased. In order to benefit from the situation, the firms had to either speed up their processes and increase the throughput from the factories or pick the most profitable orders from the field. Second, this approach tests both the concept of premium pricing used by the firms as the willingness of the customers to pay price premiums from shorter COLTs, which was then used in analyzing the last research question. The purpose of the correlation test was to identify if the price and time had any correlation with the analyzed order delivery transactions and what kind of relationship. In this way the research was able to identify if the case firms were using premium pricing (price and COLT correlation was negative) or higher prices for the longer lead time orders (price and COLT correlation was positive). As such, premium pricing could mean, for example, that the supplier created time-based flexibility by delivering the needed parts faster than in the agreements, firms purchased from alternative suppliers who were faster than in normal process, or firms were able to provide more capacity in-house by working overtime or through improved capacity loading of the existing capacity or simply hiring temporary staff.

At the time of the gathering of the case firm data, all the case firms used a cost based approach for pricing the products. In practice, this meant that different cost related activities such as shipping added costs and thus price. For all the studied case firms the costs were relatively standard within the operations. The only significant exception was the transportation costs, which could be 5–10% higher for some product deliveries than for others, depending on the delivery terms. Higher costs naturally came when the product was delivered to the customer site with duties paid rather than making the product available at the case firm's premises.

In order to conduct valid analysis on the dependency of the price and COLT, different modes of transportation (Incoterms) needed to be checked before conducting analysis for the second research question. The analysis of the modes of transportation used by different customers and customer segments indicated that the mode of transportation was customer specific. In practice, this meant that custom-

ers were using the same mode of transportation constantly, with only minor exceptions. However, different customers did use different modes of transportation and thus the comparison between different customers and premium pricing would not be valid. Similarly, but not at as high a level as customers, different customer segments appeared to be using standard modes of transportation. These findings together enabled the research to analyze the correlations between prices and COLTs on a highly reliable basis.

5.6 Testing research question two and hypothesis

Testing the second research question was done with both qualitative interviews as well as quantitative analysis in the case firms. The interviews focused on testing the managerial view of whether the case firms were asking a higher price in cases where the customer demanded a shorter order lead time. The focus of the data analyses was on testing the correlation between order delivery data and quoted product prices for these orders.

The case firm interviews revealed very different strategies in terms of the use of time-based dynamic pricing. Two of the case firms admitted that they had a defined and systematic process for creating flexibility on COLTs and one of them claimed they handled flexibility case by case without a predefined process. Two of the case firms claimed that a shorter COLT did not mean higher prices for customers, and one claimed that a higher price was charged with a shorter COLT.

Testing the second research question: “Do the case firms ask for a price premium if the customer order lead time is shorter?” with statistical analysis was done by analyzing the relationship between the COLT and price paid by the customer. The most important time aspect from the customer point of view was the COLT. Thus, the main focus was on testing the relationship between COLT and price. However, in this case study also additional process times were analyzed in order to enhance the interpretation of the statistical COLT and price correlation analyses.

For the second research question it was hypothesized that time-based dynamic pricing was not used by the case firms. In other words, the case firms did not charge price premiums from their customers if the order was delivered faster.

$H_0: \rho = 0$ (The case firm was not using time-based dynamic pricing)

$H_1: \rho \neq 0$ (The case firm was using time-based dynamic pricing)

These hypotheses were tested with three different correlation analyses. More details on the correlation analyses used in this study can be found in Section 4.5.3.

The following three sections of the study will cover the qualitative and quantitative analyses conducted in the three case firms, one by one. In doing so, the study will test the hypotheses set for the second research question. The results from the hypotheses testing are shown from both qualitative and quantitative analyses. At the end of the chapter, the research question findings are collectively summarized and analyses indicated for each case firm.

5.6.1 Mighty Machines

5.6.1.1 Interviews

Offering flexibility for COLT was argued to be part of the process and good customer service at Mighty Machines. Thus, it was claimed that time-based dynamic pricing did not exist and had not been even discussed within the case firm. The emphasis was on serving the customers and keeping them satisfied. Keeping the customer satisfied was the way in which this case firm defended its strategy against price premiums. Customer satisfaction, particularly from high volume key customers, meant more business and profits in the long run. It was highlighted that flexibility was not only from Mighty Machines towards their customers, but also vice versa. In practice, this could mean flexibility in cases when the overall customer project experiences changes in time schedules and Mighty Machines has a very high load in their processes, or allowing partial deliveries from Mighty Machines to ensure a steady workload at the project site. It was also indicated that Mighty Machines was not creating flexibility on their own. An important part of time-based flexibility came from their supplier networks, which were flexible if needed. Creating flexibility not only covered in-house operations and logistics as in the other case firms; in Mighty Machines time-based flexibility could be created with changing the procurement approach for a specific order. This was done by choosing low volume and high cost suppliers from their existing procurement network to create the needed flexibility.

5.6.1.2 Data analyses

The second angle for the qualitative interview results was done with statistical correlation analyses. Here, in the first part of the quantitative correlation analyses, four customers, Kisu, Misu, Sisu and Visu, were analyzed. Correlation analyses were used for testing the strength of the dependency between the COLT and price

paid by the customer. Here, Pearson's, Spearman's and Kendall's correlation analyses were used.

5.6.1.3 Customers

The first correlation analyses were done at the customer level with Pearson's correlation analyses and by using SPSS. At the customer level Mighty Machines had four different customers that qualified for the statistical analyses. These were Kisu, Misu, Sisu and Visu. Correlation analyses done for the four different customers, and as Table 29 shows, indicate a significant correlation at the 0.01 level (2-tailed) for customers Kisu and Sisu. Generalizing this would mean that positive significant correlation would indicate that when the lead times increased, the price increased, and vice versa. For customer Misu the tested Pearson's correlation between lead times and prices was zero with PLT and positive for other lead times. However, the relationship was not significant, and thus statistical data analyses could not provide clear evidence of the dependency between lead times and prices. Analyses done for Visu, on the other hand, indicated a negative correlation, which meant that faster lead times and COLT would have been premium priced. However, the negative correlation between COLT and price was not significant. Thus, there was no evidence to claim that price premiums would have been charged from COLTs that were delivered faster.

Table 29. The strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient.

Customer name			COLT	TTPT	PPILT	PLT
Kisu	Price	Pearson Correlation	.673**	.812**	.303*	.673**
		Sig. (2-tailed)	.000	.000	.040	.000
		Covariance (indexed)	1.00			
		N	46	46	46	46
Misu	Price	Pearson Correlation	.320	.269	.203	.000
		Sig. (2-tailed)	.084	.151	.282	.999
		Covariance (indexed)	0.14			
		N	30	30	30	30
Sisu	Price	Pearson Correlation	.332**	.375**	.257**	.326**
		Sig. (2-tailed)	.000	.000	.008	.001
		Covariance (indexed)	0.86			
		N	107	107	107	107
Visu	Price	Pearson Correlation	-.208	-.084	-.082	.156
		Sig. (2-tailed)	.231	.630	.639	.371
		Covariance (indexed)	-0.30			
		N	35	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

As with Pearson's correlation, Kendall's and Spearman's correlations were tested between lead times and prices. The results in Table 30 indicated similar outcomes as from Pearson's correlation analysis. For customers Kisu and Sisu, the correlations were significant and positive at the level 0.01 (2-tailed). The different calculations methods for Pearson's, Kendal's and Spearman's correlations indicated a different correlation direction for customer Misu. The tested Pearson's correlation for Misu indicated a positive correlation between lead times and prices, when both Spearman's and Kendall's correlations indicated a negative correlation between two in-house lead times and prices. These lead times were PPILT and PLT. As such, this indicated that, depending on the calculation method, the correlation direction is likely to fluctuate when the correlation is not significant. For Visu, the lead time and price correlations indicated negative values with COLT, TTPT and PPILT with all correlation calculation methods used.

Table 30. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients.

Customer name				COLT	TTPT	PPILT	PLT
Kisu	Kendall's tau_b	Price	Correlation Coefficient	.442**	.467**	.457**	.554**
			Sig. (2-tailed)	.000	.000	.000	.000
			N	46	46	46	46
	Spearman's rho	Price	Correlation Coefficient	.558**	.601**	.569**	.682**
			Sig. (2-tailed)	.000	.000	.000	.000
			N	46	46	46	46
Misu	Kendall's tau_b	Price	Correlation Coefficient	.026	.149	-.216	-.230
			Sig. (2-tailed)	.861	.280	.119	.095
			N	30	30	30	30
	Spearman's rho	Price	Correlation Coefficient	.101	.150	-.269	-.336
			Sig. (2-tailed)	.597	.428	.151	.069
			N	30	30	30	30
Sisu	Kendall's tau_b	Price	Correlation Coefficient	.469**	.502**	.331**	.460**
			Sig. (2-tailed)	.000	.000	.000	.000
			N	107	107	107	107
	Spearman's rho	Price	Correlation Coefficient	.698**	.727**	.460**	.622**
			Sig. (2-tailed)	.000	.000	.000	.000
			N	107	107	107	107
Visu	Kendall's tau_b	Price	Correlation Coefficient	-.134	-.048	-.003	.043
			Sig. (2-tailed)	.261	.690	.977	.722
			N	35	35	35	35
	Spearman's rho	Price	Correlation Coefficient	-.191	-.061	-.013	.048
			Sig. (2-tailed)	.271	.728	.941	.784
			N	35	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

5.6.1.4 Customer segments

The second level of analysis for Mighty Machines was done on the customer segment level: The acquired order delivery and financial data from four different customer segments. One of the four customer segments did not have enough order delivery transactions for statistically relevant analysis. Thus, the focus of the correlation analyses was on the three customer segments fulfilling the requirements for statistically valid analyses. These three customer segments will be referred to as customer segments A, B and D in the coming analysis.

Table 31. The strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient.

Customer segment			COLT	TTPT	PPILT	PLT
A	Price	Pearson Correlation	.239*	.318**	.072	.247*
		Sig. (2-tailed)	.025	.003	.503	.020
		N	88	88	88	88
B	Price	Pearson Correlation	.484**	.510**	.274**	.327**
		Sig. (2-tailed)	.000	.000	.000	.000
		N	178	178	178	178
D	Price	Pearson Correlation	.221*	.306**	-.228*	-.103
		Sig. (2-tailed)	.039	.004	.032	.338
		N	88	88	88	88

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Customer segment A

The results for Pearson's correlation analysis, shown in Table 31, indicate a positive correlation between lead times and prices for customer segment A. Out of the tested COLTs for customer segment A, only TTPT had a significant correlation with price at the level 0.01 (2-tailed). Also COLT and PLT had a significant positive correlation with price, but at the level 0.05 (2-tailed). PLT with shipping had a positive, but not significant correlation. As such, these results did not indicate any negative correlation between lead times and prices. Instead, the positive and even significant correlation of COLT and price clearly indicated the price being higher for longer, not shorter, deliveries. Thus, there was no evidence that customer segment A had been paying price premiums from shorter lead time orders.

Customer segment B

Pearson's correlation analysis for customer segment B indicated price having a significant positive correlation with all the tested lead times. The analyzed correlation was significant at the 0.01 level for all lead times. This indicated a strong tendency of price growing in parallel with lead times. In practice, this indicated that customers from segment B had been paying more for long lead time orders

and thus there was no evidence that the customer segment would have been paying price premiums from faster deliveries.

Customer segment D

The correlation test on customer segment D indicated significant positive correlation at the level 0.05 (2-tailed) for COLT and at the level 0.01 (2-tailed) for TTPT. Interestingly, the Pearson's correlation analyses indicated negative and even significant correlation at level 0.05 for PPILT. Also, the PLT had a negative correlation with price. The significant negative correlation at the level 0.05 (2-tailed) between price and PPILT could indicate that customer segment D would be paying more when the in-house production, packing and invoicing lead time (PPILT) was shorter. However, since this study focuses on lead time COLT, which is the one that the customer sees, the negative correlation between PPILT and price has no impact on answering the second research question. As such, this indicates only that the price paid by the customer could have a negative correlation with in-house operation times. The reasons for this could be many, but since the focus of this research was on answering if the customers would be paying more for shorter COLTs, this would not require further study here. Further research on the reasons why could be interesting in deeper future analyses in the case firm Mighty Machines.

A second approach to the correlation analyses was to confirm significant Pearson's correlation results with Kendall's and Spearman's correlation calculations. The results of these calculations are shown in Table 32. The correlation calculations indicated that customer segment A had positive correlation between price and measured order lead times. The correlation between price and TTPT was significant at the level 0.01 (2-tailed), indicating that an increase of in-house process times also increased prices. A similar indication was seen with PLT, even though the significance level was 0.05 (2-tailed). Despite these significantly correlating in-house lead times with price, no evidence of the premium pricing of shorter COLTs could be shown for customer segment A.

Kendall's and Spearman's correlation calculations indicated similar results for customer segment B to the Pearson's correlation calculations. The correlation between price and all lead times was positive and significant at the level 0.01 (2-tailed). This indicated a parallel increase and decrease of price and lead times as one of them increased or decreased. Since the correlation was positive, no evidence of the premium pricing of shorter COLTs could be shown.

As Pearson's correlation calculations indicated a significant positive correlation between price and TTPT for customer segment D, both Kendall's and Spearman's

correlation calculations confirmed a significant positive correlation. The in-house processes PPILT and PLT correlated negatively with price, but not significantly. Thus, no evidence of premium pricing for shorter COLTs in customer segment D with analyzed order delivery data could be shown with any of the tested correlation calculations.

Table 32. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients.

Customer segment			COLT	TTPT	PPILT	PLT
A	Price	Kendall's Correlation	.126	.207**	.040	.156*
		Sig. (2-tailed)	.087	.005	.588	.034
		N	88	88	88	88
	Price	Spearman's Correlation	.190	.302**	.062	.219*
		Sig. (2-tailed)	.077	.004	.564	.041
		N	88	88	88	88
B	Price	Kendall's Correlation	.389**	.416**	.357**	.412**
		Sig. (2-tailed)	.000	.000	.000	.000
		N	178	178	178	178
	Price	Spearman's Correlation	.577**	.619**	.506**	.567**
		Sig. (2-tailed)	.000	.000	.000	.000
		N	178	178	178	178
D	Price	Kendall's Correlation	.144	.224**	-.108	-.054
		Sig. (2-tailed)	.057	.002	.144	.470
		N	88	88	88	88
	Price	Spearman's Correlation	.173	.309**	-.140	-.077
		Sig. (2-tailed)	.107	.003	.194	.473
		N	88	88	88	88

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

5.6.1.5 Summary of the analyses at Mighty Machines

Pearson's, Kendall's and Spearman's correlation analyses at the customer level indicated significant correlation between COLT and price at the level 0.01 (2-tailed) for two customers: Kisu and Sisu (Table 33). The direction of the lead time and price correlations varied for Misu, depending on the different lead times observed and correlation calculation methods used. However, none of the correlations were significant at the 0.01 or 0.05 level, and thus indicated no evidence of premium pricing of the COLTs or other lead times. Also for Visu, no significant correlations between COLTs and prices could be indicated with any of the correlation calculation methods used. Again, an interesting negative correlation was indicated by all the correlation calculation methods for COLTs, TTPTs and PPILTs when PLT was indicated as positive by all methods. As such, together these results provide enough evidence to say that there was no evidence that shorter COLTs would have been premium priced for any of the studied customers for Mighty Machines. However, further investigation would be interesting in order to understand the way the pricing of time was handled together by the indi-

vidual sales persons in charge of quoting the product prices to different end customers.

Table 33. Summary of the correlation directions and significances from the customer level analyses at Mighty Machines.

Customers		COLT	TTPT	PPILT	PLT
Kisu	*Pearson's*	+++	+++	++	+++
	Kendall's	+++	+++	+++	+++
	Spearman's	+++	+++	+++	+++
Misu	*Pearson's*	+	+	+	0
	Kendall's	+	+	-	-
	Spearman's	+	+	-	-
Sisu	*Pearson's*	+++	+++	+++	+++
	Kendall's	+++	+++	+++	+++
	Spearman's	+++	+++	+++	+++
Visu	*Pearson's*	-	-	-	+
	Kendall's	-	-	-	+
	Spearman's	-	-	-	+

+++ = Significant positive correlation at level 0.01 (2-tailed)

++ = Significant positive correlation at level 0.05 (2-tailed)

+ = Positive correlation

--- = Significant negative correlation at level 0.01 (2-tailed)

-- = Significant negative correlation at level 0.05 (2-tailed)

- = Negative correlation

Similar results from customer segments can be seen in Table 34. In the correlation analyses, the only customer segment with significant negative correlation between lead time and price can be seen in customer segment D, where the PPILT and price had significant negative correlation at the 0.01 level (2-tailed). However, no evidence of the premium pricing of the customer segment level COLTs could be shown with the correlation analyses conducted for the acquired order delivery and financial data from Mighty Machines.

Table 34. Summary of the correlation directions and significances from the customer level analyses at Mighty Machines.

Customer segments		COLT	TTPT	PPILT	PLT
A	Pearson's	++	+++	+	++
	Kendall's	+	+++	+	++
	Spearman's	+	+++	+	++
B	Pearson's	+++	+++	+++	+++
	Kendall's	+++	+++	+++	+++
	Spearman's	+++	+++	+++	+++
D	Pearson's	++	++	--	-
	Kendall's	+	+++	-	-
	Spearman's	+	+	+	+

+++ = Significant positive correlation at level 0.01 (2-tailed)

++ = Significant positive correlation at level 0.05 (2-tailed)

+ = Positive correlation

--- = Significant negative correlation at level 0.01 (2-tailed)

-- = Significant negative correlation at level 0.05 (2-tailed)

- = Negative correlation

All in all, the qualitative interviews and quantitative analysis of the acquired data did not indicate any evidence that customers or customer segments had been paying higher prices from faster COLTs. Interesting in the analyses results was the fluctuation between the correlations among the tested groups. For some the correlation was significant, whilst for others there was no indication of correlation whatsoever. Again, further investigation is needed as to why longer lead time for some customers and customer segments would mean higher prices, when for others it appears to make no difference if the lead time is longer or shorter.

5.6.2 Power Control

The interview sessions with Power Control were conducted as usual. However, the order delivery data from the second case firm was limited to 125 order delivery transactions. This made interpretation of the results challenging yet possible. It was challenging in that customer specific analysis could not be conducted and the focus needed to be on customer segment analyses. A second issue was the limited amount of order delivery transaction details. This case firm was able to deliver only two lead time measurements. The first was customer order lead time (COLT). The second was planned order lead time (POLT), which as such could be used to indicate what the planned relationship between lead time and price was.

