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The Role of Management Accounting Systems in Implementing Lean Business Strategies

A Research Paper Presented by:

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Abstract

In this research paper the relations among Lean strategic implementation, management accounting and management control practice, and organizational performance are examined as proposed by the ex ante framework. For this purpose, four cases that have started a Lean strategic initiative are analyzed. Based on the findings of this case study research, the evidence both consistent and inconsistent with the ex ante model is presented and a revised theoretical framework is developed. Within the theoretical framework, numerous intervening and bidirectional relationships are identified. A bidirectional relationship between MA and MC practices, subsequent to a Lean strategic initiative, is demonstrated. Also, a bidirectional relationship is identified between the Lean strategic initiative and the MAS in use by the firm. The MAS is not only affected directly by a Lean strategic implementation, but the degree of Lean strategic implementation is also directly related to the MAS. The findings furthermore showed that changes in MAS, subsequent to a Lean strategic initiative, are moderate and the traditional MAS is still the predominant system in use. The findings showed that when the MAS is inadequately adjusted to a Lean business strategy, the MAS fails to capture the benefits leading from the Lean initiative. This results in Lean benefits incorrectly being assessed by the management when evaluating the Lean progressions made. The findings also demonstrated that the use of traditional MAS within a Lean environment seems to create short-term objectives and discourage the creation of excess capacity. Analysis moreover showed that when the MAS is inadequately adjusted to a Lean business strategy, the degree of Lean implementation is directly influenced as the traditional MAS hinders in achieving some level of control during operations and causes for the management to reject Lean in the long term.

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I would like to dedicate this research paper to my dear beloved grandfather, Kemal Bahadir.

I cannot think you 're not alive somewhere.
I think of you just as I did before.
No sudden gust of wind has closed the door
Or made your presence vanish in thin air.

Ayca Bahadir

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List of Abbreviations

Absorption Costing	AC
Bill of Material(s)	BOM
Budgeted Fixed Overhead	BFO
Budgeted Variable Overhead	BVO
Chief Commercial Officer	CCM
Chief Executive Officer	CEO
Chief Financial Officer	CFO
Chief Operations Officer	COO
Chief Technology Officer	CTO
Continuous Improvement	CI
Customer Relationship Management	CRM
Day-By-The-Hour Report	DBH
Define-Measure-Analyze-Improve-Control	DMAIC
Direct Costing	DC
Just-In-Time	JIT
Kaizen Costing	KC
Key Performance Indicators	KPI's
Lean Accounting	LA
Management Accounting	MA
Management Accounting System(s)	MAS
Management Control	MC
Massachusetts Institute of Technology	MIT
Materials Requirement Planning	MRP
Online Analytical Processing	OLAP
Operational Equipment Effectiveness	OEE
Plan-Do-Check-Act	PDCA
Return on Sales	ROS
Standard Costing	SC
Standard Work-In-Process Inventory	SWIP
Supplier Relationship Management	SRM
Supply Chain Management	SCM
Target Costing	TC
Toyota Business System	TBS
Toyota Production System	TPS
Total Quality Management	TQM
Training-Within-Industry	TWI
Value Stream Costing	VSC
Value Stream Map(ing)	VSM
Variable costing	VC
Work-In-Process Inventory	WIP

1. Introduction

Since the 1980s, there have been significant changes in the external environment faced by firms. These changes include the availability of information processing technologies, an increased information density, reduced barriers to entry, increased global competition, increasingly demanding customers and shorter product life cycles (Hiromoto, 1991; Dent, 1996; Shields, 1997; Baines and Langfield-Smith, 2003). The market in which firms nowadays operate is characterized by severe competition with respect to price, timely delivery, flexibility and quality (Dent, 1996; Shields, 1997; Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009). Firms react to the competitive forces by changing their business strategies leading to organizational innovations that have set the foundation for Lean.

The term 'Lean' was first proposed by Krafcik, a member of a research team at the Massachusetts Institute of Technology's (MIT) International Motor Vehicle program during the late 1980s. However, the origin of lean strategy is generally attributed to Toyota (Kennedy and Widener, 2008, p.303; Fullerton and Kennedy, 2009). Lean is a complete business strategy that combines a wide variety of management practices, such as Just-In-Time production (JIT), Jidoka, Kaizen and Total Quality Management (TQM), to create more value for customers while minimizing waste (Womack and Jones, 1990, 1996, 2003; Shah and Ward, 2003; Grasso, 2005; Callen, 2005; Maskell and Kennedy, 2007; Becker, 2007; Solomon and Fullerton, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009).

Lean focuses on integrating these management practices to create a streamlined value creation process where the product will flow in a steady sequence towards the customers. Waste is the expenditure of resources that adds no value to your customers and thus a target for elimination. Working from the perspective of the customer, "value" is defined as any action or process that a customer would be willing to pay for. Within Lean it is assumed that creating more value, improving quality and reducing waste will lead to more orders, more customers and ultimately increase profits.

Despite this widely held assumption that Lean increases profit, the empirical evidence is decidedly mixed (Fullerton and Mcwatters 2001, 2002; Womack and Jones 2003; Taylor and Wright 2003; Callon, 2005; Becker, 2007; Maskell and Kennedy 2007; Kennedy and Widener 2008; Kennedy and Fullerton 2009). Studies have suggested that one explanation for these inconclusive results is that benefits from Lean are dependent on complementary changes in a firm's management accounting system (MAS) (Green, Amenkhienan and Johnson, 1992; Brickley, Smith, and Zimmerman, 2001; Oldham & Tomkins, 1999; Sprinkle, 2000; Nicolaou 2003; Fullerton and McWatters 2002; Baines and Langfield-Smith 2003; Callen 2005; Kennedy and Widener 2008; Fullerton and Kennedy, 2009). According to these studies, as MAS provide the necessary information for improved decision making and control, a successful implementation of a business strategy requires a complementary decision making and control system.

However, researchers state that the current MAS do not support a Lean environment (Green et al., 1992; Johnson, 1992; Fullerton and McWatters 2002; 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009). Firms still use and rely on traditional accounting information. The traditional model of cost accounting is believed to contradict the Lean philosophy by encouraging firms to build more inventories, by building a complex system of data collection and reporting, making it more difficult for shop-floor decision makers to understand and use for decision making and by using standards and variances for performance evaluation (Johnson and Kaplan, 1989;

Johnson, 1992; Ittner and Larcker, 1998; Kennedy and Brewer, 2006; Maskell and Baggaley, 2004; 2006; Maskell and Kennedy, 2007; Kennedy and Fullerton, 2009).
Given that a MAS is a primary source for decision making and control, and the need for MAS to change to support managers' new information requirements within a new strategy, the reluctance to adjust the MAS to a Lean business strategy could have significant consequences for the success of a Lean business strategy.

The subject of accounting for a lean business strategy has received little attention within management accounting (MA), since little empirical research has been performed on this subject. It seems that the reluctance to change an entrenched traditional accounting system is fed by a lack of empirical evidence of the value the change may bring (Fullerton and Kennedy 2009). Therefore, more empirical research has to be done to analyze the necessity of having a supportive MAS for the successful implementation of Lean. This study could then contribute to MA literature by providing motives for further research and discussion surrounding this subject.

This study entails an empirical research on the characteristics associated with the implementation of accounting for lean by firms. A broader purpose is to examine and map the development of Lean accounting in organizations and environments that have adopted Lean and to develop a framework that advances theory. The aim of the thesis is thus to contribute to the overall knowledge on Lean thinking.

The main research question of this paper is:
How does the development of a management accounting system for Lean contribute to the overall success of the implementation of Lean strategies by firms?

To answer this research question properly, the question is divided in to the following sub questions:

1. What is the main tenet of Lean?
2. What is the main tenet of Lean Accounting?
3. What does the literature state about the relationship between changes in a firm's strategy, its MAS and organizational performance?
4. What does the literature state about the relationship between a Lean strategic implementation, MAS and organizational performance?
5. What do researchers state about the current MAS practice within a Lean environment?
6. Does the current MAS practice influence the overall success of Lean strategic implementation by firms?

The paper is organized as follows. In the second section, first the environmental changes and production processes that have set the foundation for Lean will be addressed. Second, the main tenet of Lean and the Lean basic principles will be highlighted. The second section will be completed by illuminating the Lean Maturity Path. Due to the large content of Lean, only the central constructs and concepts within Lean are reviewed. In the third section, the main tenet of Lean Accounting will be highlighted by following the three stages within the Lean Maturity Path. In the fourth section, an overview is given of the literature that discusses the relationship between changes in a firm's strategy, complementary changes in its MAS and organizational performance. Moreover, the discussion surrounding the current MAS practice within a Lean environment is thoroughly analyzed, whereby an ex ante framework is provided. In the fourth section also the research design and method

is discussed. In the fifth section, an analysis is made to evaluate the relations among Lean strategic implementation, MA and MC practice, organizational performance as provided in the ex ante framework and overall management support. The results are also summarized and an overall conclusion is provided supported with an ex post framework. In the final section, conclusions are offered and discussed.

2. Lean Business Strategy

2.1 Introduction

In paragraphs two and three, the environmental changes and production processes that have set the foundation for Lean will be addressed. In the fourth paragraph, the main tenet of a Lean Business Strategy will be highlighted. Hereby, the Toyota Production System will be reviewed, as the central concepts within this production system have been particularly inspiring for Lean. The central constructs and concept within Lean will be described in the fifth paragraph, whereby the Lean basic principles of *Value Specification, Value Stream Identification, Continuous Flow, Pull and Perfection (Kaizen)* are elaborated on. These Lean principles mature as they are implemented and continuously perfected within the firm following a so-called Lean Maturity Path. The chapter will be completed by illuminating the Lean Maturity Path.

2.2 Changes in Environment and Strategy

2.2.1 Changing Environments

Since the 1980s, the external environment faced by firms is changing due to financial and market deregulation, increased global competition, reduced barriers to entry and the availability of information processing technologies, leading to an increased information density, increasingly demanding customers and shorter product life cycles (Hiromoto, 1991; Dent, 1996; Shields, 1997; Baines and Langfield-Smith, 2003).

Especially the availability of information processing technologies, such as the internet, has had a multiplier effect on these environmental changes. On the internet, customers have a wide variety of choices and there is a high information density, making prices transparent. The internet has also widened the geographic market with heavy competition from all over the world. This has resulted in increased customers' bargaining power and pressure to compete on prices. Furthermore, the internet has reduced the barriers to entry, which has led to a sharp increase of competitors and a continuous flow of substitute products and services. These changes resulted in increased customer demands, diversified customer needs and shorter product life cycles which has intensified the competition (Dent, 1996; Shields, 1997; Baines and Langfield-Smith, 2003; Fullerton and Kennedy, 2009). Moreover, the internet has offered great possibilities to offer direct-to-customer marketing and sales, which has further intensified the existing competition.

As a result, the market in which firms nowadays operate is characterized by severe competition with respect to price, timely delivery, flexibility and quality (Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009).

2.2.2 Environment and Strategy

Firms have reacted to the severe competition by changing their business strategies to achieve sustainable competitive advantage and improve operational performance. Firms and their environments have a reciprocal relationship (Laudon and Laudon, 2006, p. 88). Firms can influence their environment, such as by transforming the business enterprise, but are at the same time open to and adapt to their environments.

It is well established in MA research that a firm's strategy is determined by the forces in its environment and that a proper match between its environment and strategy is key in developing sustainable competitive advantage

(Porter, 1980, 1996; Chong and Chong, 1997; Perera et al., 1997). Several empirical studies have examined the relationship between environment and strategy. For example, Chong and Chong (1997) found a relationship between perceived environmental uncertainties and strategy. Empirical findings of Perera et al. (1997) supported the relationship between changes in the environment and changes towards a more customer-focused strategy. Fuchs et al. (2000) found that successful firms aligned key elements of their strategy with the environment. Consistent with prior empirical findings, Baines and Langfield-Smith (2003) have shown in their study that there is a strong relationship between changes in the environment and changes in a firm's strategy, reflecting environmental change as a driver of strategic change.

The reaction of firms to the growing level of competition by changing their business strategies have led to organizational changes of which some have set the foundation for Lean.

2.3 Context

Lean is a coherent business strategy that incorporates a wide variety of management practices to continuously improve the value creation process by eliminating activities that require resources but create no value for the customer (Womack and Jones, 1990, 2003; Shah and Ward, 2003; Grasso, 2005; Callen, 2005; Maskell and Kennedy, 2007; Becker, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009). The core idea of Lean is to create more value for customers while minimizing wasteful activities. Working from the perspective of the customer, "value" is defined as any action or process that a customer would be willing to pay for. Lean focuses on streamlining the value creating process so the product will flow in a steady sequence towards the customer. The term 'Lean' was first proposed by Krafcik, a member of a research team at the MIT's International Motor Vehicle program during the late 1980s. Although the origin of Lean strategy is generally attributed to Toyota (Kennedy and Widener, 2008, p.303; Fullerton and Kennedy, 2009), the basis for Lean has been set much earlier (Womack and Jones 2003, p. 22-23).

In the 1450s, Venice had already developed methods to streamline the production processes in the Arsenal, enabling people to produce nearly one warship each day (Chambers and Pullan, 1992). However, the first person to integrate an entire production process and realize the potential of flow was Henry Ford[1] (Womack and Jones, 2003, p. 22). At Highland Park in 1913, Ford created what he called flow production by lining up all the machines needed to produce the parts for the Model T Ford in process sequence. Ford decreased the production time and amount of effort required to assemble a Model T as components going in to the vehicle were assembled directly on the assembly line. However, his system was limited to one specification and one colour of Model T. When consumers wanted more variety, Ford was unable to provide that.

2.4 The Improved Production System of Toyota

Sakichi Toyoda, founder of the Toyoda Group, Kaiichiro Toyoda, the son of Sakichi and managing director at Toyoda, and Taiichi Ohno analyzed the situation in the 1930s at Ford and concluded that simple innovations could enable providing a variety in product offerings while keeping the production flow (Becker, 2007). They refined Ford's original thinking, and invented the Toyota Production System (TPS).

[1] http://www.lean.org

2.4.1 Jidoka

Sakichi implemented the concept Jidoka in 1926. Jidoka stands for autonomation, which is the automation of human intelligence (Marchwinski and Shook, 2008, p.38). Jidoka means automation of the human quality control of the production process. Human quality control is the detection and prevention of mistakes within the production process by people (employees and managers). Sakichi automated the human quality control by inventing a system that stopped the production process automatically when a mistake was detected (Womack and Jones, 2003; Becker, 2007). Besides preventing the production of poor quality, Jidoka enables the separation of work assigned to individuals and work assigned to machines. Since the quality control of the production is automated, it is not necessary for individuals to constantly monitor each machine. This makes multi-process handling possible, where one individual can operate several machines.

2.4.2 Just-In-Time

In 1936, Kiichiro Toyoda travelled to the Ford Motor Company in Detroit for a year to study the American automotive industry and returned to Japan with a strong knowledge of the Ford production system and concluded that the real challenge was to create continuous flow in low-volume production. Kiichiro developed a concept-production system which was referred to as Just in Time (JIT) within the Toyoda Group. Later on in 1949 to 1950, Taiichi Ohno expanded the JIT-concept and implemented the system on the production floor (Ohno, 1988, p. 31).

While focusing on streamlining the production flow, JIT emphasizes on minimizing in-process inventory and associated carrying cost. In order to do so, JIT consists of three important components:

1. **Pull Production:** JIT production is a pull production system, where production is initiated by the customer by requesting the product through customer orders[2]. The customer "pulls" the product through the delivery channel (Fullerton and McWatters, 2002; Womack and Jones, 1996, 2003; Baines and Langfield-Smith 2003; Maskell and Baggaley 2004; Callen 2005; Kennedy and Widener 2008). In the same way, each step in the production process is initiated (pulled) by a signal, named "kanban", from a downstream production process.
2. **Customer takt time:** The takt time is the rate at which customers demand a product. The takt time is calculated by dividing the available production time (in seconds) by customer demand. The main objective of using takt time is to match the production exactly to the customer demand to prevent over/under production and to maximize flow. The cycle time is the production time in seconds needed to perform an operation on one product. By comparing the cycle time with the takt time the achievement of takt time is monitored (Womack and Jones, 2003; Maskell and Baggaley 2004). When the cycle time is longer than the takt time, JIT emphasizes continuous improvement[3] to pursue the production of the product at the same rate as customer demand for the product.
3. **Continuous Flow:** Toyota expanded Ford's system of flow production by focusing on streamlining the production process in low volume production with no limitation on offered assembly lines. Toyota concluded that by right-sizing machines and minimizing their changeover times (the time it takes to

[2] When using a push production system in contrast, the production is initiated by the firm itself and pushed towards the customer.
[3] In section 2.5 of this research, the process of continuous improvement (referred to as Kaizen) will be illuminated.

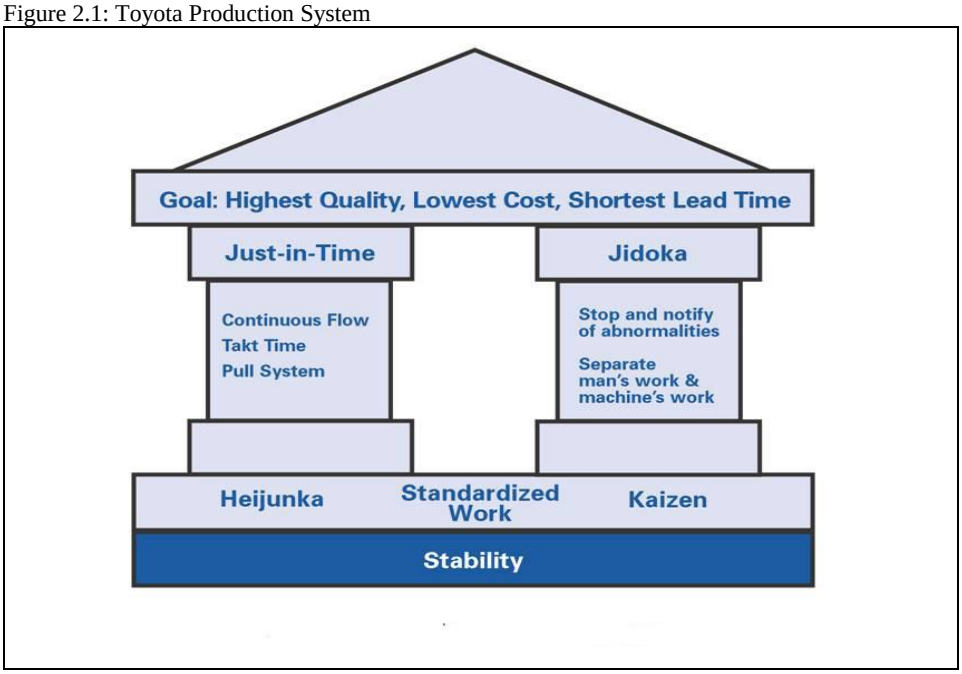
make a machine ready to produce a different product), so that different processing steps could be conducted immediately adjacent to each other, and by lining up the machines in process sequence, each machine could make small volumes of different parts continuously[4] (Womack and Jones, 2003).

Besides these three components, JIT is mainly built on Heijunka, which stands for production level scheduling. Based on kanbans and takt time, the type and quantity of the production within a period is smoothed out, to make the daily production more efficient (Womack and Jones, 2003; Maskell and Baggaley, 2004; Marchwinski and Shook, 2008).

2.4.3 Toyota Production System

The development of the TPS is generally attributed to Taiichi Ohno, who improved, implemented and integrated different concepts within Toyota in to one production system (Becker 2007). As figure 2.1 illustrates, the TPS is the integration of the two concepts within Toyota explained earlier in the chapter, namely Jidoka and JIT.

Figure 2.1: Toyota Production System



(Marchwinski, Shook and Schroeder, 2008)

However, the basis for TPS is to first have a basic stability in terms of manpower, machines, material and methods, called the 4Ms. When trying to implement the system, Ohno discovered that firstly problems in the 4Ms need to be fixed, in order to implement the TPS successfully. In the 1950s, Toyota adopted an industrial training program that the U.S. used during the World War II called Training-Within-Industry (TWI) to stabilize its workforce[5]. TWI has three specific job training components:

- Job instruction: taught how to instruct people safely, correctly and conscientiously.
- Job relations: taught the relationship between supervisor and employee and how to solve basic human related problems in production.
- Job methods: taught how to analyze jobs and make simple improvements.

[4] www.lean.org
[5] http://www.leaninstituut.nl/publications/achieving_basic_stability.pdf

To stabilize its machines, Ohno let his people monitor and improve its machines continuously to ensure that both theoretical capacity as well as actual capacity (output) can meet customer demand. To achieve basic stability in its materials, Ohno stated that a buffer stock (to cover variations in customer demand) and a safety stock (to cover losses such as scrap) are necessary. To ensure stability in its methods, Toyota practiced standardized work by selecting standard methods for manufacturing. Using this simple framework of the 4Ms, Toyota built the basis for its overall production system.

Except for endorsing basic stability, standardized work also serves as a basis for comparison. The TPS is maintained and improved by continuously combining standardized work with Kaizen. Kaizen stands for the continuous improvement (CI) of both the complete production flow and the individual production processes by eliminating waste to create more value for the customer. Waste, called muda (Ohno, 1988; Womack and Jones, 2003), is every activity that requires resources but creates no value for the customers. Thus, waste includes all the non-value-adding activities within the production process. Taiichi Ohno (1988, p. 19-20) stated his list of muda as follows:

1. Defects in products
2. Overproduction
3. Inventories
4. Unnecessary processing
5. Unnecessary movement of people
6. Unnecessary transport of goods
7. Waiting by employees on an upstream activity to finish

Ohno (1988) also categorized each type of muda on this list into either type one muda or type two muda. Type one muda includes activities that create no value but are currently unavoidable, and type two muda includes activities that create no value and are immediately avoidable. According to Ohno (1988), the type two muda need to be eliminated immediately with the use of Kaizen. After eliminating all type two muda, the elimination of type one muda follows when pursuing continuous improvement.

In sum, Toyota concluded that by right-sizing machines for the actual volume needed and by minimizing their changeover times so that each machine could make small volumes of many part numbers, by lining the machines up in process sequence, introducing self-monitoring machines to ensure quality with continuous improvement, and by having each process step notify the previous step of its current needs for materials, it would be possible to obtain low production cost, high variety, high quality and rapid order lead times to respond to their customer desires[6].

2.5 Lean – Implementing TPS throughout the whole business

Toyota has been reluctant to publish or endorse what they consider to be the right way to implement the TPS (Smalley, 2005). It is not until the publication of the book ‘The Machine that Changed the World’ (Womack and Jones, 1990), that the TPS got worldwide acknowledgement as a model-production system. The book was the result of a five-year study led by the MIT. It was also then, that Krafcik, a member of the research team at the

[6] www.lean.org

MIT, introduced the term 'Lean'. Nowadays, varying terms are used for Lean worldwide, such as '*Schlanke Produktion'* in Germany and *'Yalin'* in Turkey. This research however, will continue to use the term Lean since it is still used the most frequently worldwide.

The principles of the TPS (figure 3.1) have set the foundation for Lean. But instead of being solely a production system, Lean is a coherent business system. It is therefore more suitable to use the term Toyota Business System (TBS), instead of TPS, when referring to Lean. Lean focuses on creating flow, high quality, high value and high variety for the customers, fast order lead times[7] and the elimination of waste throughout the whole value stream instead of only the production process. Grasso (2005) stated when explaining Lean, that "all business processes and functions integrate into a unified, coherent system whose single purpose is to continue to provide better value to customers through CI and elimination of waste using Lean principles and tools". Shah and Ward (2003, p. 129) describe that, "Lean is a multi-dimensional approach that encompasses a wide variety of management practices, including JIT, quality systems, work teams, cellular manufacturing, supplier management, etc. in an integrated system. The core thrust of Lean is that these practices can work synergistically to create a streamlined, high quality system that produces finished products at the pace of customer demand with little or no waste". This definition of Lean describes a highly integrated business system, incorporating more than pure manufacturing processes (Kennedy and Widener, 2008, p.304; Fullerton and Kennedy, 2009). Recapitulating existing literature, Lean is a coherent business strategy that incorporates a wide variety of management practices such as JIT-production, Jidoka, Kaizen and TQM, to continuously improve the value creation process by eliminating activities that require resources but create no value for the customer (Womack and Jones, 1990, 1996, 2003; Shah and Ward, 2003; Grasso, 2005; Callen, 2005; Maskell and Kennedy, 2007; Becker, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009).

Womack and Jones (1996, 2003) formulated the following five basic Lean principles, which are based on the principles of the TPS (figure 2.1)[8]:

1. Specify Value

The starting point for Lean is to specify value desired by the end customer. Lean focuses on finding customers' real needs. Womack states that "If you really embrace a lean thought process, (…) you have to find a way to have a real dialog with your customer instead of having two monologs with the customer."[9] Therefore, value can only be defined by the customer. Value is expressed in terms of any product, action or process that meets the customer's need at a specific price at a specific time (Womack and Jones, 2003, p. 16-19). Thus, value is defined as any product, action or process that a customer would be willing to pay for. The most important task in specifying value is to determine a target cost (Womack and Jones, 2003, p. 35; Maskell and Baggaley, 2004). A target cost is the maximum amount of development and production cost, in order for the customer to be satisfied while the manufacturer obtains an acceptable return. Ohno developed the following formula to determine the target cost: Target Cost = Price - Profit. Target Costing (TC) is a

[7] An order lead time (also called throughput time or total product cycle time) is the time it takes for a product or service to flow through the entire value stream. In other words, the time a customer has to wait until he/she receives the product or service (Womack and Jones, 2003).

[8] http://www.lean.org/WhatsLean/Principles.cfm

[9] http://www.leaninstituut.nl/publications/index.htm

form of price-led costing[10]; both maximum prices and minimum profits are determined by customer needs, leaving target costs as the only item under control of the firm[11].