5.6.2.1 Interviews

In the interviews for the first research question it was claimed that different COLTs were not offered. Instead, COLTs were the sum of the results from various dependent factors like availability of materials and process related capacities. Statistical analysis only confirmed that the COLTs offered were different. Based on this observation, the case firm was asked if a shorter COLT would be premium priced if, for example, parts and capacities were available with shorter notice than average. Here, the answers were in line with the answers to the first research question. Since COLTs were not, or rarely, offered based on customer needs, there was no official process to premium price shorter COLTs. Thus, it was clearly indicated that the lead time of the final product was not premium priced.

5.6.2.2 Data analyses

Due to the limited nature of the order delivery and financial data only customer segment based analyses were conducted. The data from Power Control was split into two customer segments as for Mighty Machines. Dividing the data into two customer segments, A and B, enabled a similar approach to the one conducted when testing the validity of the hypotheses in the first research question, even though on a smaller scale.

5.6.2.3 Customer segments

The correlation analyses done for customer segment A indicated that the correlation between price and COLT was positive, but not significant (see Table 35). At the same time, the planned order lead time (POLT) and price indicated a similar correlation. Thus, customer segment A lacked evidence of price premiums paid on shorter COLTs or even POLTs.

The correlation analyses done for the second biggest customer segment B, with 35 orders, indicated positive significant correlation between price and COLT at the level 0.01 (2-tailed). According to Pearson's and Spearman's correlation calculations, the correlation of POLT was positive but only at the level 0.05 (2-tailed). Overall, significant positive correlation meant that both of the compared parameters increased or decreased in parallel. Thus, no evidence of the use of premium pricing for shorter COLT or even POLTs could be shown with the conducted correlation calculation analyses.

Table 35. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients.

Customer Segment			COLT	POLT
A	Price	Pearson Correlation	.267	.162
		Sig. (2-tailed)	.087	.304
		Kendall's Correlation	.070	.116
		Sig. (2-tailed)	.533	.308
		Spearman's Correlation	.097	.150
		Sig. (2-tailed)	.542	.342
		N	42	42
B	Price	Pearson Correlation	.516**	.385*
		Sig. (2-tailed)	.002	.022
		Kendall's Correlation	.445**	.325**
		Sig. (2-tailed)	.000	.008
		Spearman's Correlation	.557**	.419*
		Sig. (2-tailed)	.001	.012
		N	35	35

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

5.6.2.4 Summary of analyses at Power Control

The price and lead time correlation tests on actual and promised order lead times did not reveal any significant negative correlation. Negative correlation would have indicated the use of premium pricing for shorter order lead time deliveries. As such, neither of the customer segments from the case firm appeared to be paying more for short order lead times. Instead, the results from customer segment B indicated that it was paying more for longer rather than shorter COLTs.

5.6.3 Agile Grid

Interviews and data analyses were conducted according to plan in the case firm Agile Grid. The interviews followed the same concept as with Mighty Machines and Power Control. The selected product allowed the study to focus on nearly two years of order delivery information with prices. Thus, the correlation analyses could be conducted for both customer and customer segment levels.

5.6.3.1 Interviews

Previously in the interviews the key persons had claimed that different COLTs were offered to different customers and customer segments. Similarly, the same key persons claimed that premium pricing was used for certain orders that needed to be expedited due to specific customer needs. The justification for premium pricing of the shorter COLTs was claimed to be the increase in costs for the case firm. According to the interviews, it was uncommon to be able to offer expedited

COLTs through the firm´s normal process capacity. Thus, Agile Grid had to produce extra capacity to handle rushed orders. Basically, producing extra capacity meant working overtime, and ultimately higher variable costs. As such, it was claimed that this kind of change in variable costs was the main reason for premium pricing. A second reason was the logistics expedited to shorten the COLT. However, according to the interviewed persons, logistics expediting was only a minor cause of price premiums. In the case firm it was argued that if the expediting could be done without additional overtime work or logistics expedition, a premium price would not be added on top of the customer price. Ultimately, the interview indicated clearly that premium pricing did exist in the case firm Agile Grid. Premium pricing existed, even though it was used only to cover increased costs rather than for creating more profits.

5.6.3.2 Data analyses

The detailed order delivery and pricing information from the selected product enabled analyses on the customer and customer segment levels. Thus, this study was able to divide the data into two periods, just as for the first research question. In the first period customers 1, 2, 4, 5, 6 and 9 had enough cases for statistically relevant analyses, whilst in the second period customers 1, 4, 7, 8 and 9 qualified for statistically relevant correlation analyses. More explanation about the justification of splitting the order delivery data into two periods can be found in Section 5.3.3.2.

5.6.3.3 Customers

First, correlation analyses were performed for the first period order delivery and price data. During the first period there were six customers which qualified for the analyses. The results from testing Pearson’s, Kendall’s and Spearman’s correlations between price and different lead times are shown in Table 36.

Table 36. Strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient during the first period.

Customer			COLT	TTPT	POLT
Customer 1	Price	Pearson Correlation	-.102	-.106	-.110
		Sig. (2-tailed)	.100	.089	.077
		Covariance (indexed)	-0.20	-0.23	-0.23
		N	260	260	260
Customer 2	Price	Pearson Correlation	-.163	-.195	-.210
		Sig. (2-tailed)	.358	.269	.234
		Covariance (indexed)	-1.02	-1.25	-1.40
		N	34	34	34
Customer 4	Price	Pearson Correlation	-.143*	-.100	-.159**
		Sig. (2-tailed)	.016	.093	.007
		Covariance (indexed)	-0.29	-0.22	-0.39
		N	284	284	284
Customer 5	Price	Pearson Correlation	.304**	.280**	.272**
		Sig. (2-tailed)	.000	.001	.002
		Covariance (indexed)	1.00	1.00	1.00
		N	133	133	133
Customer 6	Price	Pearson Correlation	-.148	-.129	-.099
		Sig. (2-tailed)	.411	.475	.583
		Covariance (indexed)	-0.21	-0.21	-0.15
		N	33	33	33
Customer 9	Price	Pearson Correlation	.043	.231	.006
		Sig. (2-tailed)	.809	.188	.975
		Covariance (indexed)	0.18	0.54	0.03
		N	34	34	34

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The results indicated a negative correlation between price and COLT for customers 1, 2, 4 and 6. For these customers the negative correlation was constant throughout the measured lead times. Of these four customers, the analyses indicated that price had a significant negative correlation with COLT at the level 0.05 (2-tailed) for customer 4. Interestingly, for the same customer the POLT had significant negative correlation at the level 0.01 (2-tailed). As such, the negative correlations between price and COLT with the majority of key customers made the case firm Agile Grid different from the other case firms. So far, Agile Grid was the only case firm that gave an indication of the use of premium pricing for shorter COLTs. These indications were still tested with Kendall's and Spearman's correlation calculations.

Table 37. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients during the first period.

Customer				COLT	TTPT	POLT
Customer 1	Kendall's tau_b	Price	Correlation Coefficient	.006	.013	.016
			Sig. (2-tailed)	.882	.772	.709
			N	260	260	260
	Spearman's rho	Price	Correlation Coefficient	.000	.005	.012
			Sig. (2-tailed)	.994	.933	.848
			N	260	260	260
Customer 2	Kendall's tau_b	Price	Correlation Coefficient	-.086	-.120	-.139
			Sig. (2-tailed)	.491	.338	.267
			N	34	34	34
	Spearman's rho	Price	Correlation Coefficient	-.126	-.173	-.193
			Sig. (2-tailed)	.479	.328	.274
			N	34	34	34
Customer 4	Kendall's tau_b	Price	Correlation Coefficient	-.037	.011	-.077
			Sig. (2-tailed)	.364	.780	.062
			N	284	284	284
	Spearman's rho	Price	Correlation Coefficient	-.052	.009	-.110
			Sig. (2-tailed)	.381	.876	.063
			N	284	284	284
Customer 5	Kendall's tau_b	Price	Correlation Coefficient	.225**	.209**	.190**
			Sig. (2-tailed)	.000	.001	.003
			N	133	133	133
	Spearman's rho	Price	Correlation Coefficient	.308**	.281**	.255**
			Sig. (2-tailed)	.000	.001	.003
			N	133	133	133
Customer 6	Kendall's tau_b	Price	Correlation Coefficient	-.120	-.128	-.135
			Sig. (2-tailed)	.378	.345	.316
			N	33	33	33
	Spearman's rho	Price	Correlation Coefficient	-.148	-.154	-.166
			Sig. (2-tailed)	.410	.391	.356
			N	33	33	33
Customer 9	Kendall's tau_b	Price	Correlation Coefficient	.370**	.122	.326*
			Sig. (2-tailed)	.004	.334	.011
			N	34	34	34
	Spearman's rho	Price	Correlation Coefficient	.513**	.176	.449**
			Sig. (2-tailed)	.002	.319	.008
			N	34	34	34

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The Kendall's and Spearman's correlation calculations in Table 37 indicated similar results to the Pearson's correlation calculations, except that customer 1 did not have negative correlation values and the correlation for customer 4 was not significant. For customer 4 the correlation significances were weak and not even close to having significant correlation. Also the correlation values for customer 1 were close to zero, with weaker correlation significances than with Pearson's analyses. Despite that, the correlations tested for the first period order delivery data indicated that this case firm was more likely to be using premium pricing

than the two previous case firms, even though only indicative evidence of the price premiums could be shown with customer 4. The next step was to conduct similar tests for the second period of the order delivery data.

The Pearson's correlation calculations in Table 38 indicated a change in the relationship of price and COLT compared to the first period. Only customer 4 had a negative correlation between price and COLT. The correlation was significant at the level 0.05 (2-tailed), which indicated a likelihood that customer 4 paid price premiums from shorter COLTs. Other customers that had negative correlation between the analyzed variables in the first period now had positive correlation values. Overall, this was an unexpected change, but could be well explained with the observations made during the analyses of the first research question. There, the mean COLTs reduced significantly from the first to the second period. This could explain the case firm's ability to serve the customers' needs faster throughout their regular processes, at least for the product analyzed in this study.

Table 38. Strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient during the second period.

Customer			COLT	TTPT	POLT
Customer 1	Price	Pearson Correlation	.190*	.203**	.157*
		Sig. (2-tailed)	.014	.009	.044
		Covariance (indexed)	0.15	0.12	0.14
		N	165	165	165
Customer 4	Price	Pearson Correlation	-.151*	-.128	-.128
		Sig. (2-tailed)	.033	.071	.072
		Covariance (indexed)	-0.26	-0.17	-0.24
		N	199	199	199
Customer 7	Price	Pearson Correlation	.359**	.344**	.346**
		Sig. (2-tailed)	.000	.000	.000
		Covariance (indexed)	1.00	0.66	1.00
		N	146	146	146
Customer 8	Price	Pearson Correlation	.125	.222	.146
		Sig. (2-tailed)	.510	.239	.443
		Covariance (indexed)	0.71	1.00	0.86
		N	30	30	30
Customer 9	Price	Pearson Correlation	.271*	.238	.267*
		Sig. (2-tailed)	.028	.054	.030
		Covariance (indexed)	0.73	0.47	0.76
		N	66	66	66

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 39 indicates similar results from Kendall's and Spearman's correlation tests as with the Pearson's analysis. Customer 4 had significant negative correlation at the level 0.05 (2-tailed), whereas other customers had positive correlation between prices and COLTs.

Table 39. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients during the second period.

Customer				COLT	TTPT	POLT
Customer 1	Kendall's tau_b	Price	Correlation Coefficient	.111*	.116*	.093
			Sig. (2-tailed)	.045	.037	.093
			N	165	165	165
	Spearman's rho	Price	Correlation Coefficient	.161*	.167*	.128
			Sig. (2-tailed)	.039	.032	.100
			N	165	165	165
Customer 4	Kendall's tau_b	Price	Correlation Coefficient	-.111*	-.077	-.080
			Sig. (2-tailed)	.024	.117	.107
			N	199	199	199
	Spearman's rho	Price	Correlation Coefficient	-.171*	-.115	-.115
			Sig. (2-tailed)	.016	.105	.106
			N	199	199	199
Customer 7	Kendall's tau_b	Price	Correlation Coefficient	.231**	.236**	.226**
			Sig. (2-tailed)	.000	.000	.000
			N	146	146	146
	Spearman's rho	Price	Correlation Coefficient	.352**	.351**	.349**
			Sig. (2-tailed)	.000	.000	.000
			N	146	146	146
Customer 8	Kendall's tau_b	Price	Correlation Coefficient	-.117	-.056	-.068
			Sig. (2-tailed)	.407	.686	.637
			N	30	30	30
	Spearman's rho	Price	Correlation Coefficient	-.178	-.100	-.095
			Sig. (2-tailed)	.347	.600	.616
			N	30	30	30
Customer 9	Kendall's tau_b	Price	Correlation Coefficient	.178*	.156	.167
			Sig. (2-tailed)	.043	.076	.058
			N	66	66	66
			N	66	66	66

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

During the first period of analysis the negative correlation between price and COLT for customer 4 was confirmed to be significant at the 0.05 level (2-tailed) by Pearson's correlation tests. During the second period the negative correlation between COLT and price was indicated to be significant at the 0.05 level (2-tailed) by all three correlation calculation methods used. This indicated that premium pricing was probably used for customer 4, which appeared to need or was offered expediting of their product orders more than for the other customers. During the first period there were also other customers that had negative correlation between the tested prices and COLTs. However, the calculated correlations indicated positive figures during the second period for these customers. This could indicate that the customer needs were satisfied by the significant decrease of the mean COLTs from the first to second period.

5.6.3.4 Customer segments

The following section focuses on the analyses conducted at the customer segment level. The acquired data contained information from six customer segments, from which three had enough cases for statistically relevant analysis. The relationships between price and order delivery lead times were studied first with the help of Pearson's correlation coefficient and covariance calculations. The calculated Pearson's correlation coefficients in Table 40 indicated significant negative correlation between price and COLT at the 0.01 level (2-tailed) for customer segment B. For customer segments A and C, the correlations were positive, but not significant. The negative and significant correlation indicated that customer segment B could very likely be paying more for faster COLTs. The significance level also indicated that the correlation was strong, with negative correlation for customer segment B. The POLT for customer segment B also had significant negative correlation at the 0.01 level (2-tailed). This supported the indication that premium pricing for customer segment B was probably used when the COLTs were shorter.

Table 40. Strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient during the first period.

Customer segment			COLT	TTPT	POLT
A	Price	Pearson Correlation	.188	.234*	.159
		Sig. (2-tailed)	.056	.017	.106
		Covariance (indexed)	1.00	1.00	1.00
		N	104	104	104
B	Price	Pearson Correlation	-.175**	-.115	-.189**
		Sig. (2-tailed)	.003	.056	.001
		Covariance (indexed)	-0.32	-0.20	-0.45
		N	280	280	280
C	Price	Pearson Correlation	.057	.049	.043
		Sig. (2-tailed)	.261	.333	.398
		Covariance (indexed)	0.13	0.10	0.11
		N	390	390	390

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Testing the order delivery data from the first period by using the rank based correlation coefficients calculation method indicated some changes on the correlations between COLTs and prices. The significant negative correlation observed for customer segment B with Pearson's calculation method was not significant with Kendall's and Spearman's correlation calculation methods. Table 41 indicates the correlation coefficients for customer segment B to be significant only between POLT and price. This indicated that the planned order lead time (POLT) also called promised order lead time to customer was likely to be premium priced for

faster COLTs. It also indicated that the promised delivery dates were not fully met due to different correlation significance levels between COLTs and POLTs. This indication would probably be valid since all the different correlation calculation methods used indicated the same. However, when making conclusions based on the correlation analyses, the observer also needs to take into account that these calculation methods interpret the results using slightly different calculation approaches.

Table 41. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients during the first period.

Customer segment				COLT	TTPT	POLT
A	Kendall's tau_b	Price	Correlation Coefficient	.244**	.225**	.217**
			Sig. (2-tailed)	.000	.001	.002
			N	104	104	104
	Spearman's rho	Price	Correlation Coefficient	.324**	.295**	.281**
			Sig. (2-tailed)	.001	.002	.004
			N	104	104	104
B	Kendall's tau_b	Price	Correlation Coefficient	-.068	-.015	-.114**
			Sig. (2-tailed)	.099	.709	.006
			N	280	280	280
	Spearman's rho	Price	Correlation Coefficient	-.107	-.033	-.164**
			Sig. (2-tailed)	.074	.585	.006
			N	280	280	280
C	Kendall's tau_b	Price	Correlation Coefficient	.057	.057	.054
			Sig. (2-tailed)	.105	.108	.124
			N	390	390	390
	Spearman's rho	Price	Correlation Coefficient	.078	.071	.068
			Sig. (2-tailed)	.122	.160	.182
			N	390	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

In the customer level data analyses it was observed that some customers with negative correlation between COLT and price during the first period had positive correlation during the second period. Similarly, the customer segment level analyses during the second period indicated a change from negative to positive (Table 42). Customer segment B had significant negative Pearson's correlation at the 0.01 level (2-tailed) in the first period, whilst the Pearson's correlation was positive during the second period. As such, this suggested that the need for either premium pricing or for expedited and faster COLTs was no longer present. When looking at the POLT and price correlation, it was now positive at the 0.05 level (2-tailed). Thus, now it was likely that POLT and price for customer segment B were both increasing and decreasing in parallel. In summarizing the Pearson's correlation analyses for the second period at customer segment level, it would seem that there was no evidence of the premium pricing of actual orders.

Table 42. Strength of the relationships and covariance between order lead times and price tested with Pearson's correlation coefficient during the second period.

Customer segment			COLT	TTPT	POLT
A	Price	Pearson Correlation	.168	.216	.185
		Sig. (2-tailed)	.143	.059	.106
		Covariance	1262.386	1690.745	1360.474
		N	77	77	77
B	Price	Pearson Correlation	.059	.099	.111*
		Sig. (2-tailed)	.273	.065	.039
		Covariance	293.921	472.439	541.469
		N	347	347	347
C	Price	Pearson Correlation	.315**	.347**	.311**
		Sig. (2-tailed)	.000	.000	.000
		Covariance	687.104	752.951	724.460
		N	180	180	180

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The significant Kendal's and Spearman's correlations at the 0.01 level (2-tailed) in the first period for customer segment A (Table 41) were no longer significant in the second period (Table 43). Similarly, for customer segment B, Kendall's and Spearman's correlations indicated a change from negative towards positive correlations. Both approaches still indicated negative correlations between price and COLT for customer segment B, but relatively close to zero. Spearman's correlation, on the other hand, indicated zero for both TTPT and POLT. For customer segment C, all the tested correlations in all the tested areas indicated significant positive correlations at the 0.01 level (2-tailed).

Table 43. Strength of the relationships between lead times and price tested with Kendall's tau-b and Spearman's rho correlation coefficients during the second period.

Customer segment				COLT	TTPT	POLT
A	Kendall's tau_b	Price	Correlation Coefficient	.049	.095	.048
			Sig. (2-tailed)	.547	.239	.553
			N	77	77	77
	Spearman's rho	Price	Correlation Coefficient	.060	.108	.076
			Sig. (2-tailed)	.601	.350	.514
			N	77	77	77
B	Kendall's tau_b	Price	Correlation Coefficient	-.041	-.003	-.007
			Sig. (2-tailed)	.268	.926	.852
			N	347	347	347
	Spearman's rho	Price	Correlation Coefficient	-.053	.000	.000
			Sig. (2-tailed)	.321	.999	.997
			N	347	347	347
C	Kendall's tau_b	Price	Correlation Coefficient	.160**	.174**	.154**
			Sig. (2-tailed)	.003	.001	.003
			N	180	180	180
	Spearman's rho	Price	Correlation Coefficient	.225**	.245**	.210**
			Sig. (2-tailed)	.002	.001	.005
			N	180	180	180

**. Correlation is significant at the 0.01 level (2-tailed).

5.6.3.5 Summary of the analyses at Agile Grid

Agile Grid was the only case firm among those tested where the analyses indicated that certain customer groups could actually be paying more for faster COLT. This was indicated by the significant negative Pearson's correlation for customer 4 at the 0.05 level (2-tailed) in Table 44 and for customer segment B at the 0.01 level (2-tailed) in Table 45. Kendall's and Spearman's correlations analyses supported the observation, even though not all of these correlation analyses indicated significant negative correlations concurrently. Despite this, the analyses supported the results from the interviews, where it was claimed that faster COLTs are given to customers who are requesting them with price premiums. Based on the interviews and order delivery data analyses, it could be claimed that Agile Grid is using premium pricing for faster COLTs for some of its customer groups.

Table 44. Summary of the correlation directions and significances from the customer level analyses at Agile Grid.

Customers		Period 1			Period 2		
		COLT	TTPT	POLT	COLT	TTPT	POLT
1	Pearson's	-	-	-	++	+++	++
	Kendall's	+	+	+	++	++	+
	Spearman's	0	+	+	++	++	+
2	Pearson's	-	-	-			
	Kendall's	-	-	-			
	Spearman's	-	-	-			
4	Pearson's	--	-	---	--	-	-
	Kendall's	-	+	-	--	-	-
	Spearman's	-	+	-	--	-	-
5	Pearson's	+++	+++	+++			
	Kendall's	+++	+++	+++			
	Spearman's	+++	+++	+++			
6	Pearson's	-	-	-			
	Kendall's	-	-	-			
	Spearman's	-	-	-			
7	Pearson's				+++	+++	+++
	Kendall's				+++	+++	+++
	Spearman's				+++	+++	+++
8	Pearson's				+	+	+
	Kendall's				-	-	-
	Spearman's				-	-	-
9	Pearson's	+	+	+	++	+	++
	Kendall's	+++	+	++	++	++	+
	Spearman's	+++	+	+++	++	++	+

+++ = Significant positive correlation at level 0.01 (2-tailed)

++ = Significant positive correlation at level 0.05 (2-tailed)

+ = Positive correlation

--- = Significant negative correlation at level 0.01 (2-tailed)

-- = Significant negative correlation at level 0.05 (2-tailed)

- = Negative correlation

Table 45. Summary of the correlation directions and significances from the customer segment level analyses at Agile Grid.

Customer segments		Period 1			Period 2		
		COLT	TTPT	POLT	COLT	TTPT	POLT
A	Pearson's	+	++	+	+	+	+
	Kendall's	+++	+++	+++	+	+	+
	Spearman's	+++	+++	+++	+	+	+
B	Pearson's	---	-	---	+	+	++
	Kendall's	-	-	---	-	-	-
	Spearman's	-	-	---	-	0	0
C	Pearson's	+	+	+	+++	+++	+++
	Kendall's	+	+	+	+++	+++	+++
	Spearman's	+	+	+	+++	+++	+++

+++ = Significant positive correlation at level 0.01 (2-tailed)

++ = Significant positive correlation at level 0.05 (2-tailed)

+ = Positive correlation

--- = Significant negative correlation at level 0.01 (2-tailed)

-- = Significant negative correlation at level 0.05 (2-tailed)

- = Negative correlation

One of the main reasons for the fluctuations of the correlation results and significances could be that the shorter COLTs were not always premium priced. As was claimed in the interviews, the shorter COLTs were not premium priced if expediting the order could be done through their normal capacity plans. If one is to investigate more closely the change of Pearson's correlations between the periods, for example at the customer segment level, it can be seen in Table 46 that the change was to positive correlation figures. Even though the direction of the Pearson's correlation for customer segment A was towards being slightly negative, it was still positive (0.168). Customer segment B, which had significant negative Pearson's correlation coefficient (-0.175) at the 0.01 level (2-tailed), was identified to have positive Pearson's correlation coefficient (0.059) during the second period. Also customer segment C had a positive increase in the calculated Pearson's correlation coefficient from the first to second period.

Table 46. Price and lead time Pearson's correlation changes between the first and second period.

Customer segment (change from 1st → 2nd period)			COLT change	TTPT change	POLT change
A	Price	Pearson Correlation (+→+)	-0.020	-0.018	0.026
		N (-)	-27	-27	-27
B	Price	Pearson Correlation (-→+)	0.234	0.214	0.300
		N (+)	67	67	67
C	Price	Pearson Correlation (+→+)	0.258	0.298	0.268
		N (-)	-210	-210	-210

As shown in Table 46, the only customer segment with negative Pearson's correlation coefficient was customer segment B in the first period (-). During the second period the calculated Pearson's correlation between the price and COLT had turned positive (+). At the same time, customer segments A and C still had had positive Pearson's correlation between price and COLT. This indicated that the price premiums that appeared to exist during the first period for customer segment B had disappeared. Now the analyses indicated that customer segments were likely to be paying more for deliveries that had longer COLTs. The root cause for this might not be explained by the quantitative data analyses, however Table 47 ought to give an indication as to why the situation between the first and second period changed so dramatically.

Table 47. Changes in price, COLT, TTPT and POLT in percentages between the first and second period of analyzed order delivery data.

Change from 1st to 2nd period	Mean
Price	0.25 %
COLT (Customer order lead time)	-46.03 %
TTPT (Total throughput time)	-77.87 %
POLT (Promised order lead time)	-34.04 %

While the mean price between the first and second period changed only by 0.25 percent, the mean COLT reduced by more than 46 percent during the second period. The mean TTPT reduced even more drastically, by close to 78 percent, from the first period. Also the decreased COLTs and TTPTs were acknowledged in the sales department and mean POLTs were reduced by more than 34 percent. This could be just a coincidence, but comparing these changes with the information received from the interviews and data analyses, this could well be the result of being able to satisfy customer requirements faster through standard processes.

Thus, the need for overtime work and premium pricing to cover the additional costs would not exist anymore.

5.6.4 Summary of research question 2 and its hypothesis

Three different case firms and the correlation of the price paid by the customer and the actual customer order lead time (COLT) were analyzed in order to identify if customers or customer segments would be paying price premiums for faster deliveries. The tested correlations for Mighty Machines and Power Control were all positive, indicating that no price premiums were paid for shorter order deliveries. Among all the tested case firms, only Agile Grid indicated the possible use of premium pricing among customers and customer segments. Indications of premium pricing of shorter COLTs were made during the interviews and in the data analyses. During the interviews the key persons claimed that higher prices were charged to customers if they needed to have the product faster than the planned order lead time from the standard processes. According to the interviewed persons, the extra payment would be used only to cover additional expenses like overtime work, and not to create additional profits. A similar indication was observed during the analyses of the first period of the order delivery transaction data, when significant negative correlations between prices and COLTs were observed with the different correlation calculation methods used. Significant negative correlations were observed among different customers and customer segments, which indicated that certain customers were likely to pay price premiums if COLTs were shorter. These results are summarized in Table 48.

Table 48. Results from qualitative interviews and quantitative data analyses for the second research question.

$H_0 : \rho = 0$ (The case firm was not asking price premiums from shorter lead time orders)	**Mighty Machines**	**Power Control**	**Agile Grid (1st period)**	**Agile Grid (2nd period)**
$H_0 : \rho = 0$ (Interviews)	TRUE	TRUE	FALSE	
$H_0 : \rho = 0$ (Data analyses)	TRUE	TRUE	FALSE	TRUE

5.7 Testing research question three and hypothesis

The purpose of the first research question was to test if the case firms offered different lead times for different customer groups. The second tested if premium pricing was used for customer orders that were delivered with shorter lead times. Now when the prerequisites for approaching the third research question were met, the natural continuum was to test the profitability aspect of time. Thus, the third research question tested if it was more profitable for electrical equipment and appliance case firms to handle order deliveries with shorter rather than with longer order lead times.

H_0: Customer order lead time did not have positive impact on profitability

H_1: Customer order lead time did have impact on profitability

Due to the sensitive nature of the figures used in the analyses, the results were displayed with the help of simple scatterplot graphs and without profit and COLT values. In the graphs the values were growing from left to right on the x-axis and from bottom to top on the y-axis. Also linear fit line with linear R^2 values were used to visualize the development of the profits (y-axis) on growing COLTs (x-axis). Graphical analyses were supported with Pearson's, Kendall's and Spearman's correlation coefficient analyses. The analyses were conducted in the following sequence. First, the data was split into different customers with a significant amount of recorded samples, and then analyzed. Second, the data was split into different customer segments with a significant amount of recorded order delivery samples, and subsequently analyzed. Third, overall conclusions were made, presented and discussed based on the two previously presented approaches and by analyzing the aspect of profitability and time from the case firm's perspective.

The challenge in this research was to get concrete profitability figures which would not have been influenced by additional costs which did not relate directly to the product. In this study indirect labor, overheads and depreciation were not included in the product profitability calculations. As such, R&D expenses (where applicable), direct labor and materials were included directly in the product's profitability calculation. However, in some cases these costs were applied through pre-calculated multipliers, which caused some concerns. Thus, the relevancy of the added costs were tested and confirmed by comparing the lead time versus profitability results with lead time versus calculated profits. The calculated profits were done by subtracting the key component costs charged by the component suppliers from the product's overall price. This was considered a valid approach, since for products where pre-calculated multipliers were used the correlation of

the material costs and price was more or less one-to-one. Additional to that also currency was taken into consideration. In this way the changes in currency rates did not create too much disturbance. Hedging at the material level was done only in one of the case firms. In this case firm hedging was done only for one specific material, but overall material hedging was very seldom used in the field of electrical equipment and appliances manufacturing. For material clauses some risk margins were calculated in the case firms, but it was claimed that the follow-up was not really active. As such, the profitability figures used in analyzing the relationship between lead time and profitability are valid.

5.7.1 Mighty Machines

When answering the first research question, it was shown that significantly different customer order lead times (COLTs) were given for different customers and customer segments. Testing the second research question indicated that customers were not charged price premiums for faster COLTs. As such, the information from the two previous research questions indicated that time-based flexibility was used, but no price premiums were charged. Based on this information, the study proceeded to answer the third research question by analyzing the profitability and lead time data. In the following section the dependency of the order lead time on overall profitability was tested on customer and customer data.

5.7.1.1 Customers

Correlations between profits and COLTs were tested for the four selected customers. Pearson's correlation analyses results for Kisu, Misu, Sisu and Visu in Table 49 indicated positive correlation only for Kisu. Profitability and COLT correlations were all negative for Misu, Sisu and Visu. Here, negative correlation indicated that the profit and COLT were moving in different directions. This would mean that when COLT was increasing, the profitability would decrease. Thus, a shorter COLT could mean higher profits for customers Misu, Sisu and Visu. Since the negative correlations for customers Sisu and Visu were significant at the 0.01 level (2-tailed), higher profits from shorter COLTs is very likely.

The Kendall's and Spearman's correlation analyses in Table 50 indicated similar results as for the previous Pearson's correlation analyses. The only major difference was that Kendall's and Spearman's correlations were significant and positive for customer Kisu at the 0.01 level (2-tailed), when Pearson's correlation was positive but not significant. The correlation for Misu remained negative also with Kendall's and Spearman's correlation analyses. The negative significant correlations indicated by Pearson's analyses for Sisu and Visu were also negative and

significant with Kendall's and Spearman's correlation analyses. These results again confirmed the observation for customers Sisu and Visu, which was that shorter COLTs would likely be actualized with higher profits.

Table 49. Pearson's correlation between profit and COLT at customer level.

Customer name			COLT
Kisu	Profit	Pearson Correlation	.216
		Sig. (2-tailed)	.149
		N	46

Customer name			COLT
Misu	Profit	Pearson Correlation	-.327
		Sig. (2-tailed)	.078
		N	30

Customer name			COLT
Sisu	Profit	Pearson Correlation	-.746**
		Sig. (2-tailed)	.000
		N	107

Customer name			COLT
Visu	Profit	Pearson Correlation	-.635**
		Sig. (2-tailed)	.000
		N	35

**. Correlation is significant at the 0.01 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

Table 50. Kendall's and Spearman's correlations between profit and COLT at customer level.

Customer name			COLT
Kisu	Profit	Kendall's Correlation	.317**
		Sig. (2-tailed)	.002
		N	46
	Profit	Spearman's Correlation	.460**
		Sig. (2-tailed)	.001
		N	46

Customer name			COLT
Misu	Profit	Kendall's Correlation	-.130
		Sig. (2-tailed)	.353
		N	30
	Profit	Spearman's Correlation	-.211
		Sig. (2-tailed)	.263
		N	30

**. Correlation is significant at the 0.01 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

Customer name			COLT
Sisu	Profit	Kendall's Correlation	-.434**
		Sig. (2-tailed)	.000
		N	107
	Profit	Spearman's Correlation	-.621**
		Sig. (2-tailed)	.000
		N	107

Customer name			COLT
Visu	Profit	Kendall's Correlation	-.434**
		Sig. (2-tailed)	.000
		N	35
	Profit	Spearman's Correlation	-.600**
		Sig. (2-tailed)	.000
		N	35

**. Correlation is significant at the 0.01 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

The correlation analyses between profit and COLT were supported with scatterplot graphs. The scatterplots in Figure 14 indicated a quite drastic reduction of profits for customers Sisu and Visu when the COLTs increased. Further elimina-

tion of the data outliers could have made the angle even steeper; however, the indication was clear. Sisu's and Visu's profitability was heavily connected with the COLTs. For Kisu and Misu, the dependency could not be shown either with correlation calculations or with scatterplot graphs. Thus, it can be stated that for customers like Sisu and Visu the profits were COLT sensitive, when for other customers like Kisu and Misu the COLT did not play such a major role in making profits.

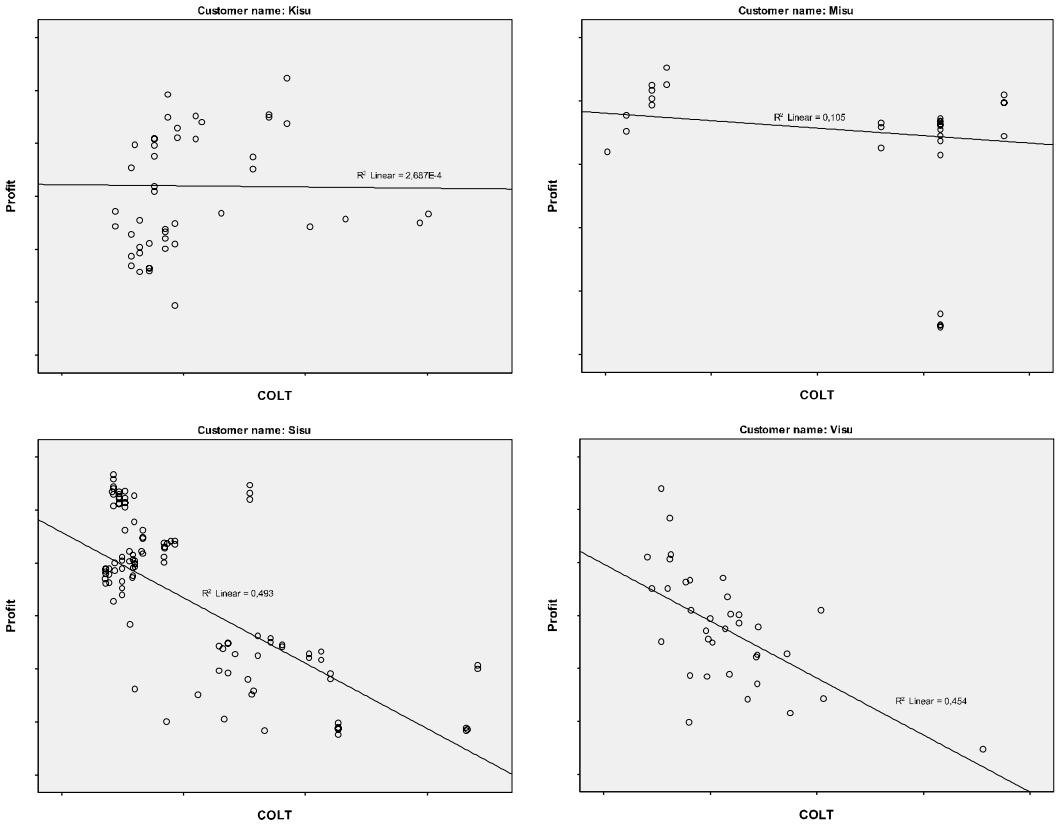

Figure 14. Profit distribution on time-axis and fit line for the four key customers of Mighty Machines.

Closer visualization of the profit and COLT behavior at the customer level with Loess fit line (50% points to fit) in Figure 15 confirmed the negative direction for Sisu and Visu. The decrease of profit as COLT increased was seemingly obvious for these two. The behavior of Misu's profit and COLT correlation went up and down, and it seemed there was no consistency between profit making and COLT. However, the trend for Kisu was positive until the transition point marked in Figure 15. From that point forward the development trend between the profits and COLTs was purely negative, indicating falling profitability when COLTs increased.