2. Identify the Value stream

Identifying the entire value stream for each product is the next step in Lean. The value stream is the set of all actions required to bring a product from order entry to final delivery. These include production processes but also many processes that support the production processes, such as marketing, order entry, procurement, material handling, maintenance, customer service, etcetera. This step comprises identifying the people and devices needed per value stream as well (Maskell and Baggaley, 2004). Firms that are mature with Lean extend their value stream understanding beyond their own four walls and include suppliers and buyers into their value streams.

The activities within the value stream can be value-adding as well as non-value-adding. A crucial task in identifying the value stream is to find and eliminate waste (muda), which are all non-value-adding activities. The perception of waste is directly derived from Taiichi Ohno's (1988) list of seven types of muda mentioned in section 2.4.3 of this research. However, Womack and Jones (2003, p. 355) have added an 8th type of muda to this list, which is the design of goods and services that do not meet customers' needs. Similar to what Ohno stated (1988, p. 19-20)[12], the focus within Lean is also on eliminating first type II muda (non-value-added activities that are avoidable), but this time throughout the whole value stream. By screening the entire value stream, Lean changes the focus from departmental thinking to the complete flow of the product from customer order to its final delivery.

3. Create Flow

The following step in Lean is streamlining the value creating process so that the product will flow in a steady sequence towards the customer. The concept of flow within Lean is similar to the JIT-concept of continuous flow within the TPS. But instead of solely focusing on the production process, Lean focuses on lining up all value creating activities in process sequence (Womack and Jones, 2003, p. 24). Furthermore, Lean seeks to create a continuous flow of material as well as a continuous flow of information throughout the entire value stream (Maskell and Baggaley, 2004). Material flow is the flow of products (and services) and Lean organizations seek to bring a product from order entry to final delivery without any stoppages, scrap and rework. Informational flow is the flow of information throughout the entire organization and value stream to support decision making and control. This comprises information from within the organization as well as information from the external environment. Within Lean, continuous flow is also called single piece flow where each product, service and information proceeds through the value stream without any interruptions, scrap and rework[13].

As stated earlier[14], Lean ignores traditional boundaries of jobs, technologies, functions (often organized into departments) and firms. Lean changes the focus from optimizing separate technologies, processes and

[10] Instead of cost plus pricing where: Cost + Profit = Price. This way, the firm determines the price by calculating the total internal costs and adding up a profit margin, which is a % of the calculated costs.
[11] In chapter three of this research, TC will be further elaborated.
[12] See Toyota Production System on page 16 of this research.
[13] In contrast to the batch-and-queue practice, where large quantities of one part are made and sent to the batch to wait in the queue for the next operation in the production process.
[14] See second principle of Lean, when the value stream is identified described on the previous page.

departments, to optimizing flow of product, services and information throughout the entire value stream (Womack and Jones, 2003, p. 52). To achieve this, Lean advocates the layout of all activities within a value stream for one product (family) in a tight U-shaped sequence, called a cell. Because of this sequence, different steps can be conducted immediately adjacent to each other. Lean also identifies standardized work. Standard work is a precise description of each work activity specifying the flow of the product through the cell, by defining each activity, its timing and the exact sequence within the cell. The purposes of standard work are to ensure that the product is made correctly and at the right rate[15], and to ensure basic stability[16]. Within the cell, devices (from computers to machines) are right sized, and changeover times are minimized which makes it possible for product teams to rapidly shift between product variants and the concept of Jidoka is implemented by introducing self-monitoring devices to ensure quality[17]. However, the flow system within the cell has an everything-works-or-nothing-works quality; to keep the products, services and information flow, wasteful activities need to be eliminated[18]. The workforce and professional supporting staff need to be constantly in contact with each other and the status of the entire value creation process needs to be visible for everyone. Lean also advances cross training of people within the value stream of one product (family). This way, in case someone is absent or needed for another task there is always replacement. Furthermore, with the use of Jidoka, cross training of people makes multi-process handling possible, where one individual can operate on several tasks[19].

By taking these steps, Lean changes the focus from departmentalized and batch thinking, to optimizing flow of products, services and information throughout the entire value stream.

4. Introduce Pull

Similar to the TPS, Lean makes use of a pull system. The products only flow when pulled by the next step. At the TPS however, pull is only introduced on the production floor, whereas with Lean the pull system comprises the whole value stream. A kanban system is installed to enhance pull; the value creating activities are initiated by customer demand and each step upstream in the value stream is pulled by a signal card, named “kanban”, from a downstream activity. The kanban system then becomes the pacemaker of the entire organization since the process is initiated by and does nothing until it receives a kanban.

5. Manage towards Perfection

The value stream is continuously improved with the use of kaizen by eliminating waste to create more value for the customer. Kaizen can be divided into Flow-Kaizen and Process-Kaizen. Flow-Kaizen stands for the continuous, incremental improvement of the complete flow of products, services and information throughout the entire organization and value stream. This is Kaizen at the management level. Process-Kaizen stands for the continuous, incremental improvement of individual processes. This is kaizen used on the work floor. According to Womack and Jones (1996, 2003), kaizen has to be repeated over and over again as a core activity during the life cycle of the product (family). Lean advocates that every continuous flow-cell needs a CI team that continuously identifies the points for improvement. Within Lean it is believed that, for both

[15] Where the cycle time = takt time
[16] The Lean concept of basic stability is directly derived from the TPS, section 2.4.3 of this research.
[17] This makes the concept of flow within Lean similar to the JIT-concept of continuous flow within the TPS.
[18] The concept of waste is illuminated on page 15.
[19] See section 2.4.1 of this research for a description of Jidoka.

flow- as well as process-kaizen, visual transparency enables CI by offering immediate feedback on employees (Fullerton and Kennedy, 2009). The status of the entire value creation process needs to be communicated between the workforce and the professional support staff at all times. Lean therefore believes in transparency and empowerment of employees within the value stream by transferring decision rights to lower level employees and by enabling employees to monitor their own work.

Lean also uses standard work as a basis for comparison for Kaizen. Standard work is a precise description of each work activity specifying cycle time and takt time. The concept of takt time and cycle time is directly derived from the JIT-concept of customer takt time[20]. Takt time matches production to the customer demand to prevent over/under production and to maximize flow. By comparing the cycle time with the takt time the achievement of takt time is monitored (Womack and Jones, 2003; Maskell and Baggaley 2004). When the cycle time does not meet the takt time, Lean emphasizes CI to pursue the production of the product at the same rate as customer demand for the product.

Kaizen is typically accompanied by a TQM program. TQM is a management practice that encompasses both improving product quality (performance, reliability, conformance to users' needs, durability and serviceability) and efficiency (lowering cost and increased productivity)[21]. Deming (1991) argues that customers seek the highest quality products and services and are willing to pay a premium for them. Thus, improvements in quality, as defined by the customer, result in improved organizational performance. Firms using TQM report the cost of quality which can be categorized into four groups:

a. Prevention costs: costs incurred to prevent defects in products before production
b. Appraisal costs: costs incurred when detecting and eliminating defective units during the production process
c. Internal failure costs: costs of rework, which incur after the production process but before delivery.
d. External failure costs: costs incurred after delivery of the products, such as warranty work, costs of returns and the opportunity costs of forgone sales from a reputation for low-quality products (Wang, Gao and Lin, 2007).

Both TQM as well as Lean aim for a zero defect level, where all the quality defects, which constitute a large part of the list of eight types of waste (muda) within Lean (Ohno, 1988; Womack and Jones (2003), are eliminated. TQM advocates that quality is the responsibility of the people (employees, managers and senior managers) within the firm. TQM is often used by the CI team and is an important subsystem of Kaizen. With Kaizen, the focus is namely on the prevention, detection and elimination of defects before and during the production process, by identifying and eliminating waste in the value stream processes (Womack and Jones, 2003; Maskell and Baggaley, 2004).

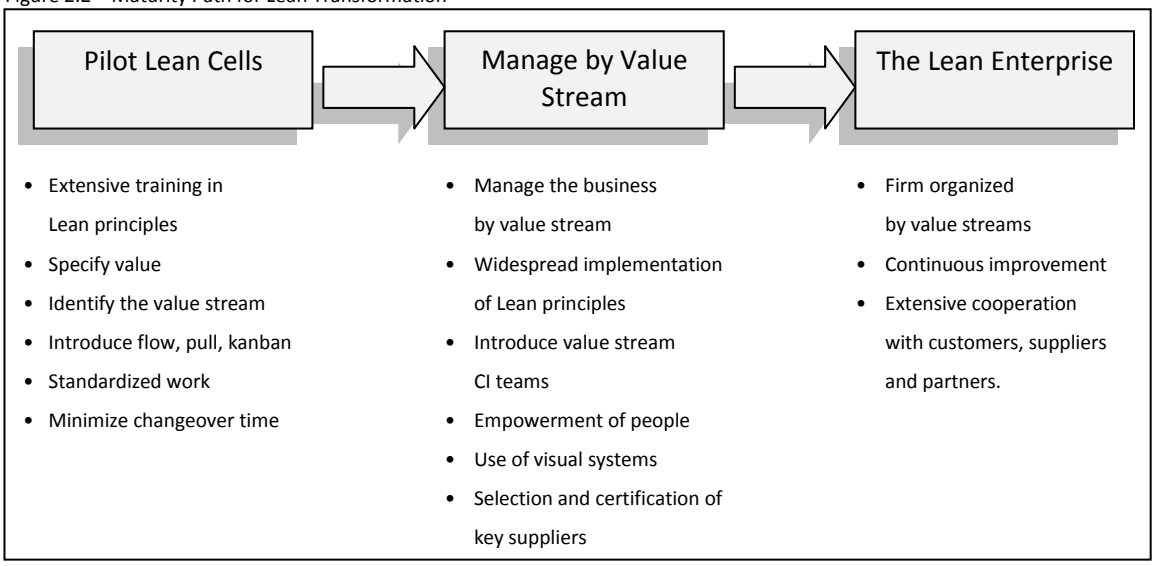
2.6 Lean Maturity Path

According to Maskell and Baggaley[22] (2004) there is a maturity path towards the successful implementation of Lean. Figure 2.2 shows how the maturity path is organized in to three steps. In practice, there is no clear

[20] The concept of customer takt time is described in section 2.4.2 of this research.
[21] Zimmerman, 2009, p. 663
[22] http://www.maskell.com/lean_accounting/subpages/lean_accounting/value_stream_management.html

distinction between the three stages of maturity. It is common for a firm to be at different levels of maturity in different parts of the organization. It is also common that within the same department there are varying levels of maturity.

Figure 2.2 – Maturity Path for Lean Transformation[23]



2.6.1 Maturity Path - Stage 1: Pilot Lean Cells

Most firms start off with extensive training in the five basic Lean principles discussed in section 2.5 of this research. This is followed by the introduction of pilot Lean cells or processes (firms often start at production processes). At this pilot cell or process, the basis for the first four basic principles of Lean has been set. Value desired by the end customer is specified and the value stream for that cell or process is identified. Within the pilot cell or process, the initial improvements to the value stream flow are implemented. Devices (from computers to machines) are right sized, changeover times are minimized and a kanban system is installed to enhance a pull system. To ensure stability in the first implementation phase, standardized work is specified, indicating the takt time[24] and cycle time[25]

Finally, in the first stage of the Lean maturity path the firm's bigger value streams per product (family) are defined. In the early stages of Lean, firms often focus their attention on the production process. But the firm's value stream includes marketing and sales, procurement, customer service and more (Maskell and Baggaley, 2004).

2.6.2 Maturity Path - Stage 2: Manage by Value stream

Within this stage, the implementation of Lean principles is more widespread within the firm's value stream. Continuous flow and kanban pull are extended throughout the firm's value stream. At this stage, all activities that require resources but create no value for the customer (waste) and all value-adding activities are identified and a culture for CI (Kaizen) is started. Also, CI teams are trained and established. The CI team is made up of people working in the value stream. The purpose of the CI team is to evaluate the value stream each week and initiate projects to improve every week. Employees are empowered by transferring decision rights to lower level

[23] http://www.maskell.com/lean_accounting/subpages/lean_accounting/value_stream_management.html
[24] Takt time = the rate at which customers demand a product.
[25] The cycle time = the production time in seconds needed to perform an operation on one product.

employees and visual systems are implemented to increase transparency to enable employees to monitor their own work. Finally, having key suppliers which deliver exactly what is ordered is a requirement for Lean transformation to work. Therefore, key suppliers are selected based on on-time delivery, quality and correct quantities.

2.6.3 Maturity Path - Stage 3: The Lean Enterprise

Firms that are mature with Lean extend their value stream understanding beyond their own four walls and include all activities within the entire value stream. Key suppliers are selected and certified based on their on-time delivery, quality and correct quantities. Certification therefore requires an education of suppliers to the Lean firm's standards. A Lean enterprise has a high level of cooperation with third-party organizations including customers, suppliers and other partners. Lean therefore emphasizes on customer relationship management (CRM) as well as supplier relationship management (SRM). While continuous improvement proceeds, external waste will also be addressed and eliminated. However, the intense cooperation also raises some trust and privacy issues. Jointly analyzing every action needed to develop, order and produce a good or service makes every firm cost transparent (Womack and Jones, 2003, p. 276). Often firms cooperate at the minimum level necessary and hope for a cost reduction inside their own firm which they do not have to share. In the context of a Lean enterprise, Lean advocates the jointly implementation, evaluation and improvement of the Lean principles throughout the entire value stream.

2.7 Conclusion

In the last three decades, environmental changes have resulted in a growing level of competition (Hiromoto, 1991; Dent, 1996; Shields, 1997; Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009). Firms have reacted to these changes in their environment by changing their business strategies to achieve sustainable competitive advantage and improve operational performance (Porter, 1980, 1996; Chong and Chong, 1997; Perera et al., 1997; Fuchs et al., 2000; Baines and Langfield-Smith, 2003).

Some of the organizational innovations resulting from the severe competition have set the foundation for the development of the Lean business strategy. The origin of Lean, however, is traceable to 1450 when Venice developed methods to streamline to production processes in the Arsenal and later in 1913 when Ford created what he called flow production by lining up all the machines needed to produce the parts for the Model T Ford in process sequence. Toyota refined Ford's production flow system by implementing the following concepts within its production system: Jidoka, JIT, pull production, customer takt time, continuous flow and standardized work to achieve basic stability and Kaizen. These concepts within the TPS focus on right-sizing machines, minimizing changeover times and lining up machines in process sequence to create continuous flow, introducing self-monitoring machines to ensure quality, enhancing pull and continuously improving the production flow by eliminating wasteful activities to obtain low production cost, high variety, high quality and short order lead times to respond to customers needs.

The concepts within the TPS have been particularly inspiring for Lean. However, Lean incorporates more than pure production processes. Lean is a highly integrated business system that is built upon five basic Lean principles of customer value specification, value stream identification for each product (family), continuous flow of materials and information, pull processing of products and the continuous perfection of the value stream processes (Kaizen). These principles are applied on each activity within the value stream to streamline and

continuously improve the value creation process by eliminating activities that require resources but create no value for the customer.

According to Maskell and Baggaley (2004), there is a maturity path towards a firm's successful transformation to Lean. Following this so-called Lean Maturity Path, the Lean principles are gradually implemented, continuously evaluated and improved within the firm's value stream. However, the success of Lean implementation does not only depend on how Lean is implemented within the firm's value stream, but also on how well the firm coordinates its Lean efforts with its suppliers, customers and business partners. When firms are mature with Lean, Lean therefore emphasizes the development of the so-called Lean enterprise that has mutually dependent relationships with its customers, suppliers and business partners to focus on the continuous flow of materials and information and eliminating internal as well as external waste throughout the entire value stream of a product to enhance its core competency of creating more value for the customer with less waste (Womack and Jones, 1996; 2003; Maskell and Baggaley, 2004).

3. Accounting for a Lean Business Strategy

3.1 Introduction

In this chapter the main tenet of Lean Accounting (LA) will be highlighted. Advocators of LA state that as the firm matures with Lean, different techniques of LA become appropriate. Therefore, the different LA techniques will be illuminated by following the three stages within the Lean maturity path discussed in the previous chapter.

3.2 Visual transparency

Informational flow is the flow of information throughout the entire organization and value stream to support decision making and control. In the previous chapter, it is explained how Lean focuses on the continuous flow of information throughout the value stream (Womack and Jones, 2003; Maskell and Baggaley, 2004). Lean advances visual transparency, meaning that information on the value creation process is made continuously available for both (senior) managers as well as employees. The employees and managers are constantly in contact with each other and the status of the entire value creation process is visible for everyone.

The value stream is continuously improved with the use of Kaizen by eliminating waste to create more value for the customer. Lean advances that this Kaizen process is supported by a CI team made up of the people working in the value stream. The purpose of the CI team is to continuously evaluate and initiate projects to improve the value stream. With visual transparency, problems are quickly revealed as they occur so that they can be corrected and eliminated (Maskell and Kennedy, 2007). Visual transparency, therefore, enables continuous improvement by offering immediate feedback on the status of the value stream (Womack and Jones, 2003; Maskell and Baggaley, 2004, 2006; Fullerton and Kennedy, 2009).

Lean furthermore believes in the empowerment of employees by transferring decision rights to lower level employees. Visual transparency supports the empowerment of employees by enabling employees to monitor their own work (Fullerton and Kennedy, 2009). Moreover, visual transparency also reduces information asymmetries as information on the process becomes available at different levels within the organization (Maskell and Baggaley 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy, 2009).

3.3 Lean Accounting

A firm's MAS provides the flow of information necessary for planning and making decisions (decision making), and for monitoring and motivating the behaviour of people within the organization (decision control) (Sunder, 1997). Accounting for a Lean business strategy, also called Lean Accounting (LA), comprises a firm's MAS in a Lean environment. Researchers argue that LA provides accounting techniques that enable visual transparency (Maskell and Baggaley, 2004; Maskell and Kennedy, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy 2009).

Although LA has been developing since 1990s, up until 2005 the methods of LA were not clearly documented. In September 2005 at the 'Lean Accounting Summit' in Detroit, a group of LA practitioners and academics decided to document the current state of field of LA in the 'Principles, Practices and Tools (PPT) of LA' (Maskell and Baggaley, 2006; Fiume et al., 2007)[26]. According to the PPT, the objectives of LA are:

[26] www.leanaccountingsummit.com

1. Provide accurate, timely, and understandable information to motivate lean transformation throughout the organization, and for decision making leading to increased customer value, growth, profitability, and cash flow.
2. Use lean tools to eliminate waste from the accounting processes while maintaining thorough financial control.
3. Fully comply with internal reporting requirements.[27]
4. Support the lean culture by motivating investment in people, providing information that is relevant and actionable and that empowers continuous improvement at every level of the organization.

Within the PPT, it is further stated that Lean methods, such as Kaizen, need to be applied to accounting practices as well in order to reduce waste, such as by reducing steps in transaction processing. Moreover, the group of LA advocates emphasized that LA practices contain visual measurement and management systems that support a firm's implementation of Lean leading to timely information that is readily understandable for anyone in the firm on a continuous basis (Maskell and Baggaley, 2006).

According to Kennedy and Widener (2008), an accounting perspective of Lean suggests that firms combine techniques to minimize waste in work processes and to facilitate decision making and control in a lean environment, by reducing steps in transaction processing and by emphasizing social controls such as visualization. Fullerton and Kennedy (2009) state that firms implementing LA streamline their accounting processes and use more visual presentations of performance on the floor whereby the information is continuously available, simpler to prepare and easier for decision makers to understand.

Recapitulating existing literature, LA provides the necessary information for decision making and control in a Lean environment by focusing on implementing Lean principles of value, continuous flow and kaizen to accounting practices and by containing visual measurement and management methods to endorse visual transparency (Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy 2009).

In the previous chapter, a Lean maturity path for the implementation of Lean is illuminated. Advocators of LA state that as the firm matures with Lean, different techniques of LA become appropriate, since at every stage of Lean implementation different information is necessary to support the transformation to Lean (Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007)[28]. Therefore, this chapter will illuminate the advanced LA methods by following the sequence of the Lean maturity path.

3.4 Lean Maturity Path - Stage 1

3.4.1 Cell Performance Measurements

Since LA focuses on providing the necessary information for decision making and control within the Lean pilot cells by implementing Lean principles on accounting practices, new performance measurements can be appropriate to support the Lean pilot cells (Maskell and Baggaley, 2004). These cell performance measurements

[27] And also to fully comply with external reporting requirements such as GAAP or IFRS, but this is beyond the scope of this research.
[28] www.leanaccountingsummit.com

are gathered, used and maintained by the people in the cell, are presented visually and reflect the primary steps taken within the Lean implementation on a timely manner. It is therefore believed that cell measurements endorse visual transparency. Examples of LA cell measurements advanced in this stage are:

1. Operational Equipment Effectiveness (OEE)

OEE tracks the ability of operational equipments (from computers to machines) to deliver a product (or service) on time and to the right quality (Maskell and Baggaley, 2004). The OEE is calculated as follows (Maskell and Baggaley, 2004):

*OEE = Equipment availability * Performance efficiency * Quality*

1. *Equipment availability* is a percentage of the total production time that the equipment was actually working and is calculated as follows:

$$\textit{Equipment Availability} = \frac{\textit{(Net available time – Downtime)}}{\textit{Net available Time}}$$

The net available time is the total scheduled production time of a shift. The amount of downtime is the amount of time the equipment was not available when it should have been. Often downtime is caused by equipment breakdowns, setups, adjustments and changeovers. The availability of equipment is thus the percentage of time the equipment was working when it was needed.

2. *Performance efficiency* is the percentage of actual equipment performance and is calculated as follows:

$$\textit{Performance efficiency} = \frac{\textit{Actual Production Rate}}{\textit{Ideal Production Rate}}$$

The ideal production rate for each device is directly derived from the cycle time of a cell needed to achieve customer takt time. It is therefore the hourly production rate at which the continuous flow of products and services throughout the cell is maintained[29]. The actual production rate is the actual hourly production rate.

3. *Quality* is measured by the percentage of the product made in the cell without any rework, repair or scrap, also referred to as Firt-Time-Trough (FTT)[30] (Maskell and Baggaley, 2004). The FTT is a quality measure because it measures the effectiveness of the cell's standardized work. The purpose of standardized work is to ensure that the product is made correctly and at the right rate[31], to maintain the continuous flow of products and services throughout the cell. The FTT is measured as follows (Maskell and Baggaley, 2004; Maskell and Kennedy, 2007):

$$\textit{FTT} = \frac{\textit{Total Units Processed – Rejects or Rework}}{\textit{Total Units Processed}}$$

[29] The ideal production rate is therefore not necessarily the maximum rate of production of the equipment.
[30] This measure is also referred to as First-Time-Right.
[31] Where the cycle time = takt time (Womack and Jones, 1996, 2003; Maskell and Baggaley 2004).

The FTT is calculated by dividing the amount of units completed right the first time by the total units produced. The FTT percentage can be calculated for each activity within the cell as well as for the entire cell. The FTT for the whole cell is the product of the individual FTT's of each activity within the cell:

*Cell FTT = FTT1 * FTT2 * FTTn*

According to Maskell and Baggaley (2004), OEE takes time to track and measure and is therefore more suitable to monitor devices that create bottlenecks within the pilot cell. They state that, in order to improve the cell's performance, the factors surrounding problems such as, the number of occurrences and duration of downtime, reasons for machine slowdown and quality issues, are recorded by the people operating the device (Maskell and Baggaley, 2004). Some firms use the full OEE calculation on bottleneck devices and also track the downtime of other devices in the Lean cell. Other firms combine measurements of downtime and FTT to monitor a device's effectiveness. The FTT measurement, however, is used most often to measure quality.

2. Day-By-The-Hour (DBH) Report

With the use of a DBH report, the cell's ability to achieve customer takt time is monitored by comparing the cycle time with the takt time (Womack and Jones, 1996, 2003; Maskell and Baggaley 2004; Maskell and Kennedy, 2007)[32]. As indicated in Appendix I, there are three purposes for the DBH report (Maskell and Baggaley, 2004):

1. The main purpose of the DBH report is to put focus on matching the production to the customer demand to prevent over/under production (waste).
2. The second purpose is to provide feedback to the people working within the cell by enabling them to see the status of the activities.
3. The third purpose is to gather information that can be studied and used to continuously improve the cell's performance.
4. The DBH report is also used to provide the work or production schedule to the cell. The products are scheduled with the use of kanbans, which are customer orders or every following signal from a downstream activity, pulling the upstream steps in the cell.

3. WIP-to-SWIP Report

While focusing on continuous flow, Lean emphasizes on minimizing in-process inventory and associated carrying cost. At the same time, in the early stages of Lean, the concept of basic stability within Lean requires a buffer stock (to cover variations in customer demand) and a safety stock (to cover losses such as scrap) in order to achieve stability in its materials. Within the first stage of Lean implementation, Lean pilot cells are therefore designed to contain a certain amount of inventory.

[32] See Appendix I for an example of a DBH report.

The WIP-to-SWIP is measured by dividing the WIP inventory quantity within the cell by the SWIP inventory quantity[33] (Maskell and Baggaley, 2004):

$$WIP\text{-}to\text{-}SWIP = \frac{Total\ WIP\ Cell\ Inventory}{Standard\ WIP\ Cell\ Inventory}$$

The WIP is the actual work in progress inventory. The SWIP is the minimum necessary in-process inventory to maintain standard work and comprises the buffer stock as well as the safety stock. When standard work is defined during the first stage of Lean implementation, the SWIP is determined by the number of kanbans within a cell. If the WIP equals the SWIP determined for the cell, then the right amount of inventory is pulled by the kanban[34]. The WIP-to-SWIP therefore tracks the effectiveness of the pull system.

4. Support Cell Performance Measurements

Except for the three LA cell measurements explained in this section, other support cell measurements are advanced to be used during the transformation to Lean (Maskell and Baggaley, 2004; Maskell and Kennedy, 2007). Some of these measurements are illuminated in Appendix III.