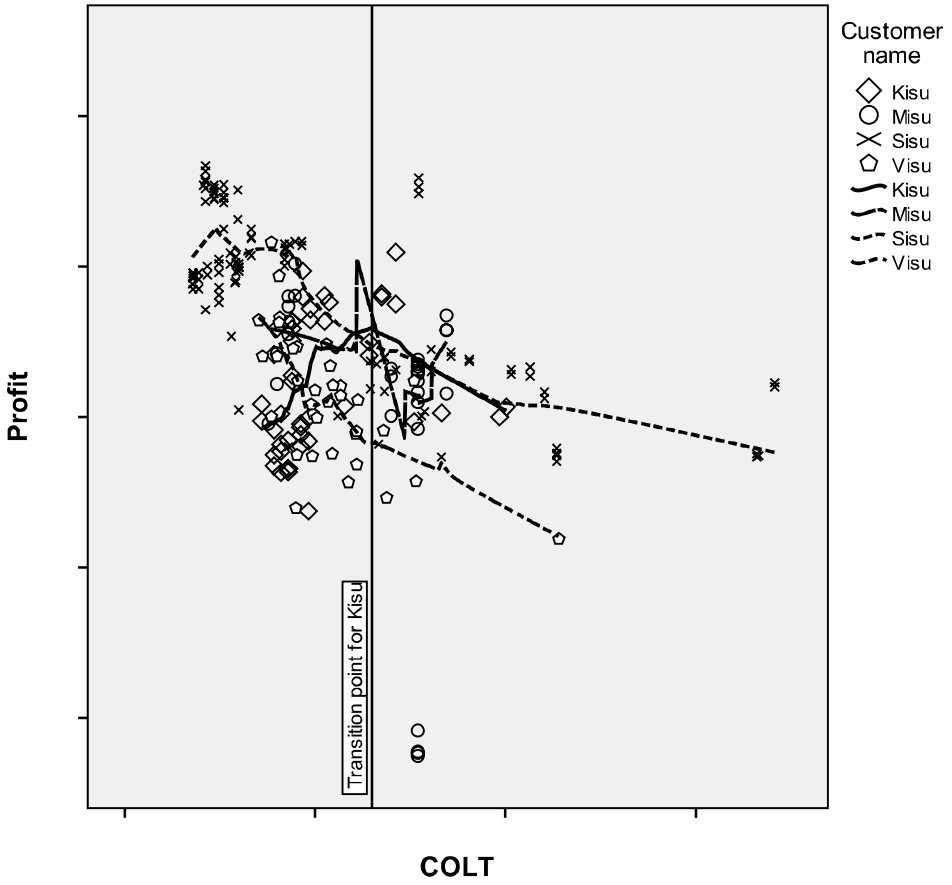

Figure 15. Profit distribution on time-axis and Loess (50%) fit line for the four key customers of Mighty Machines.

Quite interestingly regarding customer Kisu, a certain order delivery time defined the turning point for the direction of the profitability. The reason for the change in the transition point would be valuable information for Mighty Machines, because the price was increasing as the COLT increased until the transition point, as shown in Figure 16. Now, looking at Figure 15 and the left hand side graph in Figure 16, the indication was that when profitability was dropping, the prices were going up. Keeping this in mind, and looking at the right hand side graph in Figure 16, the observation is that as profits were decreasing and prices increasing, the theoretical penalties were heavily increasing. As such, it appears that for customer Kisu the prices increased significantly shortly after the transition point and the theoretical penalties on Kisu's orders from Mighty Machines increased markedly.

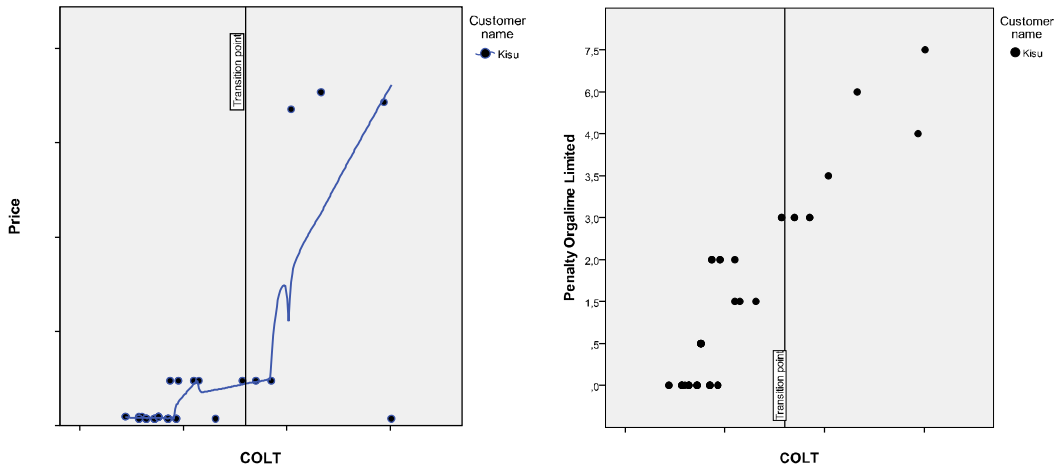

Figure 16. Price distribution with Loess (50%) fit line (on the left) and theoretical penalty (on the right). Both on time-axis for Mighty Machine's customer Kisu.

The question as to whether higher prices were charged for longer COLTs to cover the likely penalties of long lead times would be interesting to analyze more closely in the future. However, two interesting aspects appeared during the analysis. As shown in the Table 51, the first one was that key component material costs and prices correlated nearly with value 1 for all different customers. For example, for customer Sisu the Pearson's correlation of price and material was the highest, with correlation value 0.980. The smallest Pearson's correlation value was with customer Misu. This value was 0.831, and as with all the others, significant at the 0.01 level (2-tailed). The second was that when the prices increased by 1 percent the key component material costs grew at a rate from 1.4 to 1.9 percent depending on different customers in relation to the price. Thus, the reason why profitability decreased, price and theoretical penalties increased as the time increased, would be highly valuable information to understand from the point of view of the management of Mighty Machines. Then, if needed, the focus could be on the right corrective measures and actions.

Table 51. Correlation and regression analysis between price and key material costs for different customers.

Coefficients[a]

Customer name		Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
				B	Std. Error	Beta		
	Kisu	1	(Constant)	6931.612	2002.798		3.461	.001
			Material Costs	1.563	.017	.997	89.902	.000
	Misu	1	(Constant)	12246.796	9918.587		1.235	.227
			Material Costs	1.427	.180	.831	7.912	.000
	Sisu	1	(Constant)	15856.467	2644.048		5.997	.000
			Material Costs	1.531	.030	.980	50.234	.000
	Visu	1	(Constant)	-51565.255	21402.881		-2.409	.022
			Material Costs	1.935	.106	.954	18.211	.000

a. Dependent Variable: Price

5.7.1.2 Customer segments

A second approach was done by splitting the data into different customer segments. The aim of this approach was to test if profitability was order lead time dependent at the customer segment level. The approach was similar to that done with customers. Here, the Pearson's correlation coefficient was used to examine the association between profits and COLTs for three different customer segments. The correlation analysis in Table 52 indicated significant negative correlation between profits and COLTs for customer segments A and B. The correlations for customer segments A and B were significant at the 0.01 level (2-tailed). For these customer segments the results strongly suggest that shorter COLTs were more likely to be profitable. For customer segment D there was indication of negative association, but not at a significant level. Thus, the Pearson's correlation test results indicated that the association between profits and COLTS was negative and for two of the three customer segments the negative association was identified with the highest possible significance level.

Table 52. Pearson's correlations between profit and COLT for three customer segments.

Customer segment			COLT
A	Profit	Pearson Correlation	-.485**
		Sig. (2-tailed)	.000
		N	88
B	Profit	Pearson Correlation	-.397**
		Sig. (2-tailed)	.000
		N	178
D	Profit	Pearson Correlation	-.206
		Sig. (2-tailed)	.054
		N	88

**. Correlation is significant at the 0.01 level (2-tailed).

The associations indicated by the Pearsonian approach were re-tested with Kendall's and Spearman's correlation tests. The results in Table 53 indicated significant correlations at the 0.01 level (2-tailed) for customer segments A and B. similar to Pearson's correlation test. The Kendall's and Spearman's correlation tests indicated the association between price and COLT to be negative and significant at the 0.05 level (2-tailed) for customer segment D. This indicated that order deliveries with shorter COLTs would be likely to be more profitable for Mighty Machines at all customer segment levels.

Table 53. Kendall's and Spearman's correlations between profit and COLT for three customer segments.

Customer segment				COLT
A	Kendall's tau_b	Profit	Correlation Coefficient	-.336**
			Sig. (2-tailed)	.000
			N	88
	Spearman's rho	Profit	Correlation Coefficient	-.486**
			Sig. (2-tailed)	.000
			N	88
B	Kendall's tau_b	Profit	Correlation Coefficient	-.223**
			Sig. (2-tailed)	.000
			N	178
	Spearman's rho	Profit	Correlation Coefficient	-.332**
			Sig. (2-tailed)	.000
			N	178
D	Kendall's tau_b	Profit	Correlation Coefficient	-.186*
			Sig. (2-tailed)	.012
			N	88
	Spearman's rho	Profit	Correlation Coefficient	-.234*
			Sig. (2-tailed)	.028
			N	88

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Further analyses with scatterplot graphs in Figure 17 indicated the same negative correlation as with the correlation tests for all customer segments. The curves could have been even more aggressively negative if yet more outlier eliminations had been made. However, the association was clear.

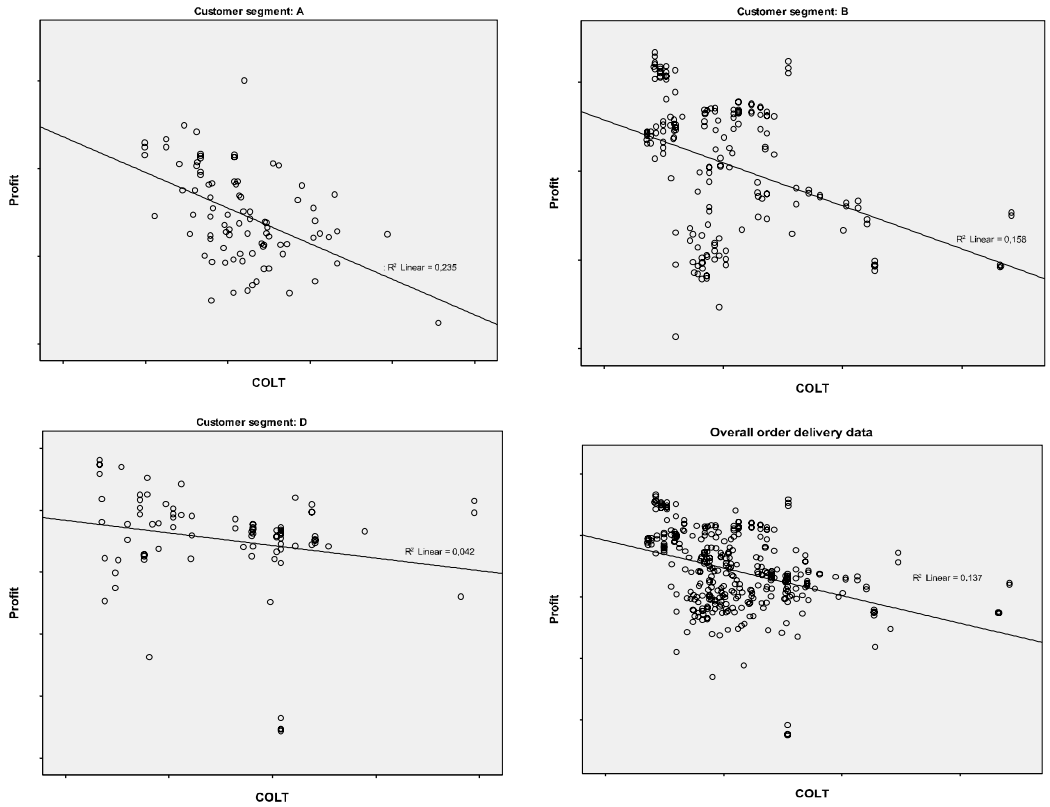

Figure 17. Profit distribution on time-axis and fit line.

5.7.1.3 Summary of analyses at Mighty Machines

The hypothesis tests for the first research question indicated that different customers and customer segments are served with significantly different COLTs by Mighty Machines. The hypothesis test for the second research question suggested that Mighty Machines would not be charging price premiums for short COLTs. Now the hypothesis tests for the third research question quite clearly indicated that the COLT would probably have had an impact on profits. This association between profit and COLT was negative. Based on the analyses, it was clear that for some customers and customer segments the profitability decreased as the COLTs increased. From these order delivery data analyses it was likely that higher profits were made when the order was delivered to the customer in less time. Thus, the null hypothesis in Table 54 can be rejected.

Table 54. Third research question hypothesis.

RQ3: Was it more profitable for the electrical equipment and appliance case firms to handle order deliveries with shorter lead time?	**Mighty Machines**
$H_0 : \rho = 0$ *(COLT did not have positive impact on the profitability)*	FALSE

5.7.2 Power Control

Testing the first hypothesis for the third research question appeared to be a constraint with the acquired data from Power Control. The available data was found to be unreliable for the purpose of testing the profitability aspect of order lead time. In the data, the order information was structured in a way that costs on single product level could not be indicated accurately. Costs were indicated on the order level but not consistently on the order line level. This meant that some order lines, containing the actual product, had no costs allocated to them. Also the order line cost allocations were much higher than the actual price in some order lines. Since the profitability (gross margin) was not available and could not be calculated from the extraction of price and cost, the profitability figures were not reliable enough to test the hypothesis for the third research question.

Table 55. Reliability issues due to missing cost allocations and negative profits on the acquired data from Power Control.

Order lines:	Without costs	With negative profit	With positive profit
Overall cases	*58.80 %*	*13.43 %*	*86.57 %*
Application 1	*18.98 %*	*6.02 %*	*33.33 %*
Application 2	*0.00 %*	*0.00 %*	*7.41 %*
Application 3	*39.81 %*	*7.41 %*	*45.83 %*
Customer segment A	*56.02 %*	*11.57 %*	*60.65 %*
Customer segment B	*2.78 %*	*1.85 %*	*17.13 %*
Customer segment C	*0.00 %*	*0.00 %*	*8.80 %*

As shown in Table 55, the consistency of reporting the financial figures on order line based delivery information was irregular throughout the entire data acquired. If this was the real case when handling the financial and order data, the case firm ought to pay immediate attention to the reporting. As such, it was impossible to indicate which products in the delivery were profitable and which were not. Thus, neither managerial focus on less and more profitable areas could be obtained, nor corrective actions.

The later attempt to conduct analyses for the third research question and explore the order delivery data with a longer time period in order to have more cases and improved data quality was negated by major changes in the case firm. The product line offering and overall order delivery structure had undergone heavy restructuring. These changes affected the order lead times radically and changed the balance between production mixes. Thus, even after these attempts this research was not able to construct statistically relevant analyses from the third case firm, Power Control.

5.7.3 Agile Grid

The case firm Agile Grid had plenty of order delivery data available for the first and second research question analyses. However, the profitability data was in a different system and needed to be retrieved one by one with order number and order line. This made the process very time-consuming and problematic. For this reason, it was agreed that enough profit data would be retrieved for analyzing the main customer based on the previous analyses. This customer was chosen to be customer 4, as in the study of customer segments, the agreement was to procure enough data for analyzing the two biggest customer segments, B and C.

5.7.3.1 Customers

Enough profitability data for customer 4 was collected from both periods of the analyses. From the first period 49 order samples with profits were studied, and from the second period 53. The correlation tests done with Pearson's, Kendall's and Spearman's methods in Table 56 indicated negative, but not significant correlation between the profits and COLTs. The correlations test results shown in Table 56 were also negative in both periods of the analyses.

Table 56. Profit and COLT correlations for customer 4 from the first and second period calculated with Pearson's, Kendall's and Spearman's methods.

Customer				1st Period COLT	2nd Period COLT
Customer 4	Profit		Pearson Correlation	-.181	-.230
			Sig. (2-tailed)	.214	.093
			N	49	53
Customer 4	Kendall's tau_b	Profit	Correlation Coefficient	-.184	-.057
			Sig. (2-tailed)	.083	.576
			N	49	53
	Spearman's rho	Profit	Correlation Coefficient	-.255	-.51
			Sig. (2-tailed)	.077	.715
			N	49	53

Even though the correlations were not significant, the negative correlations would indicate that profits would be likely to decrease when the COLTs were increasing. However, as can be observed from Figure 18, the distribution of the profits did not show any clear associations with time. Thus, the null hypothesis for the third research question appears to be true: Shorter COLT did not appear to have positive impact on the profitability of the customer order, at least for customer 4.

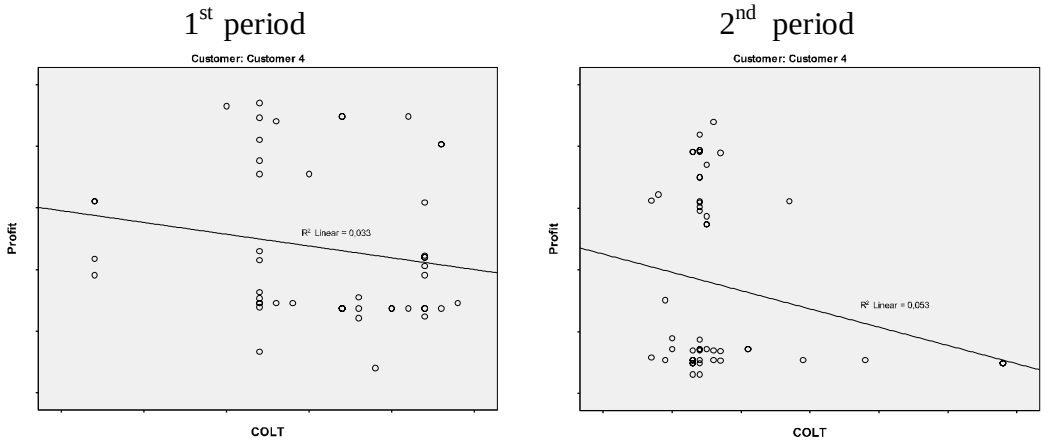

Figure 18. Profit and COLT scatterplots for customer 4.

5.7.3.2 Customer segments

For customer segment B, 51 order deliveries with profits were acquired from the first period and 44 from the second. For customer segment C, 79 order deliveries with profits were collected from the first period and 32 from the second. As the test results indicate in Table 57, the correlations for customer segments B and C were both negative with all the used methods. As for customer 4, the correlations were negative, but not significant.

Table 57. Profit and COLT correlations for customer segments B and C from the first and second period calculated with Pearson's, Kendall's and Spearman's methods.

Customer segment				1st Period COLT	2nd Period COLT
B	Profit		Pearson Correlation	-.173	-.143
			Sig. (2-tailed)	.225	.210
			N	51	79
C	Profit		Pearson Correlation	-.048	-.088
			Sig. (2-tailed)	.757	.632
			N	44	32
B	Kendall's tau_b	Profit	Correlation Coefficient	-.179	-.144
			Sig. (2-tailed)	.083	.075
			N	51	79
	Spearman's rho	Profit	Correlation Coefficient	-.245	-.207
			Sig. (2-tailed)	.083	.67
			N	51	79
C	Kendall's tau_b	Profit	Correlation Coefficient	-.031	.121
			Sig. (2-tailed)	.775	.364
			N	44	32
	Spearman's rho	Profit	Correlation Coefficient	-.045	.145
			Sig. (2-tailed)	.774	.429
			N	44	32

The data collected for customer 4, one of the biggest customers for Agile Grid, was also a major contributor to the customer segment B analyses, since out of the 51 collected order deliveries 49 were from customer 4. Similarly, for the second period, out of the 79 collected order deliveries, 53 were from customer 4. Thus, the results in Figure 19 were almost identical to the scatterplot graphs for customer level analyses in Figure 18. As the scatterplots indicated for customer 4, the distribution of the samples for customer segment B did not indicate a clear association between profits and COLTs. Associations cannot be seen either for the first or second period of the analyzed samples since the orders on the profit and COLT axis were distributed along the axis without any clear pattern of association.