3.4.2 Backflushing

One of the objectives of LA is to use Lean methods such as kaizen to eliminate waste from accounting processes while maintaining financial control (Maskell and Baggaley, 2006; Fiume et al., 2007). According to LA advocates, transactions are waste within accounting processes and are often in place to bring control into processes that are out of control (Maskell and Baggaley, 2004). As processes are brought under control with the use of Lean tools supported by the cell performance measurements, transaction processing steps are advised to be eliminated to streamline the accounting processes and enable visual transparency (Kennedy and Widener, 2008, Fullerton and Kennedy, 2009).

In the early stages of Lean transformation, Lean organizations often use backflushing of labour, materials and inventory costs to eliminate labour, material, machine and overhead resources tracking at each production step. When the items are completed, backflushing is applied to the completed work order instead. Backflushing is achieved by multiplying the number of items produced by the standard cost of the resources required to produce the items. A requirement for backflushing to work is that labour route sheets and information in the bill of materials (BOM) are complete and accurate. To assess the accuracy of inventory balances, cycle counting can be conducted (Maskell and Baggaley, 2004). With cycle counting, samples of inventory within the process are counted instead of the entire inventory. Labour costs caused by people working for more than one cell are allocated to the cell using full-time equivalent heads. This is based on an estimated percentage of labour time spent in each cell. Part-time people can be included as equivalent full-time heads as well. The costs of devices that perform for more than one cell are allocated in the same way, that is, by applying a percentage for each cell that uses the monument (Maskell and Baggaley, 2004).

[33] In Appendix II an example of a WIP-to-SWIP report is provided.
[34] The WIP-to-SWIP measure is applicable for non-production departments as well, since here inventory is also present in the form of documents, tools and so on. However, this measurement may be overkill for simple support departments (Maskell and Baggaley 2004).

Backflushing reduces the number of transactions needed to maintain the standard cost data. However, labour overtime and material scrap and rework still have to be recorded in order for these costs to be added to the standard costs of that resource.

3.4.3 Identify the Value Stream

Finally, at the first stage of the Lean maturity path, the firm's bigger value streams per product (family) are defined. A way to understand the material and information flow through each value stream is by drawing a value stream map (VSM) for each product (family). With the use of VSM, the customer demand, customer takt time, inventory, major suppliers, cycle times and other information are identified and calculated[35]. The current state of VSM shows each step of material and information flow that is currently needed to bring the product from order to delivery on a time-line. Another crucial task of the VSM is to make all non-value adding activities (waste) visible within the value stream.

3.5 Lean Maturity Path - Stage 2

3.5.1 Value Stream Performance Measurements

Where cell performance measurements support the people in the Lean cells in decision making and control, value stream performance measurements initiate continuous improvement in the value stream and provide a way to assess the benefits of Lean changes being made. In the second stage of Lean transformation, CI teams are assigned to each value stream. The purpose of value stream performance measurements is to drive the CI team in improving the processes in the value stream by monitoring the key indicators of Lean benefits. The CI team consists of managers and employees working in that value stream. As wasteful transactions are eliminated in the accounting processes, accounting and finance people can become active members of the CI team as well.

In the early stages of Lean implementation, managers seek to calculate the benefits of Lean changes being made. Managers often find short term operational benefits resulting from Lean changes. The following operational benefits are commonly associated with Lean (Womack and Jones, 1990, 1996, 2003; Shah and Ward, 2003; Grasso, 2005; Callen, 2005; Maskell and Kennedy, 2007; Becker, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009):

- Reduced lead times
- Improved quality
- Improved on-time delivery
- Reduced floor space
- Reduced inventory
- Increased available capacity

These operational benefits are believed to lead to increased customer satisfaction, more orders and new customers, which will lead to financial benefits in the long term (Womack and Jones, 1990, 1996, 2003; Maskell and Baggaly, 2004; Maskell and Kennedy, 2007).

In the short term, however, managers often find that the operational benefits are not accompanied by financial benefits. This is a classic dilemma which managers in Lean transformation often are facing. Researchers state

[35] See Appendix IV for an example of a VSM.

that managers (and other members of the CI team) who focus on these short term financial results will make poor decisions in continuing the transformation to Lean (Kaplan, 1983; Johnson and Kaplan, 1989; Lee, 1987; Johnson 1992; Ittner and Larcker, 1998).Maskell and Baggley, 2004; Maskell and Kennedy, 2007). They advance the use of the so-called 'box score', which provides a weekly summary of the value stream performance.

Box Score

The box score summarizes the operational, financial and capacity effects of Lean into one table[36]. With the box score, the effects of Lean changes on financial results are predicted and measured based on the operational effects. By enabling everyone to assess the status of the value stream performance at every moment, the display of the box score facilitates visual transparency, continuous improvement and the empowerment of people. The box score is measured, maintained and used by the value stream manager and his CI team to monitor and create improvements within the value stream.

A. Operational Performance

The following value stream measurements within the box score are indicators of operational effects from Lean:

1. **Dock-to-Dock Days** measures the flow of materials through the value stream. It is the amount of time from material receipt to the shipment/delivery of the finished product to the customer[37]. The dock-to-dock days is calculated by dividing the total amount of inventory (raw material, work in WIP and finished goods) by the average rate at which the finished products are manufactured per day[38].
2. **FTT** for the value stream is the product of the individual FTTs of the cells within the value stream[39]. This means that also the FTTs of the non-production cells are taken into account when measuring the value stream FTT.
3. **On-Time Delivery** measures the percentage of products that are delivered on time. On-time delivery is calculated as the percentage of scheduled customer orders, actually delivered according to schedule. The measurement of on-time delivery requires information technology to track the due date.
4. **Floor Space** is the space used by the value stream including the space used for the material, WIP and finished goods inventories.
5. **Sales per Person** measures both the value created by the value stream as well as the productivity of the value stream. It is calculated by dividing the revenue delivered and invoiced from the value stream by the average number of full-time equivalent employees (including management) within

[36] See Appendix V of this research for an example of a box score.
[37] Dock-to-dock days is similar to the lead time. But when calculating the lead time, the time it takes for the finished product to arrive at the customer is also included.
[38] A decrease in the dock-to-dock days, indicates an increase in the rate of material flow leading to a decrease of inventory levels in the value stream (Maskell and Baggaley, 2004).
[39] See section 3.4.1 of this research for a thorough description of the FTT measure.

the value stream in that period[40]. From a Lean point of view, there is no productivity in making a product, only in selling a product (Womack and Jones, 1996, 2003; Maskell and Baggaley, 2004, 2006).

6. **Average Value Stream Cost per Unit (Average Product Cost)** is the total value stream costs for a week, divided by the number of units delivered and invoiced during the week. Maskell and Baggaley (2004) point out that some lean firms use the average conversion cost per unit when using this value stream performance measurement. They state that, if the products within the value stream have similar production processes and similar materials cost, then the average value stream cost per unit is a proper measure. However, if the products have similar production processes but different materials costs, then the average conversion cost per unit is more suitable[41].

B. Financial Performance

The financial information within the box score shows the effects of Lean changes on the financial results. The information to assess the financial effects of Lean is derived from the value stream costing (VSC) method. Although this costing method will be explained in section 3.5.3 of this research, some definitions will be included to reinforce the understanding of the box score. In the box score the financial effects of Lean changes are listed within five items of data:

1. **Revenue** is the invoiced amount for delivery from the value stream (week).
2. **Material cost** is the cost of material purchased by the firm during the period (week).
3. **Conversion cost** is the total value stream costs per week less the weekly material cost (week).
4. **Value stream Profit** is the difference between the revenue and cost of sales. The cost of sales is the sum of materials cost and conversion cost, which equals the average value stream cost. The box score does not take into account the changes in inventory levels when calculating the value stream profit. Otherwise, these inventory levels will directly affect the value stream profit. Now, when the value stream increases its inventories the box score will show a lower profit and a higher average value stream cost (Maskell and Baggaley, 2004). This way, it is believed that the box score will motivate the CI team to reduce its inventories.
5. **Value Stream Return on Sales (ROS)** is the value stream profit divided by the revenue. It evaluates how efficient the firm is using its resources to generate a return.

C. Capacity Information

The capacity information within the box score shows the changes in the use of resource capacity as a result of Lean changes. Resource capacity is the ability to do work as provided by resources.

To exemplify, two categories of resources are considered:

People; whereby capacity is dependent on the available labour hours.

Machines; whereby capacity is dependent on the available machine hours.

The usage of resource capacity can be divided in to three categories:

[40] Productivity within Lean is therefore calculated from the point of view of the customers, in contrast to calculating it from the point of view of the firm. As to the latter, the amount produced is divided by the number of employees to calculate productivity.

[41] The method for calculating value stream costs is described in section 3.5.3 of this research.

- **Productive**: Labour or machine time spent on creating value at the pull of the customer. According to Lean, there is no productivity in making a product, but only in creating value for the customer.
- **Non-productive**: Labour and machine time spent on non-value adding activities, such as time spent on changeovers, rework, material movement, inspection, repair, maintenance, waiting for resources, planning, administration and so on (Maskell and Baggaley, 2004). That is, all activities listed as waste by Ohno (1988) and Womack and Jones (2003).
- **Available**: Machine and labour time left, after productive and non-productive time has been accounted for.

Lean focuses on eliminating waste from the value stream processes and therefore focuses on eliminating the non-productive usage of capacity resources. The waste is eliminated by implementing the five principles of Lean[42] in value stream processes leading to operational improvements. As waste is eliminated from the value stream, resource capacity in the form of labour hours and machine hours, which was previously used non-productively, becomes available (Womack and Jones, 1996, 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007). The capacity analysis included in the box score shows the shift in the use of resource capacity as both the current state and future state are presented in the table.

Changes in resource capacity usage create the bridge between operational and financial effects of Lean changes being made on the short term. Operational effects of Lean are not reflected in the financial information on the box score, since the firm continues to pay for these resources. The financial effects of Lean are believed to become visible when the firm exploits the freed up capacity to grow its business. The box score then can show the planned effects of the usage of this available capacity in the future state[43].

3.5.2 Production Control

In the early stages of Lean implementation, cost information is derived from the standard costing (SC) system and transaction processing of completed work orders, BOM and labour route sheets with the use of backflushing. As the firm continues to mature with Lean and LA methods, Lean principles of cellular processing, continuous flow rate, standardized work identifying customer takt time, kanban pull, Jidoka and empowerment of people are implemented throughout the value stream. The status of the cellular processes within the value stream is continuously evaluated and improved with the use of the visual management system, consisting of the cell and value stream performance measurements. Lean and LA methods are believed to serve as control mechanisms, bringing the value stream processes under control. Moreover, managing value streams in this manner is believed to push control out of the accounting and finance department in to the operations, which is often referred to as 'production control' (Maskell and Baggaley 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy, 2009). Maskell and Baggaley (2004) state that the production control is sufficiently present for value stream processes to be reasonably under control when:

- Inventories are minimized and reasonably under control
- Cell and value stream performances are in place and continuously used to evaluate, track and improve the value stream processes.

[42] See the chapter 2 of this research for a thorough description of the five basic principles of Lean.
[43] The firm has also an option to eliminate and sell the free resources. However, researchers advise against this last option, since it only creates short term financial results and contrast the objective of Lean of creating a long term Lean enterprise (Womack and Jones, 1996, 2003; Maskell and Baggaley, 2004).

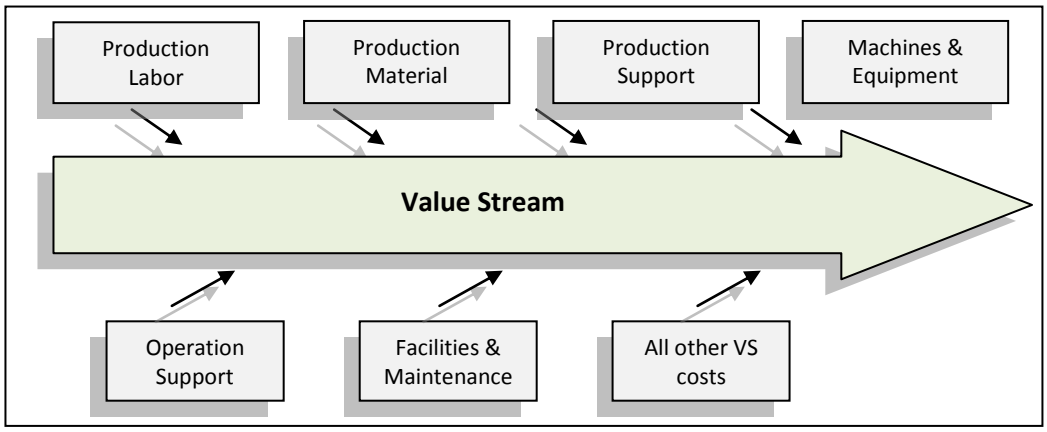
- There is little or no overlap of people, shared service departments and monuments.
- Reporting is done by value stream and not by departments

As control shifts towards the operations, it is believed that the SC system and the use of completed work orders, BOM and labour route sheets become unnecessary to maintain control (waste) and should be eliminated from the accounting processes (Haldane, 1998; Johnson and Kaplan, 1989; Ittner and Larcker, 1998; Johnson, 1992; Fullerton and McWatters, 2002; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Kennedy and Fullerton, 2009)[44]. At this point, it is advanced that SC is replaced by VSC and the completed work order, BOM and route sheets is replaced by a complete kanban pull system.

3.5.3 Value Stream Costing

VSC is a cost calculation method whereby all costs, caused by activities within the value stream, are included and considered as being direct costs related to the value stream[45] (see figure 3.1). For this reason, VSC is also called simple summary direct costing (Maskell and Baggaley, 2006; Maskell and Kennedy, 2007). VSC makes no distinction between direct and indirect costs. Costs resulting from activities outside the value stream are not included in the value stream costs. Therefore, identifying the value stream is a requirement for VSC to work. Costs included in the value stream cost calculation are: machine costs, material costs, facilities costs, labour costs, including wages and employee benefits, and other costs such as supplying and tooling. VSC is a LA costing method that matures overtime as Lean principles become more effective within the value streams. As the VSC system is established, labour, material, WIP and finished goods tracking is completely eliminated from the accounting processes.

Figure 3.1: Costs included in Value Stream Costing



(Maskell and Baggaley, 2004)

[44] The literature also states that the traditional accounting system undermines the transformation to Lean. According to LA practitioners, all other accounting systems are traditional since these systems do not focus on eliminating waste to create more customer value (Maskell and Baggaley 2004, 2006; Maskell and Kennedy, 2007; Fiume et al., 2007). Within management accounting, traditional accounting systems often refer to absorption costing (Zimmerman, 2006). Traditional costing systems will be elaborated on in Appendix VI. The discussion surrounding different accounting methods will be further illuminated in chapter 4 of this research.

[45] This perception of direct costs differs from that of traditional accounting literature. There, direct costs refer to costs being directly related to the product.

Labour costs

Labour costs are the sum of the wages and employee benefits paid to the people working in the value stream. The labour costs include those incurred by the people in the production processes as well as those incurred in supporting activities within the value stream such as production planning, customer services, marketing and sales, accounting, quality assurance, IT-support, design engineering and so on. Some people do cross-value stream work in departments that support the value stream operations. An auditor, for example, does tasks unrelated to one specific value stream. According to the VSC method, costs resulting from activities outside the value stream are not included in the value stream costs. Therefore, the costs associated with these non-value stream related tasks are advised not to be allocated to the value stream, but to be treated as business sustaining costs instead (Maskell and Baggaley, 2004).

Materials, Supplies and Tooling Costs

Maskell and Baggaley (2004) state that when inventory levels are minimized and under control and the principle of continues flow is practiced, the total material costs of a value stream will be reflected by the costs of material purchased during the week. According to their reasoning, the materials purchased during the week will be used rapidly when inventories are minimized. Thus, following the VSC method, the value stream production material costs are calculated from the summary purchases of the week and assigned to that value stream cost centre. Supplies and tooling costs are similarly assigned to the value stream.

Overhead Allocation and Utilities

With VSC, there is little or no allocation of overhead costs (Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007). Costs resulting from activities outside the value stream are not included in the costs of that value stream. However, one allocation used regularly within VSC, is the allocation of facility costs per square meters. The facility costs allocated to each value stream are calculated by multiplying the total facility cost per square meter by the square meter usage of the value stream. The total facility cost is the sum of: the rental payments, depreciation costs, utilities costs, building maintenance, guard and security services, and so on. The total facility cost per square meter is obtained by dividing the total facility cost by the total square meter used by the firm. The square meter usage of the value stream includes the production area, stockroom area and the office area used by the people working in the value stream. Sometimes, utilities costs can be significant and vary between value streams to such a degree that these costs are applied to each value stream as direct costs, by metering each value stream separately (Maskell and Baggaley, 2004).

3.5.4 Kanban Pull

As SC is replaced by VSC, the use of the completed work orders to charge costs and quantities to the finished goods is believed to become redundant. Moreover, as the kanban system to enhance pull matures, activities within the value stream are initiated by the customer order and each step upstream in the value stream is pulled by a kanban signal from a downstream activity. The work order is then believed to become unnecessary as a push device to initiate production since it is replaced by the customer order and kanban pull signals (Maskell and Baggaley, 2004). Likewise, BOM, route sheets and work orders become redundant as work instructions and routings are delivered by the kanban system, cell and value stream performance measurements. It is therefore advanced that the MRP-based production control, supported by work orders, BOM, route sheets and the

production control department, is eliminated from the LA processes (Haldane, 1998; Johnson and Kaplan, 1989; Ittner and Larcker, 1998; Johnson, 1992; Fullerton and McWatters, 2002; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Kennedy and Fullerton, 2009).

3.6 Lean Maturity Path - Stage 3

3.6.1 Virtual Company

According to Lean advocators, the success of Lean implementation does not only depend on how Lean is implemented within the firm's value stream, but also on how well the firm coordinates its Lean efforts with its suppliers, customers and business partners (Womack and Jones, 1996; 2003; Maskell and Baggaley, 2004). By using the internet and other information systems to ally with its customers, suppliers and business partners, the Lean enterprise is said to become a virtual company. As information technology is used to coordinate the independent value streams of these parties, a so called value web is created. Within the value web, the business and information processes of customers, suppliers and business partners are synchronized and all actions required to bring a product from order entry to final delivery are integrated (Lamming, 1993; Hitt, 1999; Farhoomand, 2003; Laudon et al. 2006). At this stage, the Lean enterprise focuses on the continuous flow of materials and information and the elimination of waste throughout the entire value web to enhance its core competency of creating more value for the customer with less waste (Womack and Jones, 1996; 2003; Maskell and Baggaley, 2004).

3.6.2 Macro Mapping

To understand the complete flow of the product from customer order to its final delivery, Lean enterprises use macro-mapping. Macro-mapping is comparable to VSM[46]; the current state macro-map shows each step of material and information flow that is currently needed to bring the product from order to delivery on a time-line. With the use of macro-mapping, customer demand, customer takt time, flow, associated inventory, cycle times and other information concerning the value web are identified and calculated. Macro mapping also highlights specific activities within the value web where Lean efforts can best be applied. For example, macro-mapping helps the Lean enterprise to combine continuous improvement efforts with suppliers, customers and other business partners, because it shows the amount of external waste within the value web (Womack and Jones, 2002; Maskell and Baggaley, 2004).

3.6.3 Supply Chain Management

With SCM, the Lean enterprise manages its relationships with its suppliers and business partners within the value stream. For the Lean firm to start pulling materials from its suppliers, the number of suppliers is advised to be reduced by selecting key suppliers. These suppliers are then certified based on their ability to deliver on time, in small quantities, more frequently and to the right quality.

SCM systems facilitate SCM, because they automate the flow of information across organizational boundaries (Laudon et al. 2006). It is explained that Lean focuses on the continuous flow of information (visual transparency) throughout the value stream (Womack and Jones, 2003; Maskell and Baggaley, 2004). By developing direct communication between suppliers, business partners and the Lean enterprise, SCM systems

[46] See section 3.4.3 of this research.

endorse visual transparency, where information flows in many directions simultaneously between parties in a value web (Lamming, 1993). It is advanced that if all the parties within the value stream share dynamic information about customer demand, customer takt time, flow, associated inventory, cycle times, schedules, shipments and other information concerning the value web, better scheduling decisions can be made and Lean principles can be implemented effectively.[47]

3.6.4 Customer Relationship Management

With CRM, the Lean enterprise manages its relationships with its customers. It is explained that the main tenet of Lean is to increase value for the customer while minimizing waste. The Lean enterprise has to gain a complete understanding of its customers' needs and translate that into change and improvement throughout the value stream (Womack and Jones, 2003).

The Lean enterprise therefore works closely and cooperatively with its customers. Products and services are designed not only in partnership with suppliers, but in partnership with customers as well. To assess customers' real needs customer information is collected through various communication channels. CRM systems facilitate CRM, as it consolidates the collected customer information to provide a unified view of the customer. CRM systems therefore streamline the customer information flow within the Lean enterprise. CRM systems also support in streamlining customer related business processes by integrating these processes within the Lean enterprise. Analytical CRM applications analyze the collected customer data with online analytical processing (OLAP), data mining and other data analysis techniques to specify customer demand, value and takt time. The output from the customer data analysis is used by the Lean enterprise to control, evaluate and improve the Lean activities within the value stream. The output from the customer data analysis is also used for practicing target costing (TC) and kaizen costing (KC).

3.6.5 Target Costing

According to Lean, an important task in specifying value is to determine the target costs (Womack and Jones, 2003, p. 35; Maskell and Baggaley, 2004). In order for the design and marketing people to gain an understanding of customer's needs, Ohno developed TC (Ohno, 1988; Womack and Jones, 2003; Maskell and Baggaley, 2004). TC is applied to the design of products and processes by determining the allowable development and production cost in order for the customer to be satisfied while the manufacturer obtains an acceptable return. TC comprises four steps:

1. The first step is designed to understand customer needs and how customer needs are satisfied with the current products and services (Womack and Jones, 2003; Maskell and Baggaley, 2004). The previous section explained how CRM information is collected concerning customer needs and customer satisfaction with the products and services currently designed.
2. The second step is to determine the value created by the current products and services. Value is defined as any product, action or process that a customer would be willing to pay for. With CRM analysis, value is assigned to each of the customer's needs. Then, the CI team assesses the value created by the products and services for the customers. This is done by determining for each step within the value stream how much

[47] For example, Toyota Motor Europe uses an Oracle E-business Suite software based vehicle order management system, which integrates Toyota's business processes with independent dealerships, suppliers and national marketing and sales companies. This system has helped Toyota reduce cycle times and inventory carrying costs, while increasing customer value (Womack and Jones, 2003; Rowley, 2006).

value is created for the customer. The CRM analysis is done by weighing the current prices against customer priorities on matrix charts, for example. This way, value is derived from the customers' needs in accordance with the first principle of Lean.

3. The third step comprises the calculation of the target costs for the product (family). Ohno (1988) developed the following formula to determine the target cost: Target Cost = Price - Profit. TC is a form of price-led costing[48]; both maximum prices and minimum profits are determined by customer needs, leaving target costs as the only item under control of the firm.
4. In the last step, information about the product's design and value stream process is collected and examined to ensure that the product is produced at its target costs. During the initial design of the product, a so-called cost gap can become visible between the target costs and the estimated value stream costs. By examining the collected information, the costs required by each step within the value stream are compared with the value created by each step within the value stream (calculated in the second step within TC). This is done by dividing the percentage of value for each value stream step by the percentage of cost. A value stream step having a cost/value index of less than one creates more cost than value. CI efforts are then identified to bring the estimated value stream costs in line with the target costs.

3.6.6 Kaizen costing

While TC is applied to the design of products and processes, KC is applied continually during the production, distribution and customer service phases of a product.[49] The method for determining a kaizen cost target and identifying continuous improvement efforts, however, is similar to that of TC. The kaizen cost target is also derived from assessing customers' needs and value created by the current value stream processes. With KC, however, the difference between the kaizen cost target and value stream costs is assessed based on actual cost information derived from the VSC method[50]. The CI team then establishes improvement projects to bring value stream costs in line with the kaizen target costs.

The outcome of continuous cost reduction programs such as TC and KC is a program of changes and improvements that create more customer value, eliminate waste and ultimately increase profitability (Maskell and Baggaley, 2004).

3.7 Conclusion

Researchers state that LA provides the necessary information for decision making and control in a Lean environment by focusing on implementing Lean principles of value, continuous flow and kaizen to accounting practices and by providing visual measurement and management methods to endorse visual transparency (Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Kennedy and Widener, 2008; Fullerton and Kennedy 2009). The following LA methods become appropriate as the firm follows the three stages of the Lean maturity path:

[48] Instead of cost plus pricing where: Cost + Profit = Price. With cost plus pricing, the firm determines the price by calculating the total internal costs and adding up a profit margin, which is a % of the calculated costs.
[49] The following phases comprise a product's life cycle: planning, design, production, distribution and customer service (Raffish, 2001)
[50] See section 3.5.3 of this research.

At the first stage of Lean implementation, cell performance measurements are implemented as LA tools to visually support the people in the Lean cells in decision making and control. Another objective of LA is to eliminate wasteful transactions from accounting processes and therefore the tracking of labour and inventories is eliminated at this stage by using backflushing. Finally, VSM is applied, which is a LA technique to identify the value stream for each product (family).

At the second stage of Lean, value stream performance measurements are implemented as LA tools to drive the CI team in improving the processes in the value stream by monitoring the key indicators of Lean benefits. The value stream measurements are summarized within the box score and categorized as operational, financial and capacity measurements. As the firm continues to mature with Lean and LA methods, Lean principles are implemented throughout the value stream, continuously evaluated with the use of cell and value stream performance measurements and improved by a CI team. This is believed to push control out of the accounting and finance department into the operations, which is referred to as production control. At this stage, SC is replaced by VSC and MRP-based work orders, BOMs, production routing and the production control department by Lean tools, such as the kanban system.