On customer segment C the distribution of the data was closer to the drawn fit line at a total which represents the trend for the data sample. Still, the observed data samples from customer segment C did not indicate a clear negative association between profits and COLTs. Thus, the null hypothesis is very likely to be true and it can be claimed that shorter COLTs were unlikely to increase the profitability of the order deliveries from customer segments B or C.

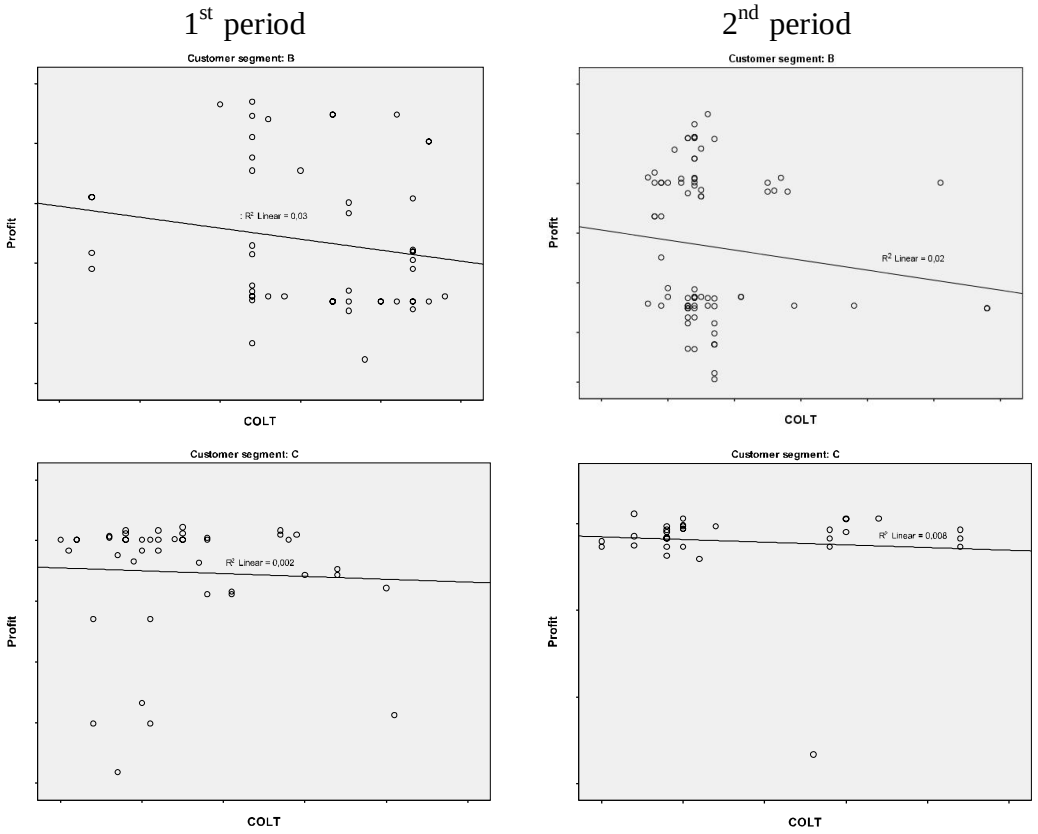

Figure 19. Profit and COLT scatterplots for customer segments B and C.

5.7.3.3 Summary of analyses at Agile Grid

For the overall analyses, the number of order deliveries with profits was limited. Thus, the focus of analyses was on customer 4 and customer segments B and C. As these data samples were more or less duplicated, overall analyses were also conducted with all the acquired data samples. The purpose of analyzing the overall data was to add order delivery cases from segments and customers that did not have enough data for statistically relevant analyses within the segment or customer group and thus produce an overall picture from the overall product perspective. The results in Table 58 indicate the associations to be positive, but not significant during the first period of analyses. The positive correlation was significant at the

0.05 level (2-tailed) during the second period of analyses. As such, the results indicated no significant negative association between profits and COLTs.

Table 58. Profit and COLT correlations for overall order delivery data from the first and second period calculated with Pearson's, Kendall's and Spearman's methods.

Overall data			1st period COLT	2nd period COLT
Profit		Pearson Correlation	.023	.199*
		Sig. (2-tailed)	.815	.018
		N	109	141
Kendall's tau_b	Profit	Correlation Coefficient	.040	.149*
		Sig. (2-tailed)	.550	.011
		N	109	141
Spearman's rho	Profit	Correlation Coefficient	.062	.213*
		Sig. (2-tailed)	.523	.011
		N	109	141

*. Correlation is significant at the 0.05 level (2-tailed).

The visualization with scatterplot graph in Figure 20 confirmed the observations from the correlation analyses. The recorded order delivery samples were distributed without any indication of association between profits and COLTs. As Figure 20 shows, the order delivery samples were far apart from the drawn fit line in total and did not indicate any clear patterns. Also, the visual scatterplot analyses supported the correlation analyses. Therefore, it can be said that it was very likely that shorter COLTs were not more profitable for Agile Grid during the two periods analyzed. This strongly indicates that the null hypothesis for the third research question was true.

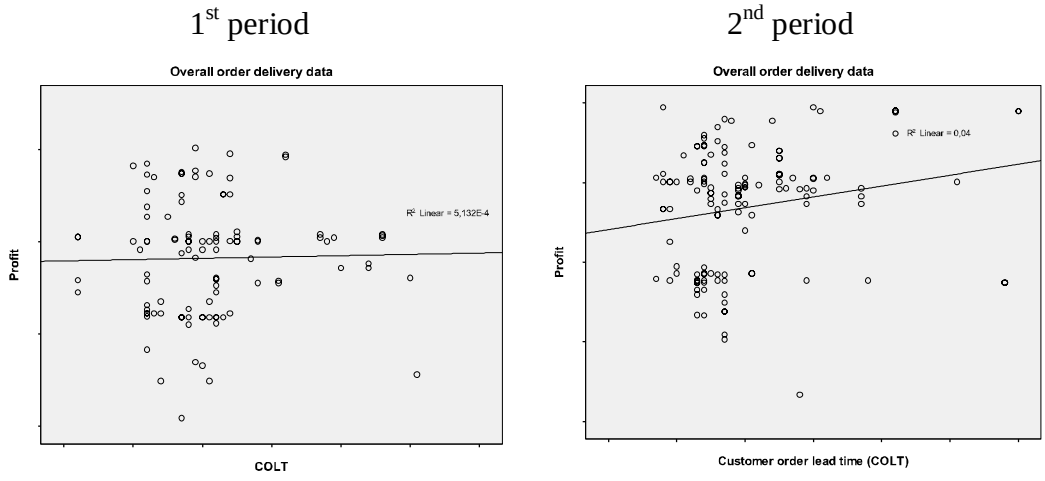

Figure 20. Profit and COLT scatterplots for overall order delivery data.

Overall, these results were surprising, since customers and customer segments were paying more for shorter customer order lead time deliveries. The strategy at

the time in Agile Grid was not to make more profit with shorter order lead time deliveries. Instead, premium pricing was used only to charge customers extra when additional variable costs were needed to complete the order. Extra costs caused by expediting the order were, for example, the overtime costs of the assembly workers or special shipping arrangements. Even though the premium pricing was explained as being charged for covering these extra expenses, some customers seemed to exploit this opportunity at least during the first period of analyzed data. There, the COLT for the customer was around 30% longer on average than during the second period. Without knowing the details of the pricing strategy at Agile Grid, the willingness of certain customers to pay extra for expedited deliveries would be the something to be looked at in more detail.

Now, when looking back at the analyses made of Agile Grid's order delivery data, and focusing on the third research question, all significant correlations were positive. This suggested that longer lead time would have meant higher profits for the case firm. At the same time, this indicated that profits from shorter COLTs would be smaller, or at least there was no evidence that they would have been more profitable at any analyzed level. This would be an interesting topic for further analysis. All in all, the analyses of the order delivery data with profit from the case firm Agile Grid confirmed the proposed null hypothesis to be true.

5.7.4 Summary of research question 3 and hypothesis

Analyses could be done with only two case firms, since only these two were able to provide product specific profitability data. Testing the hypothesis with the provided data indicated clear differences between the case firms. As indicated in Table 59, time appeared to be a quite different competitive dimension for the analyzed case firms. Time appeared to play a more meaningful role for Mighty Machines than for Agile Grid. Mighty Machines seemed to be making more profits on the same products that had shorter order lead times than with long lead time order deliveries.

Table 59. Summarizing the research question results for the case firms Mighty Machines and Agile Grid.

Mighty Machines

Customers/segments		**Kisu**	**Misu**	**Sisu**	**Visu**	**A**	**B**	**C**
Profit vs. COLT	Pearson's	+	-	---	---	---	---	-
	Kendall's	+++	-	---	---	---	---	--
	Spearman's	+++	-	---	---	---	---	--

Agile Grid

Customers/segments/all (period)		**4 (1st)**	**4 (2nd)**	**B (1st)**	**B (2nd)**	**C (1st)**	**C (2nd)**	**Overall (1st)**	**Overall (2nd)**
Profit vs. COLT	Pearson's	-	-	-	-	-	-	+	++
	Kendall's	-	-	-	-	-	+	+	++
	Spearman's	-	-	-	-	-	+	+	++

+++ = Significant positive correlation at level 0.01 (2-tailed)

++ = Significant positive correlation at level 0.05 (2-tailed)

+ = Positive correlation

--- = Significant negative correlation at level 0.01 (2-tailed)

Even so, the results indicated that time did not play that significant a role in making profits for Agile Grid; these results reflected on current sales and operations strategy. Thus, this does not rule out the possibilities discussed in sections 5.4.3.5 and 5.7.3.3. There, certain customers were willing to pay extra to get the products delivered faster. As such, adjusting the sales and operations strategy to support time-based competition could allow Agile Grid to enhance the profitability of short order lead times. Of course, there would be several other internal and external aspects to consider before entering in to the world of time-based competition. One of them would be the current performance of the case firm compared to the competition. The most common way to obtain this kind of comparison would be the customer satisfaction surveys done by many of the companies in the field of electrical equipment and the appliance business niche.

5.8 Testing research question four and hypothesis

The importance of customer satisfaction has been highlighted by many well-known business leaders. Among them is the former CEO of General Electric, Jack Welch, who has claimed (in the seminar “Leaders in London 2008”) that customer satisfaction needs to be one of the top three indicators of firms’ performance along with employee satisfaction and cash flow. While interviewing the key man-

agement from the case firms, it was claimed repeatedly by the management at Mighty Machines and Agile Grid that time-based flexibility was part of better customer service. But why did these firms focus their efforts on offering time-based flexibility in their customer order lead times when it required extra effort from them and when Agile Grid did not appear to make any higher profits from it? These questions raised a follow-up question for this case study research: "Does time-based flexibility have impact on overall customer satisfaction?"

All the case firms belong to a global company which sends out the results of standardized customer satisfaction surveys to their customers on a yearly basis. The customer satisfaction survey carried out during the year when this study had data from all the case firms was chosen as the basis for comparison. The survey contained several sub-topics that tested customer satisfaction in several operational areas. However, in these areas there was no straight connection to time-based flexibility. For this reason, the selected areas of the customer satisfaction survey were used. These areas are indicated in Table 60. For comparison, the customer satisfaction points were indexed and average customer satisfaction from the compared areas was calculated, as shown in Table 60.

Table 60. Selected customer satisfaction areas indexed and average calculated for the case firms.

Case firm	**Mighty Machines**	**Power Control**	**Agile Grid**
Number of responses	(40)	(14)	(57)
Satisfaction with the firm as supplier	1.00	0.82	0.93
Would you use the firm in the future?	0.96	0.97	1.00
Would you recommend the firm to business acquaintances?	0.98	0.87	1.00
Response to your specific needs	0.99	1.00	0.96
Getting offers at the agreed time	1.00	0.84	0.96
Ease of ordering products	1.00	0.97	0.98
Order changes due customer changes	1.00	0.95	0.99
Average customer satisfaction from the above points	0.99	0.92	0.97

The next step was to compare the customer satisfaction survey results among the results from the earlier results of this case study. This was done by ranking the average customer survey results from Table 60 and by comparing them with the overall research question answers from the three earlier research questions. These results are shown in Table 61.

Table 61. Average customer satisfaction ranking compared with earlier research question indications.

	Mighty Machines	**Power Control**	**Agile Grid**
Time-based flexibility offered?	Yes	No	Yes
Time-based premium pricing used?	No	No	Yes
Time-based profitability realization by case firm?	Yes	No	No
Average customer satisfaction ranking	1	3	2

The indication from the comparison was that customers were most satisfied with the case firm Mighty Machines. With Mighty Machines the customer pleasing combination was to offer time-based flexibility in customer order lead time for selected customers and orders but not to premium price the shorter customer order lead times. Mighty Machines was able to do this through a concept which was more profitable for them even though in many cases they had to use more expensive suppliers to get the components faster. The second most pleasing concept was the one from Agile Grid. They offered time-based flexibility for customer order lead times, but charged premium prices when expedition could not be made through their normal processes. With the time-based approach Agile Grid was not able to make better profits for the case firm. Power Control was ranked last out of the three. They did not appear to offer time-based flexibility intentionally and thus did not premium price or profit from it. Of course, the results cannot be compared one to one with the time-based aspect of the study. However, these comparisons can be considered as indicative points that can distinguish the customer preferred approach from others.

6 CONCLUSIONS AND IMPLICATIONS OF THE STUDY

The purpose of this doctoral dissertation study has been to investigate if time-based flexibility of the order lead time has impact on two key performance indicators: profitability and customer satisfaction. This has been done by studying time-based literature, interviewing key managers and persons, collecting and analyzing order delivery and financial data from selected case firms. This chapter summarizes the observations and analysis results of the dissertation in Section 6.1. In Section 6.2 the dissertation identifies the gaps between theory and practice in the field of electrical equipment and appliance manufacturing. Section 6.3 addresses the identified gaps and gives managerial implications for the case firms' management, as well as for the entire field of electrical equipment and appliance manufacturing. In Section 6.4 the dissertation indicates the limitations of the study and suggests future research areas for the build-to-order field of operations. At the end of the chapter in Section 6.5 the research process lessons are briefly discussed.

6.1 Summarizing the results for the research questions

The four research questions, with their hypotheses, tested the existence of (1) time-based flexibility, (2) time and price correlation, (3) time and profitability correlation, and (4) time and customer satisfaction relationship in three selected case study firms which were all operating in the field of electrical equipment and appliance manufacturing on a build-to-order (BTO) basis. An overview of the questions and their analysis are reviewed in Sections 6.1-6.4. More details of the analysis are shown in Chapter 5.

Table 62. Summary of the research question analyses.

Interview / data analysis	**Mighty Machines**	**Power Control**	**Agile Grid**
1: Different customer groups and customer orders were offered diverging lead times	*Yes/Yes*	*No/Yes*	*Yes/Yes*
2: Firms were charging price premiums from shorter order lead-times	*No/No*	*No/No*	*Yes/Yes*
3: *Customer order lead time had impact on the profitability*	*No/Yes*	*No/NA*	*No/No*
4: Overall, customers were more satisfied with case firms that were able to deliver products with time-based flexibility (customer satisfaction ranking points indexed)	*1st (0.99)*	*3rd (0.92)*	*2nd (0.97)*

6.1.1 Delivering products with significantly diverging COLTs

As Table 62 indicates, each case firm was delivering similar products to different customers and customer groups with significantly diverging order delivery lead times. Customer order lead times (COLTs) were significantly diverging even in cases where the products were manufactured on the same production line, by the same people with the same equipment. However, the reason "why" was different for the case firms. The availability of parts and capacity played a major role regarding order lead time. Besides the time-based restrictions of availability of parts and capacity, Mighty Machines and Agile Grid claimed to be flexible for some selected orders and customers. According to these firms, they were able to deliver faster than their standard order lead time processes, based on their capacity and parts availability, would indicate. This clearly indicated that time-based flexibility was part of their executed strategy.

The reasoning behind this strategy was claimed to be part of better customer service by both of the case firms. The Mighty Machines management claimed that by creating time-based flexibility, the firm was securing future business from customers that received the time-based flexibility that they needed. The claim from Mighty Machines was that if they can help their customers at a time of need, even though it might push the Mighty Machines processes to the limit, the outcome would be more satisfied customers, and that would ultimately create more business and profits for them. Agile Grid had basically the same thinking logic in offering time-based flexibility to selected customers. It was part of better customer service and something they were obliged to offer in this time and age. Also Power

Control had significantly diverging COLTs for different customers. However, the process for offering time-based flexibility seemed to be considered as secondary and a troublesome process to handle. This indicated that time-based flexibility was not part of the executed strategy and the process how it could be managed was not described. Thus, most of the divergences on the COLTs were considered to be due to the availability of parts and capacity.

Even though the different case firms had different sourcing, manufacturing and order delivery strategies, all of them agreed that time-based flexibility would provide better probability in winning on certain business areas. Among the specified areas, replacement business was mostly highlighted. Replacement business was identified to cover customers whose processes experienced unplanned down time due to machine or component breakdown. The down times were usually very expensive, especially in process industries. These customers did not care too much about the price. The main point was to deliver the product and/or service as fast as possible and to get the process up and running again. In that sense, being able to deliver fast would have positive impact on the last line of the financial sheet.

6.1.2 Price premiums from shorter COLTs

Of the three case firms studied, Agile Grid was the only one asking price premiums from faster COLTs. There, the management claimed that their customers were willing to accept a higher price when knowing that they would get the product delivered faster than the normal process times would indicate. In other words, this indicated that customers accepted premium pricing with certain prerequisites.

Mighty Machines did not premium price shorter COLTs, even though it might require the use of more expensive key component suppliers. These suppliers had higher prices but shorter lead times than cheaper high volume component suppliers. The main claim for operating this way was based purely on the enhancement of customer service at the point where the customer would need it most. For Mighty Machines the challenge was to serve customers with time-based flexibility without premium pricing the orders and to make profitable business with shorter lead time orders.

Power Control did not ask premium prices from orders that were shorter due to the claim that time-based COLT flexibility was not one of their strategic focus areas. Prices were based on the estimations of needed work and material costs instead of how fast the product was delivered. Even on the order delivery data level it was a burdensome job to connect lead times to financial data like pricing. Without knowing the market and competition base in detail, it would seem never-

theless that Power Control would still have the possibility to explore time-based flexibility for customers further.