Firms that are in the third stage of Lean implementation are mature with Lean tools and methods and extend their value stream understanding beyond their own four walls. The so-called Lean enterprise has cooperative and mutually dependent relationships with its customers, suppliers and business partners to coordinate its Lean efforts. Macro mapping is a LA tool appropriate in this stage to visualize material, information flow and external waste within the value web. The Lean enterprise can use information technology, such as SCM systems and CRM systems, to integrate all actions required to bring a product from order entry to final delivery and eliminate obstacles to the free flow of information. As customer needs are continuously assessed with CRM (systems), TC and KC become important LA tools to initiate improvement projects to create more value for the customer while minimizing waste, and integrate these improvement activities across value streams.

4. Research design and method

4.1 Introduction

In paragraph two, first an overview is given about the literature that discusses the relationship between Lean implementation, complementary changes in its MAS, and organizational performance. Also, literature is highlighted which indicates that the change in MAS practice is moderate whereby the traditional MAS[51] is still used most often within Lean environments. Then, literature is illuminated which discusses the effects of the use of the traditional MAS on the organizational performance of a Lean implementation. Paragraph two will be concluded with an ex ante model that is provided based on the literature review. In paragraph three, the research method used in this research paper is explained, whereby the selected cases, the use of the Agency Theory and the advanced organizational architecture as theoretical background, and the survey design are described.

4.2 Literature Review and Development of an Ex Ante Model

4.2.1 Strategic Management Accounting

As explained in chapter two of this research, it is well established in MA research that a firm's strategy is determined by the forces in its environment, reflecting environmental change as a driver of strategic change (Porter, 1980, 1996; Chong and Chong, 1997; Perera et al., 1997; Fuchs et al. 2000; Baines and Langfield-Smith, 2003)[52].

Another common theme in MA research is that changes in a firm's strategy will lead to changes in a firm's MAS (Chenhall and Langfield-Smith, 1998; Perera et al., 1997). Baines and Langfield-Smith (2003) provide empirical evidence that there is a significant relationship between changes in a firm's strategy and changes in its MAS. Their empirical evidence furthermore shows that the complementary changes in a firm's MAS will in turn enhance organizational performance. Nicolaou (2003) also provides evidence for a direct link between a firm's strategy and its MAS, and moreover shows that the design of a firm's MAS has an important influence on the successful implementation of its strategy, providing support for the central role of MAS in implementing a business strategy. More studies have suggested that the successful implementation of a firm's strategy depends on complementary changes in its MAS (Green, Amenkhienan and Johnson, 1992; Perera et al. 1997; Bhimani & Keshtvarz, 1999; Brickley, Smith, and Zimmerman, 2001; Oldham & Tomkins, 1999; Sprinkle, 2000; Fullerton and McWatters 2002; Callen 2005; Kennedy and Widener 2008; Cadez and Guilding, 2008; Fullerton and Kennedy, 2009). According to these studies, as MAS provide the necessary information for decision making and control, a successful implementation of a business strategy requires a complementary decision making and control system. This central concept within MA is often referred to as 'strategic management accounting' (SMA). Simmonds (1981) was the first to deviate from the traditional view that MAS should provide internally focused cost information to support decision making and control (Kaplan and Atkinson, 1989). He explored the importance of competitor information (related to market share, prices and so on) in developing and monitoring business strategy. Although the SMA literature shows different ways to determine whether a MAS supports the implementation of a firm's strategy (Cinquini and Tenucci, 2007; Cadez and Guilding, 2008), the shift of MAS

[51] Traditional accounting systems are thoroughly explained in Appendix VI.
[52] See section 2.2 for a literature review surrounding the relationship between environment and strategy.

from the internal oriented focus to a more strategic orientation is well established within the SMA literature (Bhimani & Keshtvarz, 1999; Guilding et al. 2000; Nyamori, Perera, & Lawrence, 2001; Cadez and Guilding, 2008; Chenhall, 2008).

4.2.2 Discussion surrounding Lean, MAS and Organizational Performance

Within Lean it is assumed that improving value and quality while reducing waste will lead to more customers, more orders and ultimately increased profits. Despite this widely held assumption that Lean enhances organizational performance, the empirical evidence is decidedly mixed (Fullerton and Mcwatters 2001, 2002; Womack and Jones 2003; Taylor and Wright 2003; Callon, 2005; Becker, 2007; Maskell and Kennedy 2007; Kennedy and Widener 2008; Fullerton and Kennedy 2009). Several studies have built on the central concept within SMA literature by suggesting that one explanation for these inconclusive results is that benefits from Lean are dependent on complementary changes in the firm's MAS, which is referred to as LA (Green, Amenkhienan and Johnson, 1992; Sprinkle, 2000; Fullerton and McWatters 2002; Baines and Langfield-Smith 2003; Nicolaou 2003; Callen 2005; Kennedy and Widener 2008; Fullerton and Kennedy, 2009).

Several aforementioned researchers specifically studied the relationship between the successful implementation of a Lean strategy and the design of the firm's MAS. For example, in their study Young and Selto (1993) find that a shift to a JIT strategy requires accompanying changes in the MAS that support its implementation. Ittner and Larcker (1995; 1997) conclude that TQM practices influenced a greater reliance on non-financial MA information which contributes to a higher organizational performance. Sprinkles (2000) states that, implementing a JIT strategy creates changes that should be reflected in the MAS and that, by aligning employees with the organization's strategic goals, this information should enhance the organization's productivity. Fullerton and Mcwatters (2002) demonstrate that the adoption of a JIT/TQM strategy that contributes to higher financial performance requires a complementary decision making and control system. Their results provide evidence that especially non-financial performance measures and incentive systems are related to a successful JIT/TQM implementation. Kennedy and Widener (2008) conclude that MAS complementary to a Lean strategy is an important intervening variable between the Lean strategic initiative and MC system. They continue by saying that accounting practices appear to occupy a prominent role in a Lean environment. Their results also show a bidirectional relationship between performance measures and social controls [53], indicating that control components influence each other. Fullerton and Kennedy (2009) also address in their study that accounting plays a prominent role in a Lean transformation and is key to its implementation success. The results of the study by Callen et al. (2005) show that JIT-plants that use productivity measurement are more profitable, providing evidence for the mediating role of productivity measurement between JIT-practices and performance outcome. Consistent with prior empirical findings, the importance of MAS in successful implementing Lean is addressed in various articles and literature surrounding Lean (Maskell and Baggaley, 2004; 2006; Grasso, 2005; Maskell and Kennedy, 2007; Rathje et al., 2009).

[53] According to Kennedy and Widener (2008) the management control systems consists of output controls (performance measurement), behavioral controls (standard operating procedures) and social controls (visualization, training, peer pressure and employee empowerment), pp. 306-307.

4.2.3 Critique and use of MAS in a Lean Environment

Previous studies have indicated that moderate change is noticeable in MAS practice within Lean environments. For example, Daniel and Reitsperger (1991) find non-financial measurements, such as setup times and downtime are reported more often to managers within a TQM environment. Banker et al. (1993) found a relationship between both TQM and JIT implementation and the availability of non-financial information on the work floor. Empirical findings of Ittner and Larcker (1995) supported the relationship between TQM practices and the use of non-traditional accounting measures.

Although empirical evidence shows that in some cases the MAS in Lean environments include more non-financial measurements, the majority of studies have found little change in MAS and show that the traditional MAS is still the predominant accounting system in use by firms (Green et al., 1992; Johnson, 1992; Ittner and Larcker, 1998; Fullerton and McWatters 2002, 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009). For example, Young and Selto (1993) find in their study that although information concerning critical success factors was well designed and available it was not provided at the work floor level where it could change operating decisions. Daniel and Reitsperger (1996) find that U.S. firms that implemented Lean did not change their MAS to the same extent as Japanese firms that implemented Lean as a complete business strategy. Similarly, Fullerton and Mcwatters (2002) show that the use of non-traditional accounting measures is often used for the evaluation and control of narrowly defined processes than the broader perspective of Lean as an organizational strategy practiced by Japanese firms. Findings of Fullerton and Kennedy (2009) show that although firms modify some of their traditional MAS after implementing lean, the traditional MAS is still the most prevalent.

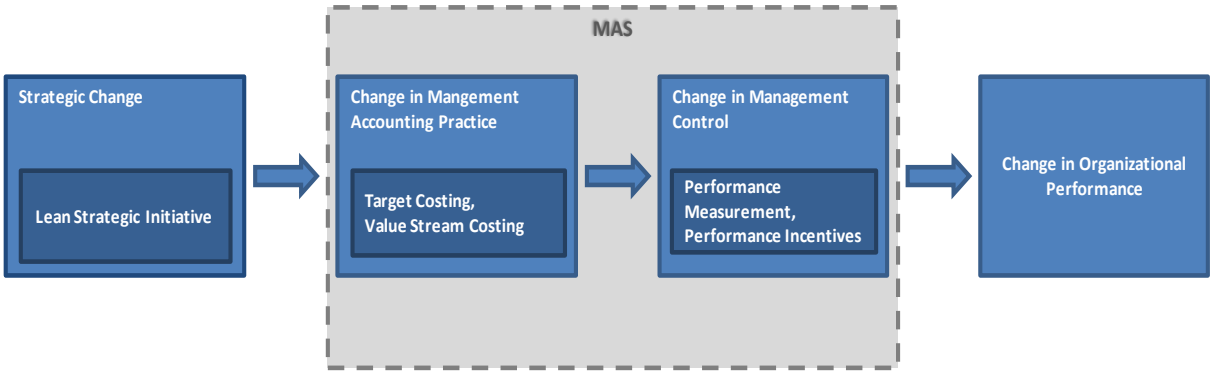
Researchers state that the current MAS within a Lean environment can cause the level of performance to be incorrectly assessed. Kaplan (1986) addresses that the traditional MAS fails to capture the benefits leading from operational benefits caused by Lean initiatives. According to Banker et al. (1989), traditional measures are weak indicators of operational performance and productivity. Young (1992) points out that without appropriate measures to evaluate and control JIT initiatives, its level of performance could be incorrectly calculated. According to Baines and Langfield-Smith (2003), the traditional MAS can distort the realities of manufacturing performance in a Lean environment.

Moreover, researchers state that the current MAS even contradicts the Lean philosophy (Kaplan, 1983; Lee, 1987; Johnson and Kaplan, 1989; Green et al., 1992; Johnson, 1992; Ittner and Larcker, 1998; Fullerton and McWatters 2002; 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009). Traditional measures cause managers to adopt short-term cost reduction objectives that hinder the effective implementation of the Lean strategy and exclude the work force (Kaplan, 1983; Johnson and Kaplan, 1989; Lee, 1987; Johnson 1992; Ittner and Larcker, 1998). Furthermore, the traditional MAS is believed to encourage firms to build more inventories, and to build a complex system of data collection and reporting, making it more difficult for work-floor decision makers to understand and use for decision making, and to use standards and variances for performance evaluation that discourage the creation of excess capacity (Kennedy and Brewer, 2006; Maskell and Baggaley, 2004; 2006; Grasso, 2005; Maskell and Kennedy, 2007; Kennedy and Fullerton, 2009). Fullerton and Kennedy (2009) moreover state that the failure to implement MAS that is complementary to the Lean transition will often lead to management rejecting Lean on the long term. Their statement however, was not empirically supported.

4.2.4 Ex Ante Model

Based on the previous empirical findings of MA research concerning Lean strategy, MAS and organizational performance, the ex ante framework illustrated in figure 4.1 is expected to be found as a result of a Lean strategic initiative.

Figure 4.1 Relationship between Lean strategic initiative, MAS and organizational performance as suggested by literature.



As indicated by prior empirical findings, a unidirectional relationship between a Lean strategic initiative, MA practice, MC system and organizational performance is expected to be found (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003; Callen 2005; Kennedy and Widener 2008). Most of the empirical research separates MA practice, which often refers to a collection of practices that provide information for decision making (such as SC, TC and so on), from MC practice, which often refers to the performance measurement system and reward system that supports decision control. Congruent with prior empirical findings, a unidirectional relationship between MA and MC systems is expected to be demonstrated, whereby according to the findings by Kennedy and Widener (2008) a bidirectional relationship between control components within the MC system is expected. Within this research, MAS includes both MA and MC by providing the necessary information for decision making and control[54]. The framework therefore suggests that if findings of this research indicate that the change in the MAS subsequent to a Lean initiative is little, this would have effect on the level of organizational performance that is assessed. Moreover, if a MAS is inadequately adjusted to a Lean business strategy, this research will study the consequences this has on the level of organizational performance being assessed as well as the degree of Lean implementation being achieved[55]. By focusing on the role of MAS in implementing Lean business strategy, this research focuses on what is stated to be often missing from research on firms employing Lean (Fullerton and McWatters, 2002; Fullerton and Kennedy 2009).

Some of the extant literature also treats organizational structure (e.g. reorganization in to cells and value streams) as a separate variable that is directly affected by a Lean strategic implementation and which itself can influence MA as well as MC practices (Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008). However within this research, changes in organizational structure are treated as an integral part of implementing a Lean business strategy, as the implemented Lean strategic principles themselves comprise changes in organizational structure.