6.1.3 Profiting from faster COLTs

The analyses of the order delivery and financial data indicated that it was more profitable for Mighty Machines to deliver customer orders with shorter COLTs. Based on the fact that Mighty Machines did not charge price premiums and in some cases was using more expensive key component suppliers for shorter COLT orders, it was slightly surprising to see that Mighty Machines was likely to profit more from short COLTs. This scenario raised some further points for analysis: How higher profits were made even if customers were not paying price premiums and more expensive key component supplier use was likely to take place? This will be analyzed in more detail in Section 6.4.

For Agile Grid, time-based flexibility did not enable higher profitability on the order line level. This appeared to be because most of the efforts to gain time were made with operations that were not part of their everyday processes and supply/delivery networks. Even so, faster customer order deliveries with premium prices did not indicate significantly better profit margins for Agile Grid; these results can be seen such that some customer groups were certainly willing to pay price premiums if the order delivery time was shorter. As such, the potential of time-based flexibility as competitive advantage existed, and it would be up to the case firm to exploit it to their advantage by focusing on time-based strategy.

At the time when the case study research was carried out, Agile Grid's manufacturing was not the constraint. Thus, they had huge potential in their manufacturing to create time-based flexibility. This opportunity was seized and this potential started to show in the second part of the time analysis conducted in the firm. As a result of this there was a decreasing need for premium pricing. As such, customer specific product profitability dropped even as much as 7 percent for some of the studied product families. However, the orders received in euros increased by nearly 30 percent in the second period compared to the first period of analysis. This indicated that even though product level profitability dropped in Agile Grid due to less need for premium pricing by the customers, the in-built time-based flexibility increased the throughput of the factory and thus increased the overall profitability.

Unfortunately, Power Control data could not be analyzed due to the reasons mentioned in Section 5.5.2. The interviews with key management in the case firm Power Control indicated that the prices were based on material, engineering, and

manufacturing costs. As such, pricing was heavily dependent on the focus markets and customer applications. Thus, there were certain pre-agreed rules in the pricing of orders which appeared to be based on parameters other than time.

6.1.4 Overall customer satisfaction and case firms

The overall customer satisfaction results indicated that the most satisfied customers were the ones dealing with Mighty Machines. Mighty Machines was the firm that was able to provide time-based flexibility without premium pricing the faster customer order lead time deliveries and through a more profitable concept was ranked the best among the three case firms in the study. The second highest customer satisfaction results was received by the case firm Agile Grid, which offered time-based flexibility for their customers with price premiums (first period of analysis). Through this concept Agile Grid was not able to make significantly higher profits. The least satisfied customers were those of the case firm Power Control. Power Control claimed to be reluctant to offer time-based flexibility. Their lead times were based on capacity and availability calculations rather than trying to create flexibility in customer order lead times. Profitability could not be calculated due to the lack of order line specific financial data, and in the interview it was claimed that pricing is done according to estimation of the needed materials and needed work. Among these case firms, the overall customer satisfaction results indicated that customers were most satisfied with a supplier that was able to give time-based flexibility to customers when needed and without premium pricing faster customer order lead times.

It would have been interesting to conduct a second set of customer satisfaction analysis during the period when Agile Grid had decreased their lead times and thus become more competitive in time-based flexibility (second period of analysis). It would have been interesting to see if Agile Grid could have challenged Mighty Machines place as best ranked by the customers. Unfortunately, these results were not available at that time.

6.1.5 Summary of research question implications

Even though the field of the study was not considered to be time or price sensitive, the case firms were mostly prepared to offer time-based flexibility with comparable prices. The results from the three case firms indicated that different customers and customer groups can be treated differently from the lead time point of view. This case study research showed that prices can be time-dependent, and the case firms could gain better profits if they were able to manage and offer

time-based flexibility for different customers and customer groups. The results of the study also strongly suggest that the customers of a firm able to offer time-based flexibility without premium pricing on short lead time orders had a higher customer satisfaction level. If we now compare the results from this research with previous research done by, for example, Ferdows and Meyer (1990) and Amoako-Gyampah and Acquaah (2008), these results clearly indicate that the manufacturing strategy component such as flexibility in COLTs would have a positive impact on competitive advantages such as profitability and customer satisfaction. The results also indicate that premium pricing shorter COLTs appears not to have a direct correlation with competitive advantage. As the case study results have shown, a firm does not necessarily have to ask price premiums from shorter COLTs to make higher profit margins. Better profit margins were achieved even without premium pricing and with higher material costs. Faster COLTs were enabled by redirecting the procurement towards faster and more expensive suppliers, but doing this more cost efficiently from the entire order delivery process perspective. The differences between the case firms on if and how they were able to engage their supply chains to provide the possibility to serve customer needs with time-based flexibility were significant. Thus, based on these results the trade-off theory would be doubtful for the majority of the customers and customer groups dealing with the three selected case firms. As the results indicated, some customers were offered time-based flexibility more than others. When this was offered through mature manufacturing and supply processes, the likelihood for building competitive advantage with this process was high.

6.2 Theoretical and empirical contribution

According to Droge et al. (2004), there are two different main approaches for becoming a time-based competitor. The first approach focuses on operational process issues related to time within an individual firm and looks for internal opportunities to reduce cycle time. There are numerous tactics associated with this approach. For example, functional business processes can be analyzed to eliminate waste, remove redundant steps, or perform steps in parallel (Bozarth and Chapman 1996; Ohno 1988; Liker 2004). Cross-functional teams can be utilized to design products, processes, and facilities that enable a reduction of overall process cycle times (Droge et al. 2004). The second approach for becoming a time-based competitor looks beyond internally focused process efforts. This approach looks into linkages with other members of the supply chain (De Toni and Meneghetti 2000; Vickery et al. 2004). This is increasingly important, especially if the supply chain strategies and models have been developed under the assumption of overall stability (Christopher et al. 2011). With this approach, supply chain

relationships are leveraged to increase the flow of information and reduce cycle times throughout the supply chain (Thomas 2008). Some researchers have proposed that closer supplier relationships are highly related to the reduction of delivery cycle times (Droge et al. 2004). The case study analysis supported prior research that most of the time-based competition and supply chain management researchers have pointed out. The case firms able to influence both internal and external members of the value creation chain appeared to obtain the greatest benefits.

Now looking at the indications of the empirical evidence collected from the three different case firms, the improvement potential can be divided into internal and external approaches, as Droge et al. (2004) indicated. For sure, the majority of claimed issues indicated issues caused by suppliers, but in many cases the root cause analysis indicated the cause of issues to be related to the supply chain strategies and models used by the case companies rather than suppliers themselves. In many cases it could be identified that price was the main driver of the purchase agreements between the case firm and the supplier. Price driven agreements appeared to lead to push-based rather than pull-based supply, and causing inflexibility, for example, in the monthly volumes. The issues created by the lack of operational control were magnified by the issues of sharing information, both internally in the firms and externally with the customers, partners and suppliers. These together magnified the costly dynamic distortions such as bullwhip effect. External challenges in this case study niche of electrical equipment and appliance manufacturing were still on building stable supply chains. Throughout the study period from 2006 to 2008, the information and material flows were interrupted a number of times. These issues can be described to be in maintaining of the dynamic flexibility of the supply chains. Here, dynamic flexibility means gearing the supply chain exclusively for factory efficiency to riddle dynamic distortions (Christopher and Holweg 2011). When looking at this from the time perspective, the need for building competitive advantage would likely require adaptable supply chain management. With this adaptable supply chain management, the case firms could be able to handle the changes in the demand and supply balance. According to Christopher and Holweg (2011), this structural flexibility can be typically achieved through a number of actions, such as:

- *Dual sourcing*, by having alternative sources for key and time-critical components
- *Asset sharing*, by being prepared to share physical assets such as manufacturing facilities, warehouses, distribution centers, logistics with other companies and manufacturing equipment.
- *Separating base from surge demand*, by recognizing that most products will have a predictable base demand level and above it fluctuating surge demand, which may be managed with postponement techniques.
- *Postponement*, by holding base materials, sub-assemblies and modules as strategic inventory and assembling or "late configuring" the products against actual orders.
- *Flexible labor arrangements*, by utilizing flexible working hour agreements with employees or by making use of externally leased personnel to adjust to the changes in demand.
- *Rapid manufacture*, by using new technology to manufacture small batches economically.
- *Outsourcing*, to external providers in order to gain access to capacity when required and convert fixed costs to variable costs.

Handfield (1995), among many other time-based competition researchers, has stated that: "Reducing time is not critical in and of itself – it is the benefits achieved through time reduction, in the form of greater cash flow, less inventory, quicker customer response, and ultimately, greater profits, which make this initiative worthwhile". This statement is supported also by QRM ideology, where the aim is to reduce lead time from receipt of order to shipment of the completed product involving the entire process in this cycle (Suri 1998). Also TPS highlights the same issues: "The only way to generate a profit is to improve business performance and profit through efforts to reduce costs" (Ohno 2007). In this case study, it can be stated that firms which had even a slightly better process to tackle time-based strategies were able to provide quicker customer response and ultimately higher profits. Firms tackling time-based strategies with a functional approach without being able to control the broader processes from suppliers to customers were not able to reduce the costs and were unlikely to obtain significantly higher profits.

Literature research on time-based manufacturing indicated the possibility of premium pricing faster lead time orders and thus obtaining higher profitability. However, the same sources stated this should not be the purpose of a time-based approach, and it would be only short-term thinking (Blackburn, et al. 1992; Suri

1998). This doctoral dissertation case study indicated that the case firm which was charging price premiums for faster delivery was unable to benefit from them due to the increased costs of being fast. Also the interviews indicated that the firm's order delivery processes were stumbling on the functional silos. The firm had very limited influence on the upstream component suppliers from a delivery time perspective. These reasons also support the previous literature, which indicated that when the entire process in the order delivery process is not activated, the results can be meagre.

The evident fact is that time itself will not create any superior competitive advantage. Being on-time, on-quality and with competitive price may set the basis for creating competitive advantage over your competitors. However, the three high level dimensions: speed, quality and price have a number of sub-dimensions which need to be tailored for different customer segments, locations and applications. A firm might have fulfilled all the high level competitive dimensions like time, quality and price that the customer expects from the product delivery. However, if this firm cannot meet the customer requirements, for example with spare part delivery promptness, or it is not able to provide the service that will guarantee a service technician on site within an hour after the product or solution has failed, they have most likely lost that business opportunity.

Even giant firms, like the computer manufacturer Dell, have failed to stay out of the reach of their competitors. Their flexible manufacturing with which they were able to ship out customized product within four to eight hours after receiving the order certainly brought them competitive advantage over their competitors for a certain period of time. Grinnell and Muise (2010) have even claimed that it is possible that no other company has mastered just-in-time (JIT) better than Dell. However, the competitive advantage apparently was not just speed when Hewlett-Packard took over the market leadership from Dell in 2009. The shift of change resulted from three main factors: (a) customer service problems due to outsourcing customer support; (b) product quality problems due to defective parts; and (c) the firm's faulty response to declining desktop sales (Grinnell and Muise 2010). Chi and Hung (2011) have highlighted the impact that Dell's pricing mistakes and sub-optimized damage control has had on the firm's image. Toyota has been the success story of the automotive industry. However, recent strategic decisions have displaced them from the most profitable automotive manufacturer's position. The strategic decisions for certain manufacturing locations and technologies caused Toyota to face very challenging business conditions (Toyoda 2010). As such, time is not everything, but still new stars like clothing retailer Zara have risen and outperformed their competitors in time-based business. The secret of Zara's success has been claimed to be in its business model (Lopez and Fan 2011). The time

factor combined with the information coming from the stores allows competitive advantage, at least for a while. The fact that Zara does not have a formalized marketing department, keeps its advertizing budget to a minimum and focuses its success on paying attention to customer needs and wants, clearly demonstrates the desire to step out of a marketing orientation and focus on market orientation (Mazaira, et al. 2003).

What this doctoral dissertation offers is an operational and analytical approach for firms in any business to build a solid base of competitive awareness. On top of this awareness, firms can build a solid framework with a collaborative approach. This collaborative approach has to be built together with upstream partners and downstream customers. This is because "without an awareness of basic information-flow principles, it is only through costly errors that managers can develop an effective intuitive judgment" (Forrester 1958).

6.3 Managerial implications

"A corporation is a living organism; it has to continue to shed its skin. Methods have to change. Focus has to change. Values have to change. The sum total of those changes is transformation".

Andrew Grove

First, methods have to change. Therefore, managers should find time to ensure that the firm has a working process for collecting and storing business-based data that can be extracted in detail if and when needed. In this day and age, electronic information and analytical implications play a huge role in decision-making. Management decisions are supported by data analyses in increasing numbers. As such, it was quite alarming to see how problematic and challenging the process for collecting and extracting fairly simple data was from some of the potential and actual case firms. Even more alarming was that some potential case firms failed to get the information. The problem was not that there was no data available, it was rather about not having reliable data or not being able to extract information from the data.

Second, the management of the firm has to understand the sources of the variability in order to handle it. Now it appeared that many of the managers in the firms just have their fingers crossed and hope that nothing happens to the processes. If something happens to the processes, the operations that take place are more about patching holes rather than finding the root cause for the variance and fixing it. For this, the management has to build different models that would tackle the volatility

caused by different sources. These models have to be simple enough that they can be launched and carried through fast after the change in the source of variability is recognized. Of course, this means changing the old operational procedures, and it relates heavily to change management. Nevertheless, it needs to be done. These firms cannot afford to have these kinds of additional costs.

Third, the high level focus has to change. It is not enough to focus on short-term in-house profit optimization. In the process of studying the different case firms through acquired order-delivery data, interview sessions and different consulting projects in tens of different firms during the past six years, it has become clear that the existing potential of the markets is not likely to be reached with today's sales and operations strategies. Even if we closed our eyes to internal sub-optimization and wished that the firm's internal functions would focus on firm level targets, we would surely face issues in the upstream and downstream parts of the value delivering chain. In delivering value to the customer in the form of products or services, in this day and age firms are commonly a part of a global delivery network. In this globally competing business, even one firm optimizing their operations without focusing on the bigger picture can reduce its competitive potential from the entire network.

Fourth, strategic values have to change. Ignorance of customer values will be fatal for the business in the long run. This is simply because firms cannot afford to be product-centric anymore. The future is clearly towards a customer-centric approach. At the end of the day, it is not enough to have only the right product or service. Firms must be able to deliver the right product, service, and solution and customer value of a preferred mix of them to the right place at the right time with acceptable costs. However, all customers do not need the same amount of flexibility as others. Some also value it more than others. Thus, the challenge is not only on the management of a combination of competitive characteristics or how the mix would be managed for different customer-based needs and values from different groups or channels, but to focus on the future needs of the customers. In many cases, this could mean finding the right balance and coordination between demand and supply chain management processes to create more customer value at lower cost than competitors (Hilletofth 2010).

6.4 Limitations and suggestions for further research

Limitations. One of the biggest limitations was, and will be, the differentiation of firms in this kind of research. Of course, all case firms will be different. Even in this case study research different firms were serving different customers with different needs and in different and changing competitive environments. Analysis of the case firms' supply models indicated that they were all different. Even though the cost was a driver of all of them, it was not as strong for all of them. Based on the information today, they could not be compared directly and reliably compared with all the measurements used in this study. It would also be challenging to indicate the measurements that would place these case firms on the same line and it would not even be appropriate. Even when indicating that time-based flexibility is likely to be beneficial for the case firms in this case study, it might be a different case for different firms in a different competitive environment. However, there is common measurement that allows a comparison between different firms in the field of electrical equipment and appliance manufacturing. This measurement is the customer satisfaction index.

Certain restrictions for this doctoral dissertation also created a limited number of connections between order delivery and financial data. The availability of the financial data on an order line basis was alarming. In many cases, the costs were bundled and reported for the entire order. For this reason, order line specific (product-based) costs or profits could not be calculated. Here, this doctoral dissertation needed to compromise in certain cases and make a profitability and time comparison analysis with a fewer number of cases than, for example, time-based flexibility and time and price analysis. This limitation is also likely to exist in future research if the financial reporting practices are not improved.

One of the main limitations for the study can be claimed to be the different operations models: assembly-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO), that the different case firms used. These different customer order penetration points (COPP) for the customer order require a different approach for supply chain management (SCM) models. Thus, the impact of the supply lead times on the analyzed overall customer order lead times (COLTs) varied between different firms and different products. For one, the key components were off the shelf components, whereas for the other they had a lead time of weeks from the supply order. Also there were limited possibilities in some case firms to connect the supplied components to specific orders. As such, this study did not focus highly on comparing the lead times of supply orders. Instead, it focused on analyzing the four aspects:

1. Was time-based flexibility offered?
2. Was time-based flexibility connected with premium pricing?
3. Were faster customer order lead times (COLTs) more profitable?
4. Did these three above choices make any difference to overall customer satisfaction?

Propositions for future research. When looking at company-wide figures, I would argue that the most important thing would to be able to understand the reason behind the figures and answer questions like:

– Why are the figures as they are?

– What figures are connected to each other?

– What are the causations between the figures?

– How do the figures correlate with each other?

When one of the main indicators for the successful capitalizing of competitive advantages can be measured as profitability, the need is to go beyond the three competitive dimensions of cost, quality and speed. As prior research has indicated, profitability will depend on the different competitive dimensions, or more specifically, the different mix of their combinations. However, the granularity level of defining the mix of competitive advantages at firm level would be too rough. Defining how the firm could generate greater profits has to go more deeply into detail. Even if a firm had the lowest price and highest quality product or service with the fastest delivery time, it could lose the deal to a competing firm even without illegal aspects like bribery. This raises a point when trying to understand the competitive white spots in the field of electrical equipment and appliances manufacturing. We need to understand aspects such as how the product or service level and references, new technology, product mix, customer channels, market locations, customer closeness, economic situation, used risk mitigations such as hedging of a certain price sensitive material, to name only a few, impact on the firm´s way of conducting profitable business. Here, it is critical to understand how different competitive characteristics and different combinations of these competitive characteristics correlate with profitability and the ability to increase market share and customer satisfaction. Thus, the first proposal for future research would be to study the impact of time-based flexibility on customer satisfaction in more detail. Even though the dissertation analyses focused on customer satisfaction and time, the focus should be studied in more detail and throughout changing economic conditions. The purpose of a future comparison of time-based

flexibility and customer satisfaction should focus on customer satisfaction with selected products and orders during a longer time line. Thus, this would indicate more precisely which products and customers value time-based flexibility and how these values change in different parts of the economic cycles.

Second, it is suggested to study why and how some firms are able to make more profits with shorter customer order lead times. Here, the starting points could be the additional costs caused by long lead times. This kind of study could be done in at least two ways. The one approach could be, for example, analyzing the differences between speeds and profits within selected case firms. There different speeds of the production lines and profitability of the customers could be analyzed as is shown in Figure 21.

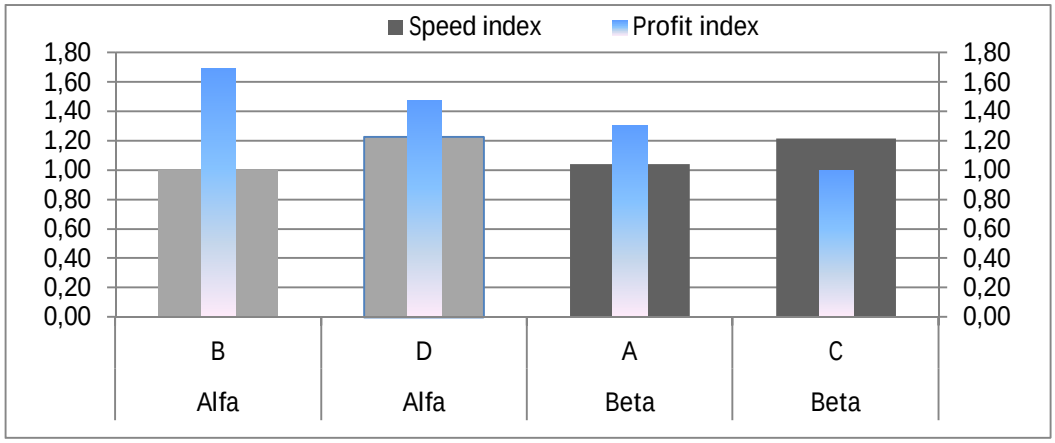

Figure 21. Differences of indexed speeds and profitability in percentages.

Another way to look deeper into profitability would be, for example, through analyzing the different costs related to time. In one of the case firms, significant positive correlation was indicated for customer order lead time and theoretical penalties of late deliveries like indicated in the Figure 22. In future research the impact of customer order lead time association with costs like late delivery penalties and expediting could be studied in more detail to answer how and why some companies are able to make more profits with shorter customer order lead times.

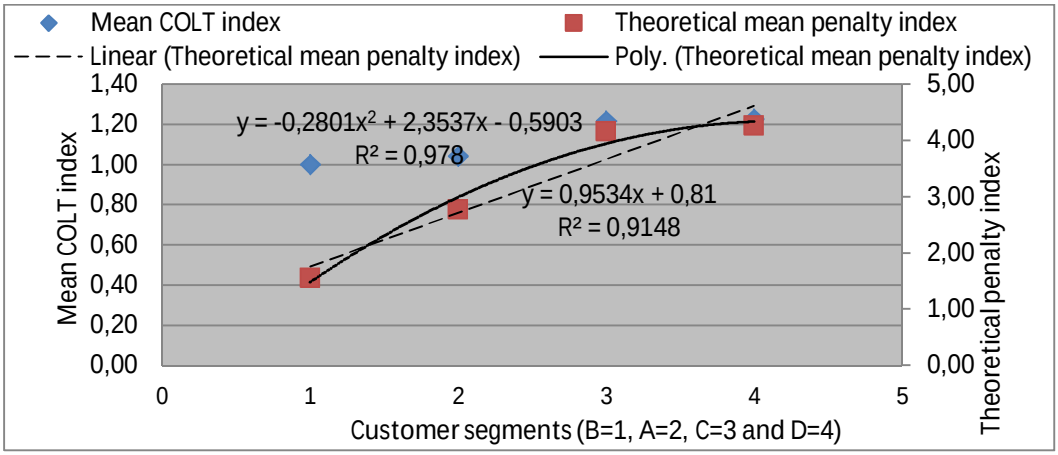

Figure 22. Mean customer order lead times indexed in different customer segments and compared with mean theoretical penalties calculated by using the Orgalime S 2000 agreement.

An additional approach for understanding why and how different firms are able to make more profits with shorter customer order lead times would be to extend this research into the supplier base, where poor supplier on time delivery (OTD) and on-quality-delivery (OQD) performance is a major contributor to the cost of poor quality (COPQ). Today, the worst performing suppliers have a significant impact on overall operational profitability and customer satisfaction. This impact occurs regardless of the size of the supplier due to the fact that the majority of the order deliveries are managed in multi-tier supply chains. If we agree that profit is equal to the return on capital minus the costs, we agree that control over costs is critical.

The profitability aspect could even be looked at from different cost accounting perspectives, since traditional cost accounting systems, like activity-based costing (ABC), motivate mass-production measurements (e.g. increased labor efficiency, maximized machine utilization) (Gläßer et al. 2010). Alternative cost accounting approaches like throughput accounting or value stream costing could support the customer valued time-based responsiveness better. Hilmola and Lättilä (2008) propose testing if the right variation of production cycle times has an impact on manufacturing firm profitability as it favors throughput accounting approach, or to test if minimizing of the variability in manufacturing and business processes improves the output in a way that it is more profitable. Maskell and Kennedy (2007) and Van der Merwe (2008) indicate that firms should use value-based costing systems rather than traditional accounting systems. Nevertheless, whatever cost accounting approach is taken, it should be highly related to process flow costs, because one of the key factors of controlling speed and improving efficien-

cy is to control the flow (Johnson 2006; Maskell and Kennedy 2007; Maynard 2008; Van der Merwe 2008).

Third, it is proposed that customer satisfaction trade-off between price and delivery time could be investigated at a more detailed level. As shown in Figure 23, profitability within a certain customer segment varies a lot. When the profit limits A and B were narrowing on a certain profit range, there were a lot of order deliveries that were more profitable, even with longer customer order lead times. Also looking at the lead time limits A and B in Figure 23, the profitability of the orders varies a lot, even when delivering with the same customer order lead time within a certain customer segment. Thus, the focus of the study could be to take the approach granularity level to a fine enough level that the study could indicate the causes for these kinds of deviations. In this way, the deviations could be identified, and pricing, as well as profitability issues, could be explained in more detail.

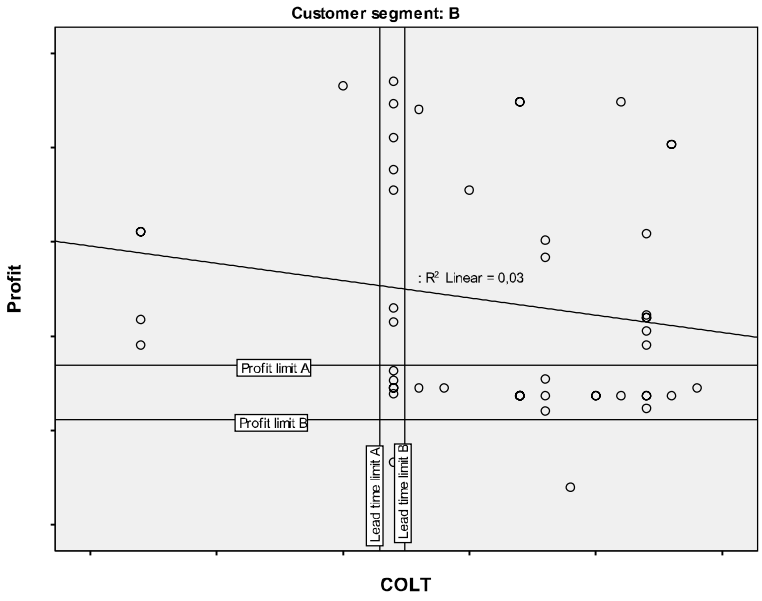

Figure 23. Profits and customer order lead times on a 2-axis graph for customer segment B from Mighty Machines.

Fourth, Porter (1980) suggested that the profitability of the firm is likely to be dependent on its market share. Based on this research, the test between profitability and its relation to market share could indicate whether Porter's indication applies in the field of electrical equipment and appliance manufacturing and specifically within these case firms. If Porter's indication applies within the tested case firms, the growing or specializing strategies could be impacted with this kind of

future research. See Section 2.4, and Porter's books "Competitive Strategy" (1980) and "Competitive Advantage" (1985) for more details.

Fifth, it would be worth looking more deeply at customer value from the operational time perspective. As time compression seems to be a highly competitive method, allied to logistics and supply chain strategies and the challenges of placing the right product at the right time to the right customer in the right quantity (Tammela et al. 2008), the research should be extended in more detail into logistics and supplier networks. Deeper research within this area would be needed because these supply networks are designed to be flexible and responsive to evolving customer needs and shifting demand patterns (Mentzer et al. 2007). Researchers like Fisher (1997) Holmström et al. (1999) and Collin (2006) have discussed the customer-supplier relationships via two links (Figure 24): The order penetration point (OPP) and value offering point (VOP). In this approach, the time-base needs of the customers are defined by VOP, which again should be defined in the demand. With this approach, the internally and externally created time-based value could be defined for operations of the whole value chain.

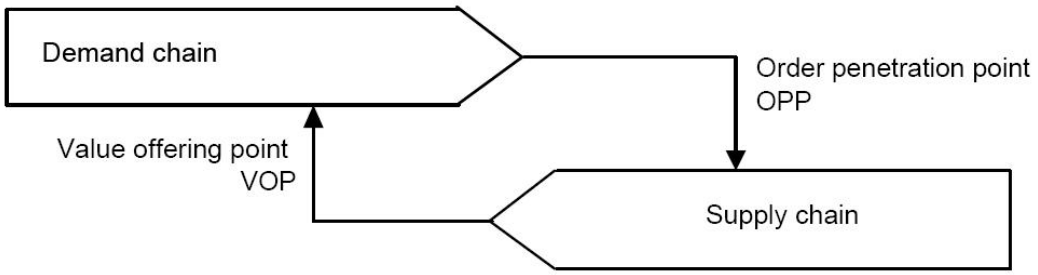

Figure 24. OPP and VOP linking supply and demand.

Sixth, the impact of different levels of workers on building competitive advantage could reveal interesting aspects on this matter. Here well trained, experienced and relatively high paid work forces could be compared with low- and medium trained, inexperienced and low- and medium paid work forces in the electrical equipment and appliances environment. The approach should be done by comparing different functions between different case firms. This could provide valuable evidence on the impact of resourcing on competitive advantage in this specific field of study because the required skill levels varied between different functions in different case firms. For example, when in one case firm the assembly worker would need several months of intensive work related training to be able to work independently, in another firm the assembly worker needed only a few weeks of basic training in order to handle the assembly process.

Seventh, one major drawback identified by Glock (2011) when studying the literature on lead time reduction in inventory models was that the vast majority of

authors assumed that lead time is independent of the lot size quantity and that a piecewise linear function is appropriate to describe the relationship between lead time reduction and lead time crashing costs. Glock continues to claim that the lead times often vary with the manufacturing lot size in practice. Thus, the relationship of the manufacturing lot sizes and customer purchase lot sizes could be further studied from the profitability point of view.

6.5 Research process approach

The chosen research process can be claimed to be unusual in this scale. A more traditional approach would have been based on questionnaires and/or interview rather than combining interview, progress reviews, questionnaires and extensive data analysis into a single package. Despite the unusual approach, it was considered to be valuable by both the firms and the researcher. It was valuable for the firms for several reasons. One of the reasons why it had more value than, for example, interview or questionnaire based approaches was that it allowed a sort of benchmarking among the participating firms in that this research approach provided the means for constant knowledge exchange in the field of electrical equipment and appliances. It created an opportunity to discuss and challenge ideas, best practices and executed strategies in certain areas of operations. This knowledge exchange also provided the needed information for interpreting the conducted analysis as well as establishing a solid network of professionals from this field of industry. Now when the results are discussed in this doctoral dissertation work, it is presumed that the participating case firms and their key managers have a much easier task to relate the findings and implications to their field of operations than it would be if this research had been based purely, for example, on questionnaires. It can be hypothesized that this is one of the ways to shrink the existing gap between the academic and industrial worlds.

6.6 Research process learning

"Do, or do not. There is no 'try'."

Yoda ('The Empire Strikes Back')

Now when everything has been discussed, some points in the research process that involve industries can be highlighted. One of the highlighted points is to either have more focus and attention on or even do differently when conducting this kind of multi-case study research again in the same or similar environment. Here, the research approach process has been divided into five sequential steps which are discussed in more detail in the coming sections.

6.6.1 Listen

Even though many researchers are full of "great" ideas for specific topics for research, these ideas might not carry a researcher through the long process of conducting successful research work. It could be claimed that there are likely changes that the contribution a researcher had in mind at the beginning of the research will be shrunken to a fraction of the original. Especially if a researcher does not have a similar level of enthusiasm together with the key players from business that are needed to conduct the research. Thus, it is very crucial to *listen* to what is happening around the research topic. What are the key challenges, issues and specific areas that people are talking about in the area of the researcher´s interest. It is true that people do not always "see the forest for the trees". But before a researcher can start to "push" ideas forward, especially in research that involves industries, a researcher needs to listen and understand the background of the business and business people. A researcher should know why certain things are done as they are done today before tangibly addressing these points and proposing future changes. In order to get to this kind of position a lot of background research and listening needs to be done.

6.6.2 Understand the whys

Before even thinking about proposing changes, it is better to understand why certain things are as they are. Even today the gap between academic research and day to day activities in industry has a relatively wide gap. If indicating that both parties involved in the research are clearly on different sides of the gap and cannot show the effort to close it, this will become the main obstacle in building trust and open communication. If the gap cannot be narrowed down or eliminated, it will

be impossible to build motivation, interest or desire from the needed partners. Even if a researcher were able to launch some actions together with business representatives, these activities would likely be considered as low priority activities from the business standpoint. Thus, the reliability of the acquired results from the actions can be misleading and in the end questionable.

6.6.3 Build and maintain trust

Reaching the point when both parties can build even moderately dynamic discussions from the area of research interest, building trust will be the next corner stone. It takes a long time to build trust, which can be lost in matter of seconds. Even in the environment where this kind of research was done, not everything can be included in the agreements, for example a non-disclosure agreement. People have to show each other that they are trustworthy in everything they say and do. At the beginning, the main part of this sharing needs to come from researcher's side with frequent, sufficiently simple and focused communication.

6.6.4 Communicate

When communicating, the format should be similar to executive summaries. Not all will be interested in the finest details. Bear in mind that the communication will reach several persons with different levels of knowledge around the subject. Setting up adequate communication can be very difficult, for example when the core organization around the research topic is constantly changing. For this reason, a lot of effort and energy on consistent and clear communication has to be in place. This is needed because it will be the enabler for the most fruitful, open discussions on the viewpoints of different persons, processes, and firms. It will be the ultimate source of knowledge on which this kind of research can build a solid contribution. It is like a guiding "compass" that helps to navigate towards correct sources of information and ultimately closer to the research targets. Thus, it is necessary to keep the "compass" informed of changes in direction.

6.6.5 Go the extra mile

Of course, it would be much easier just to send out question and wait for answers. In some cases remind the recipient about answering the set of questions or even throwing in a carrot for answering like raffling a prize among the persons who replied. However, if the desire is to reach the right people to answer your questions, the sending out of questionnaires might not be the best approach. It could

be claimed that the real professionals in industry, who actually know the details and reasoning as to why certain things are the way they are, do not have the time to reply to questionnaires, especially if they do not feel that they owe it to the person asking them to answer the questionnaires. In many cases answers are not handed out "on a plate"; instead, the researcher has to step up or even step back and make things happen. It can require persistent involvement even in activities where the researcher does not see much of a direct correlation to the research work. However, these activities done together might end up to be the needed credits in the long run. The mentality of "I scratch your back and you scratch mine" is definitely needed to establish a highly needed relationship with the right people who can genuinely contribute to the field of research.

6.6.6 Summarizing the process lessons

Do not be discouraged by the points discussed here. The process described is certainly not rocket science. Just think about these points and ask yourself:

1. Do I have the right attitude to close the gaps?
2. Am I willing to go the extra mile and do this?
3. Am I building my research on a solid case?
4. Do I have a "team" with me?

At the end of the day, the case study research process is teamwork, even though a researcher might feel to be the only one doing it. If a researcher does not have a team that trusts, listens and shares information, he does not have what it takes to conduct successful case study research in this kind of environment. It will require the right mind set, adaptation to changing situations, people skills to handle different people, and most of all the right kind of attitude and determination to make it happen.

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Appendices

Appendix 1

Information collection process

Points 1-4: Name 2-3 product families for the study and from those families name 2-4 products for the study. Then list 2-4 key components that are ordered specially for the customer order and list 4-10 of your biggest customers.

1. Select and list 2-3 different product families (most important product families / customer groups)

2. Select and list 2-4 different products from the above selected product families

3. Name and list 2-4 key components for the above selected product (key components that are purchased for the specific customer order)

4. Select and list 4-10 different customers for the selected products (biggest customers >50% of yearly sales)

Point 5: List the orders from the agreed time period or the agreed number of orders which are related to selected product families and products for the selected customers.

5. Information on past orders with the following information:

- Product family / customer group - Product - Customer name and number - Order number and date - Requested order lead-time by the customer (if recorded) - Promised lead-time (or date) - Actual lead-time (or delivery date) - Price of the order (customer price)	Customer information on order lead-time requests, promised, actual and order price
- Immediate material expenses of the order (order specific) - Material expenses for each key component - Key component lead-times for the specific order - Key component costs for the specific order	Purchasing cost versus delivery time

Point 6-7: After analysis of the data from each four participating firms, the answer to the first research question should be obvious.

6. Analysis of time-based competition possibilities of different product groups and in different customer segments

7. Results of lead-time effects on profitability within different groups and segments.

Appendix 2

Example of the collected data from the case firms:

- Project number/order number (identified by unique number)
- Order date (date of order registered into the system)
- Promised delivery date (date confirmed for the customer at order confirmation)
- Actual delivery date (date when ready to ship / EXW)
- Requested delivery date (date when customer wants the product to be ready for shipping / EXW)
- Price (price in € paid by the customer)
- Material cost (price in € for all materials)
- Manufacturing cost (direct labor costs in €)
- Advance payment 1-4 (advance payment(s) of the customer in €)
- Product (identification name for product series)
- Product code (identification number for product series)
- Manufacturing line (identified by code)
- Product family (identified by product family name)
- Customer segment (identified by customer segment name)
- Customer country (country of the order = next customer)
- Customer number (unique number to identify customer)
- Customer name (unique name to identify customer)
- Delivery term (delivery terms according to the Incoterms 2001)
- Delivery country (destination of the delivery)
- Key component 1 (name and code of the identified key component)
- Key component 2 (name and code of the identified key component)
- Key component 3 (name and code of the identified key component)
- Key component 4 (name and code of the identified key component)
- Key component 1 delivery date (supplier's delivery date for the key component)
- Key component 1 order date (firm's order date for the key component)
- Key component 2 delivery date
- Key component 2 order date
- Key component 3 delivery date
- Key component 3 order date
- Key component 4 delivery date
- Key component 4 order date
- Key component 1 supplier number (unique identification code for the supplier)
- Key component 1 supplier name (unique identification name for the supplier)
- Key component 2 supplier number
- Key component 2 supplier name
- Key component 3 supplier number
- Key component 3 supplier name
- Key component 4 supplier number
- Key component 4 supplier name
- Key component 1 price (the price paid by the firm from the key component in €)
- Key component 2 price
- Key component 3 price

- Key component 4 price
- Manufacturing start date (the date when the manufacturing of the specific product was started)
- Manufacturing end date (the date when the manufacturing of the specific product was done)
- Packing and shipping documentation start date (the date when packing and shipping department received the product/order)
- Packing and shipping documentation end date (the date when packing and shipping was done = ready for shipping)
- Shipment pickup date (the date when the order was shipped)
- Shipment delivery date (when 3rd party logistics reported the shipment as delivered)
- Profit per delivered item (product specific profit after the shipment)

Appendix 3

Example of interview questions for the case firm's supply chain manager:

Supply strategy (Supply manager)

– Do you have different supply agreements for different suppliers? Why?

– What is the standard length of your supply agreement? Why?

– What are the basics for making the agreement?

– What kind of supplier strategies do you prefer? (Many suppliers or one/few suppliers?)

– Do you have different strategies for different components?

– Do your key suppliers provide your order on MTS, ATO, MTO or ETO basis?

– How would you describe the difference in strategy between standard component and special component supplier?

– Do you rank your supplier performances? If so, what does it mean in practice?

Supply management (Supply manager)

– Are your supply management policies available for suppliers?

– Do you have different management policies for different suppliers? Why?

– Do you have different management policies for different components? Why?

– How often do you order key components?

– How often do you order standard components?

– Do you expedite special customer orders for some reason? Why and how?

– How do you manage inbound logistics?

– What is the driver for order releasing for the manufacturing? (component availability, manufacturing batches or true customer demand)

– Do you use simplified purchasing methods? (Kanban, 2-bin…)

– What are the steps for creating frame agreements?

Logistics (Logistic/Supply manager)

– What are the means of transportation for standard components?

– What are the means of transportation for key components?

– What are the ratios between different types of transportation for standard components? Why?

– What are the ratios between different types of transportation for key components? Why?

– Do you expedite transportations for any reasons? Why and how?

– How often are your standard components delivered?

– How often are your key components delivered?

Environment (Supply manager)

– At which point of the customer order do you order key components?

– At which point of the manufacturing process is the customer order decoupling point (CODP)?

– What is the share of the key component lead-time out of the total order-lead time? (Name your key components and their lead-times)

– How has your supplier networks changed in the past 2 years? (Towards insourcing/outsourcing, bigger/smaller suppliers or simple/complex networks?)

– How much has your outsourcing increased within the past 2 years? (percentage)

– Has your outsourcing moved more to LCC countries? (What was the share 2 years ago and what is it now?)

– What has happened to your on-time-delivery, delivery speed and component prices in the meanwhile?

– What are the sectors where you have gained the most with suppliers in the past 2 years? (Logistic costs, speed, improvement of on-time-delivery, improvement of manufacturing speed on suppliers´ site/ own site, quality issues, product price or with something else. What?

Appendix 4

Orgalime S 2000

"GENERAL CONDITIONS for the SUPPLY OF MECHANICAL, ELECTRICAL AND ELECTRONIC PRODUCTS

PREAMBLE

1. These General Conditions shall apply when the parties agree in writing or otherwise thereto. When the General Conditions apply to a specific contract, modifications of or deviations from them must be agreed in writing.

   The object(s) to be supplied under these General Conditions is (are) hereinafter referred to as the Product.

   Wherever these General Conditions use the term in writing, this shall mean by document signed by the parties, or by letter, fax, electronic mail and by such other means as are agreed by the parties.

PRODUCT INFORMATION

2. All information and data contained in general product documentation and price lists, whether in electronic or any other form, are binding only to the extent that they are by reference expressly included in the contract.

DRAWINGS AND DESCRIPTIONS

3. All drawings and technical documents relating to the Product or its manufacture submitted by one party to the other, prior or subsequent to the formation of the contract, shall remain the property of the submitting party.

   Drawings, technical documents or other technical information received by one party shall not, without the consent of the other party, be used for any other purpose than that for which they were provided. They may not, without the consent of the submitting party, otherwise be used or copied, reproduced, transmitted or communicated to a third party.

4. The Supplier shall, not later than at the date of delivery, provide free of charge information and drawings which are necessary to permit the Purchaser to erect, commission, operate and maintain the Product. Such information and drawings shall be supplied in the number of copies agreed upon or at least one copy of each. The Supplier shall not be obliged to provide manufacturing drawings for the Product or for spare parts.

ACCEPTANCE TESTS

5. Acceptance tests provided for in the contract shall, unless otherwise agreed, be carried out at the place of manufacture during normal working hours.

   If the contract does not specify the technical requirements, the tests shall be carried out in accordance with general practice in the appropriate branch of industry concerned in the country of manufacture.

6. The Supplier shall notify the Purchaser in writing of the acceptance tests in sufficient time to permit the Purchaser to be represented at the tests. If the Purchaser is not represented, the test report shall be sent to the Purchaser and shall be accepted as accurate.

7. If the acceptance tests show the Product not to be in accordance with the contract, the Supplier shall without delay remedy any deficiencies in order to ensure that the Product complies with the contract. New tests shall then be carried out at the Purchaser's request, unless the deficiency was insignificant.

8. The Supplier shall bear all costs for acceptance tests carried out at the place of manufacture. The Purchaser shall however bear all travelling and living expenses for his representatives in connection with such tests.

DELIVERY. PASSING OF RISK

9. Any agreed trade term shall be construed in accordance with the INCOTERMS in force at the formation of the contract.

   If no trade term is specifically agreed, the delivery shall be Ex works (EXW).

If, in the case of delivery Ex works, the Supplier, at the request of the Purchaser, undertakes to send the Product to its destination, the risk will pass not later than when the Product is handed over to the first carrier.

Partial shipments shall be permitted unless otherwise agreed.

TIME FOR DELIVERY. DELAY

10. If the parties, instead of specifying the date for delivery, have specified a period of time on the expiry of which delivery shall take place, such period shall start to run as soon as the contract is entered into, all official formalities have been completed, payments due at the formation of the contract have been made, any agreed securities have been given and any other preconditions have been fulfilled.

11. If the Supplier anticipates that he will not be able to deliver the Product at the time for delivery, he shall forthwith notify the Purchaser thereof in writing, stating the reason, and, if possible, the time when delivery can be expected.

If the Supplier fails to give such notice, the Purchaser shall be entitled to compensation for any additional costs which he incurs and which he could have avoided had he received such notice.

12. If delay in delivery is caused by any of the circumstances mentioned in Clause 39 or by an act or omission on the part of the Purchaser, including suspension under Clauses 20 or 42, the time for delivery shall be extended by a period which is reasonable having regard to all the circumstances in the case. This provision applies regardless of whether the reason for the delay occurs before or after the agreed time for delivery.

13. If the Product is not delivered at the time for delivery (as defined in Clauses 10 and 12), the Purchaser is entitled to liquidated damages from the date on which delivery should have taken place.

The liquidated damages shall be payable at a rate of 0.5 per cent of the purchase price for each completed week of delay. The liquidated damages shall not exceed 7.5 per cent of the purchase price.

If only part of the Product is delayed, the liquidated damages shall be calculated on that part of the purchase price which is attributable to

such part of the Product as cannot in consequence of the delay be used as intended by the parties.

The liquidated damages become due at the Purchaser's demand in writing but not before delivery has been completed or the contract is terminated under Clause 14.

The Purchaser shall forfeit his right to liquidated damages if he has not lodged a claim in writing for such damages within six months after the time when delivery should have taken place.

14. If the delay in delivery is such that the Purchaser is entitled to maximum liquidated damages under Clause 13 and if the Product is still not delivered, the Purchaser may in writing demand delivery within a final reasonable period which shall not be less than one week.

If the Supplier does not deliver within such final period and this is not due to any circumstance for which the Purchaser is responsible, then the Purchaser may by notice in writing to the Supplier terminate the contract in respect of such part of the Product as cannot in consequence of the Supplier's failure to deliver be used as intended by the parties.

If the Purchaser terminates the contract he shall be entitled to compensation for the loss he has suffered as a result of the Supplier's delay. The total compensation, including the liquidated damages which are payable under Clause 13, shall not exceed 15 per cent of that part of the purchase price which is attributable to the part of the Product in respect of which the contract is terminated.

The Purchaser shall also have the right to terminate the contract by notice in writing to the Supplier, if it is clear from the circumstances that there will occur a delay in delivery which, under Clause 13 would entitle the Purchaser to maximum liquidated damages.

In case of termination on this ground, the Purchaser shall be entitled to maximum liquidated damages and compensation under the third paragraph of this Clause 14.

15. Liquidated damages under Clause 13 and termination of the contract with limited compensation under Clause 14 are the only remedies available to the Purchaser in case of delay on the part of the Supplier.

All other claims against the Supplier based on such delay shall be excluded, except where the Supplier has been guilty of gross negligence.

In these General Conditions gross negligence shall mean an act or omission implying either a failure to pay due regard to serious consequences, which a conscientious supplier would normally foresee as likely to ensue, or a deliberate disregard of the consequences of such act or omission.

16. If the Purchaser anticipates that he will be unable to accept delivery of the Product at the delivery time, he shall forthwith notify the Supplier in writing thereof, stating the reason and, if possible, the time when he will be able to accept delivery.

If the Purchaser fails to accept delivery at the delivery time, he shall nevertheless pay any part of the purchase price which becomes due on delivery, as if delivery had taken place. The Supplier shall arrange for storage of the Product at the risk and expense of the Purchaser. The Supplier shall also, if the Purchaser so requires, insure the Product at the Purchaser's expense.

17. Unless the Purchaser's failure to accept delivery is due to any such circumstance as mentioned in Clause 39, the Supplier may by notice in writing require the Purchaser to accept delivery within a final reasonable period.

If, for any reason for which the Supplier is not responsible, the Purchaser fails to accept delivery within such period, the Supplier may by notice in writing terminate the contract in whole or in part. The Supplier shall then be entitled to compensation for the loss he has suffered by reason of the Purchaser's default. The compensation shall not exceed that part of the purchase price which is attributable to that part of the Product in respect of which the contract is terminated.

PAYMENT

18. Unless otherwise agreed, the purchase price shall be paid with one third at the formation of the contract and one third when the Supplier notifies the Purchaser that the Product, or the essential part of it, is ready for delivery. Final payment shall be made when the Product is delivered.

Payments shall be made within 30 days of the date of the invoice.

19. Whatever the means of payment used, payment shall not be deemed to have been effected before the Supplier's account has been fully and irrevocably credited.

20. If the Purchaser fails to pay by the stipulated date, the Supplier shall be entitled to interest from the day on which payment was due. The rate of interest shall be as agreed between the parties. If the parties fail to agree on the rate of interest, it shall be 8 percentage points above the rate of the main refinancing facility of the European Central Bank in force on the due date of payment.

In case of late payment the Supplier may, after having notified the Purchaser in writing, suspend his performance of the contract until he receives payment.

If the Purchaser has not paid the amount due within three months the Supplier shall be entitled to terminate the contract by notice in writing to the Purchaser and to claim compensation for the loss he has incurred. The compensation shall not exceed the agreed purchase price.

RETENTION OF TITLE

21. The Product shall remain the property of the Supplier until paid for in full to the extent that such retention of title is valid under the applicable law.

The Purchaser shall at the request of the Supplier assist him in taking any measures necessary to protect the Supplier's title to the Product in the country concerned.

The retention of title shall not affect the passing of risk under Clause 9.

LIABILITY FOR DEFECTS

22. Pursuant to the provisions of Clauses 23-37 inclusive, the Supplier shall remedy any defect or nonconformity (hereinafter termed defect(s)) resulting from faulty design, materials or workmanship.

23. The Supplier's liability is limited to defects which appear within a period of one year from delivery. If the daily use of the Product exceeds that which is agreed, this period shall be reduced proportionately.

24. When a defect in a part of the Product has been remedied, the shall be liable for defects in the repaired or replaced part under the same terms and conditions as those applicable to the original Product for a period of one year. For the remaining parts of the Product the period mentioned in Clause 23 shall be extended only by a period equal to the period during which the Product has been out of operation as a result of the defect.

25. The Purchaser shall without undue delay notify the Supplier in writing of any defect which appears. Such notice shall under no circumstance be given later than two weeks after the expiry of the period given in Clause 23.

The notice shall contain a description of the defect.

If the Purchaser fails to notify the Supplier in writing of a defect within the time limits set forth in the first paragraph of this Clause, he loses his right to have the defect remedied.

Where the defect is such that it may cause damage, the Purchaser shall immediately inform the Supplier in writing. The Purchaser shall bear the risk of damage resulting from his failure so to notify.

26. On receipt of the notice under Clause 25 the Supplier shall remedy the defect without undue delay and at his own cost as stipulated in Clauses 22-37 inclusive.

Repair shall be carried out at the place where the Product is located unless the Supplier deems it appropriate that the defective part or the Product is returned to him for repair or replacement.

The Supplier is obliged to carry out dismantling and re-installation of the part if this requires special knowledge. If such special knowledge is not required, the Supplier has fulfilled his obligations in respect of the defect when he delivers to the Purchaser a duly repaired or replaced part.

27. If the Purchaser has given such notice as mentioned in Clause 25 and no defect is found for which the Supplier is liable, the Supplier shall be entitled to compensation for the costs he has incurred as a result of the notice.

28. The Purchaser shall at his own expense arrange for any dismantling and reassembly of equipment other than the Product, to the extent that this is necessary to remedy the defect.

29. Unless otherwise agreed, necessary transport of the Product and/or parts thereof to and from the Supplier in connection with the remedying of defects for which the Supplier is liable shall be at the risk and expense of the Supplier. The Purchaser shall follow the Supplier's instructions regarding such transport.

30. Unless otherwise agreed, the Purchaser shall bear any additional costs which the Supplier incurs for repair, dismantling, installation and transport as a result of the Product being located in a place other than the destination stated in the contract or - if no destination is stated - the place of delivery.

31. Defective parts which have been replaced shall be made available to the Supplier and shall be his property.

32. If, within a reasonable time, the Supplier does not fulfil his obligations under Clause 26, the Purchaser may by notice in writing fix a final time for completion of the Supplier's obligations.

If the Supplier fails to fulfill his obligations within such final time, the Purchaser may himself undertake or employ a third party to undertake necessary remedial works at the risk and expense of the Supplier.

Where successful remedial works have been undertaken by the Purchaser or a third party, reimbursement by the Supplier of reasonable costs incurred by the Purchaser shall be in full settlement of the Supplier's liabilities for the said defect.

33. Where the defect has not been successfully remedied, as stipulated under Clause 32,

a) the Purchaser is entitled to a reduction of the purchase price in proportion to the reduced value of the Product, provided that under no circumstance shall such reduction exceed 15 per cent of the purchase price, or

b) where the defect is so substantial as to significantly deprive the Purchaser of the benefit of the contract, the Purchaser may terminate the contract by notice in writing to

the Supplier. The Purchaser is then entitled to compensation for the loss he has suffered up to a maximum of 15 per cent of the purchase price.

34. The Supplier is not liable for defects arising out of materials provided, or a design stipulated or specified by the Purchaser.

35. The Supplier is liable only for defects which appear under the conditions of operation provided for in the contract and under proper use of the Product.

The Supplier's liability does not cover defects which are caused by faulty maintenance, incorrect erection or faulty repair by the Purchaser, or by alterations carried out without the Supplier's consent in writing.

Finally the Supplier's liability does not cover normal wear and tear or deterioration.

36. Notwithstanding the provisions of Clauses 22-35 the Supplier shall not be liable for defects in any part of the Product for more than two years from the beginning of the period given in Clause 23.

37. Save as stipulated in Clauses 22-36, the Supplier shall not be liable for defects. This applies to any loss the defect may cause including loss of production, loss of profit and other indirect loss. This limitation of the Supplier's liability shall not apply if he has been guilty of gross negligence as defined in Clause 15.

ALLOCATION OF LIABILITY FOR DAMAGE CAUSED BY THE PRODUCT

38. The Supplier shall not be liable for any damage to property caused by the Product after it has been delivered and whilst it is in the possession of the Purchaser. Nor shall the Supplier be liable for any damage to products manufactured by the Purchaser, or to products of which the Purchaser's products form a part.

If the Supplier incurs liability towards any third party for such damage to property as described in the preceding paragraph, the Purchaser shall indemnify, defend and hold the Supplier harmless.

If a claim for damage as described in this Clause is lodged by a third party against one of the parties, the latter party shall forthwith inform the other party thereof in writing.

The Supplier and the Purchaser shall be mutually obliged to let themselves be summoned to the court or arbitral tribunal examining claims for damages lodged against one of them on the basis of damage allegedly caused by the Product.

The limitation of the Supplier's liability in the first paragraph of this Clause shall not apply where the Supplier has been guilty of gross negligence as defined in Clause 15.

FORCE MAJEURE

39. Either party shall be entitled to suspend performance of his obligations under the contract to the extent that such performance is impeded or made unreasonably onerous by any of the following circumstances: industrial disputes and any other circumstance beyond the control of the parties such as fire, war, extensive military mobilization, insurrection, requisition, seizure, embargo, restrictions in the use of power and defects or delays in deliveries by sub-contractors caused by any such circumstance referred to in this Clause.

A circumstance referred to in this Clause whether occurring prior to or after the formation of the contract shall give a right to suspension only if its effect on the performance of the contract could not be foreseen at the time of the formation of the contract.

40. The party claiming to be affected by Force Majeure shall notify the other party in writing without delay on the intervention and on the cessation of such circumstance.

If Force Majeure prevents the Purchaser from fulfilling his obligations, he shall compensate the Supplier for expenses incurred in securing and protecting the Product.

41. Regardless of what might otherwise follow from these General Conditions, either party shall be entitled to terminate the contract by notice in writing to the other party if performance of the contract is suspended under Clause 39 for more than six months.

ANTICIPATED NON-PERFORMANCE

42. Notwithstanding other provisions in these General Conditions regarding suspension, each party shall be entitled to suspend the performance of his obligations under the contract, where it is clear from the circumstances that the other party will not be able to perform his obligations. A party suspending his performance of the contract shall forthwith notify the other party thereof in writing.

CONSEQUENTIAL LOSSES

43. Save as otherwise stated in these General Conditions there shall be no liability for either party towards the other party for loss of production, loss of profit, loss of use, loss of contracts or for any other consequential or indirect loss whatsoever.

DISPUTES AND APPLICABLE LAW

44. All disputes arising out of or in connection with the contract shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the said rules.

45. The contract shall be governed by the substantive law of the Supplier's country".

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