[54] See section 3.3 of this research for the definition of MAS as is used by this research.
[55] This research will use the Lean Maturity Path discussed in chapter two as guideline in assessing the degree of Lean implementation.

4.3 Research Method

This research is conducted by analyzing four different cases of firms that have started a Lean strategic initiative. The conducting of a case study allows a detailed description of the characteristics associated with MAS in development that are complementary to a Lean business strategy. Case study research is moreover an important way for accounting researchers to develop an intimate, contextually sensitive knowledge of actual accounting practices (Patton, 1990; Keating, 1995). The research is undertaken in the natural environment of the firm starting the Lean initiative, which allows exploring an accounting issue in its complex environment (Ittner and Larcker, 2001). Moreover, the case study is also the preferred method within this research, since the focus here is on a 'contemporary phenomenon within some real-life context' (Yin, 2003).

During March and April 2011, several in-person interviews were conducted with key management personnel within the Lean initiatives at the selected cases. To avoid imposing any predetermined views on the design of the MAS, the interviews are formulated as semi-structured, whereby the interviews are held in an open form and the formulated questions served to guide the discussion[56]. Each interview is recorded and following the interview a full transcription of notes is typed and sent to the interviewee in order to be reviewed. The in-person interviews were supplemented with additional company documents and archival records, observations of the location and processes (if possible), and telephone interviews. By using four sources of information as defined by Yin (2003), the collected information is interpreted and tested on its validity and reliability. Finally, an analysis is made to evaluate the relations among the variables provided in the ex ante framework. Due to privacy issues, the cases and their related personnel will be treated anonymously within this research.

4.3.1 Case Selection and Description

Four different cases are selected that have started a Lean strategic initiative within the Netherlands in order to investigate the role of MAS in implementing a Lean business strategy. The selection of multiple cases makes it possible to generalize the findings to 'theoretical propositions' (Yin, 2003) by evaluating the ex ante framework based on extant literature. Below a brief description is provided per case.

Case I

Case I operates primarily within the oil and gas industry segment and is a subsidiary of a large global liquefied petroleum gas (LPG) distributor. The parent company operates in 27 countries, employs 13,500 people and has reported sales of over €5 billion[57]. The Dutch and Belgian subsidiaries are led by the same board of directors consisting of four directors: the Chief Executive Officer (CEO), the Chief Financial Officer (CFO), the managing director of the division in the Netherlands, and the managing director of the division in Belgium. The Dutch and the Belgian subsidiaries go by the collective name Benelux and will be denoted as Case I within this research. Case I employs about 130 people and has sales of approximately €100 million. The process of implementing Lean principles has begun within its Dutch division in 2008, and in 2010 Case I started implementing Lean within its Belgian division[58]. In 2011, the former value stream manager of the Dutch division

[56] In section 4.4 of this research, the chosen interview design will be described.
[57] Numbers are based on the annual report 2010.
[58] See chapter 5 of this research for a further description of both Lean initiatives at Case I.

is designated as the value stream manager of Benelux and reports directly to the CEO. In Appendix VII, the participants that provided the necessary information concerning the Lean initiatives at Case I have been listed.

Case II

Case II operates primarily within the electricity and oil and gas industry segment and is a subsidiary of an international electricity and gas company. The parent company mainly operates in Europe, including the Netherlands, Germany and the UK, employs 70,000 people and reported sales over €48 billion[59]. Case II supplies electricity and gas within the Netherlands and Belgium, employs 5,500 people and reported sales of €6,120 million in 2010. Case II is led by the board of directors consisting of the CEO, CFO, Chief Commercial Officer (CCO) and Chief Technology Officer (CTO). Case II started the process of implementing Lean principles in 2004, continued by a second initiative in 2007[60]. In Appendix VII, the participants that provided the necessary information concerning the Lean initiatives at Case II have been listed.

Case III

Case III operates primarily within the electricity and oil and gas industry segment and is a subsidiary of a global electricity and liquefied natural gas (LNG) distributor. The parent company operates in nearly 70 countries, employs 218,350 people and reported sales of €84.5 billion[61]. The subsidiary is active within the Netherlands, Belgium and Luxembourg, denoted as Benelux, and Germany. The business entity in the Netherlands is led by its own board of directors, consisting of the CEO, Chief Operations Officer (COO), managing director HR and managing director Strategy. The Dutch business entity will be denoted as Case III within this research. Case III supplies gas and electricity to the Dutch market and employs approximately 1,264 people[62]. The initiative whereby Lean principles were implemented started in 2009 within Case III[63]. In Appendix VII, the participants that provided the necessary information concerning the Lean initiatives at Case III have been listed.

Case IV

Case IV was mainly active as a producer and distributor of boilers within the consumer goods industry segment. Since 1994, Case IV has been a subsidiary of an international distributor of boilers mainly active within the European market and in 2004 it became a subsidiary of a global producer and distributor of electronic goods and services. The latter parent company employs 283,500 people and reported sales of approximately €48.3 billion in 2010[64].

Case IV had two divisions within the Netherlands located in Deventer and Buinen. Whereas the headquarters in Deventer comprised a production plant as well as supporting departments, the location in Buinen primarily consisted of a production plant. Case IV began its Lean strategic initiative at the end of 2000 and proceeded its Lean transition in Buinen until 2009[65]. In 2009 the parent company decided to close down the production plant in Buinen, while the location in Deventer remained open. The analysis of the characteristics associated with the

[59] Numbers are based on the annual report of 2009.
[60] See chapter 5 of this research for a further description of both Lean initiatives at Case II.
[61] Numbers are based on the annual report of 2010.
[62] In the annual report of 2010, the company reported sales of 21.483 GwH in electricity and 16.734 GwH in gas. However, these numbers are not specified financially for the Dutch entity.
[63] See chapter 5 of this research for a further description of the initiatives at Case III.
[64] The numbers are derived from the annual report 2010.
[65] See chapter 5 of this research for a further description of the initiatives at Case IV.

Lean strategic initiative will focus on the Lean implementation in Buinen. However, since the plant is shut down in 2009, it was difficult to find participants that were prepared to provide the necessary information. Nevertheless, a large amount of company documents and archival records have been made available. It was also possible to have series of multiple in-person interviews with the Lean coordinator for Buinen at that time. Therefore, the analysis of Case IV will be mainly based on the documents, supported by the collected information during these interviews.

In Appendix VII, all participants that provided the necessary information concerning the Lean initiatives at the selected cases have been listed[66].

4.3.2 Data Collection and Analysis

4.3.2.1 Agency Theory and Organizational Architecture

The agency theory is based on the assumption of economic rational persons who are driven by self-interest and want to maximize their own utility (Williamson, 1985). According to Williamson (1985), the opportunistic nature of people can even result in dysfunctional behavior in order to serve self-interest. Firms are formed by different groups of individuals and goal incongruence is caused when agents (e.g. management) have different goals than principals (e.g. shareholders), as both parties want to maximize their own utility. This goal incongruence between agents and principals can cause for firm value to decline when agents pursue their own interest at the expense of the principal's, which is referred to as agency costs. According to the agency theory, agency costs arise because of information asymmetries within the firm. Information asymmetries are the result of principals lacking the necessary information for decision making and control (Jensen and Meckling, 1976; Williamson, 1985). Many researchers within MA literature[67], have built on these concepts within the agency theory by assuming that managers are likely to choose for options that maximize their own wealth. Based on the opportunistic perspective, information asymmetry can lead to dysfunctional behavior by management. This can result in decision making by management that is not in the (long term) best interest of the firm. In order to minimize agency costs, an organizational architecture is advanced within MA literature based on the following three elements. These three elements must be in balance and coordinated with each other in order to minimize agency problems (Jensen and Meckling, 1992):

- Performance measurement
- Reward and punishment of performance
- Decision-rights assignment

Performance measurement within this context comprises both the MC and MA practices within a firm. The literature treats the firm's MA practice as being a significant part of the performance measurement system, as financial measures are collected by the MA practice (Jensen and Meckling, 1992; Zimmerman, 2009). Therefore, the two of the three advanced elements together comprises a firms MAS.

In section 4.2.4 of this research, it is explained that the role of MAS during a Lean strategic initiative in assessing the level of organizational performance as well as achieving a certain degree of Lean implementation will be examined. In order to do so, this research will be conducted with the agency theory serving as theoretical

[66] Due to privacy issues, the participants in Appendix VII are listed according to their position within the firm.
[67] Including a large part of the extant literature discussed within section 4.2 of this chapter.

background. This research will analyze if one of the three advanced elements within the organizational architecture is not sufficiently present during Lean strategic implementation, this will lead in the management shirking the effort to support the strategic implementation, as it does not seem contribute to their overall wealth.

4.3.2.2 Survey design

To examine the presence of variables provided in the ex ante framework and to guide the discussion, interview questions were formulated prior to the interviews. The formulated interview questions were pretested by a limited group of academics and managers from firms other than the selected cases. These reviews have resulted in some changes as comments and suggestions were made. The final version of the formulated interview questions are provided in Appendix VIII. The formulated interview questions comprise the underlying items that are formulated in order to assess the presence of variables provided in the ex ante framework. The measured variables were the degree of Lean strategic implementation, the status of MA practice, the status of MC practice and the status of overall success of the Lean implementation. As the underlying items were directly derived from recent empirical MA research, references are also made in Appendix VIII.

An exception however, was some of the formulated items for measuring the overall success from the Lean initiative. Within the extant empirical literature that is used to develop the ex ante framework, the degree of success of implementing a Lean business strategy is derived from the organizational performance being assessed. Within this research however, the overall success of the Lean strategic implementation will be measured based on the level of organizational performance as well as the degree of management support being assessed.

4.4 Conclusion

Despite the widely held assumption that Lean enhances organizational performance, the empirical evidence is decidedly mixed (Fullerton and Mcwatters 2001, 2002; Womack and Jones 2003; Taylor and Wright 2003; Callon, 2005; Becker, 2007; Maskell and Kennedy 2007; Kennedy and Widener 2008; Fullerton and Kennedy 2009). Several studies have suggested that one explanation for these inconclusive results is that benefits from Lean are dependent on complementary changes in the firm's MAS (Green, Amenkhienan and Johnson, 1992; Sprinkle, 2000; Fullerton and McWatters 2002; Baines and Langfield-Smith 2003; Nicolaou 2003; Callen 2005; Kennedy and Widener 2008; Fullerton and Kennedy, 2009). Although empirical studies provide a great amount of evidence for the central role of a MAS in the successful implementation of a Lean business strategy, the MAS practice shows to be reluctant to change (Green et al., 1992; Johnson, 1992; Ittner and Larcker, 1998; Fullerton and McWatters 2002, 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009). Researchers state that the traditional MAS, which is currently prevalent within Lean environments, fails to capture the benefits and even counteracts the successful implementation of the Lean business strategy (Kennedy and Brewer, 2006; Maskell and Baggaley, 2004; 2006; Maskell and Kennedy, 2007; Kennedy and Fullerton, 2009). Based on the previous empirical findings of MA research, the ex ante framework that is expected to be found is illustrated. According to this ex ante framework, a unidirectional relationship between a Lean strategic initiative, MA practice, MC system and organizational performance is expected to be found (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003; Callen 2005; Kennedy and Widener 2008). The research is conducted by analyzing four different cases of firms that have started a Lean strategic initiative. In order to do so, in-person interviews are supplemented with additional company documents and archival records, observations of the location and

processes and telephone interviews. With the collected information, the presence of the following variables is examined: the degree of Lean strategic implementation, the status of MA practice, the status of MC practice and the status of overall success of the Lean strategic implementation. The overall success of the Lean strategic implementation will be measured based on the level of organizational performance as well as the degree of management support being assessed.

5. Results

5.1 Introduction

In this chapter an analysis is made of the status of the Lean strategic implementation, MA and MC practice, organizational performance and overall management support subsequent to the Lean initiatives within the selected cases. The results are described in the following sections. Also, a conclusion is provided for each case, whereby the chapter is completed with an overall conclusion based on input from all four cases. Based on the overall findings an ex post framework is developed and the evidence both consistent and inconsistent with the ex ante model is presented.

5.2 Case I

Case I began its first Lean strategic initiative in 2008 within the Netherlands. After conducting a quick scan, with the use of VSM, the variation and maturity of front office processes and a selected number of back office processes[68] within the firm were assessed; the findings were presented to the management team of Benelux. Based on these findings, the firms started its Lean initiative by focusing on the following:

- Pilot bottle operations: Implementing Lean from customer orders till the delivery of the full bottle of gas to the depot keeper. The Lean initiative therefore focused on the production and transportation process of a full bottle and not at the back office activities.
- Creating an organization-wide CI culture and structure.

After the pilot in 2008, the firm continued to implement Lean throughout several front office processes (such as the container related processes[69] and after sales) as well as back office processes (such as the accounts receivable process) in the Netherlands. Within this research, the total implementation in the Netherlands will be denoted as the 'first initiative'.

In 2010, the firm started implementing Lean within its Belgium division by focusing on the following three pillars:

- Creating an organization-wide CI culture and structure
- Implementing Lean at the after sales processes
- Implementing Lean at bottle operations: from customer order till the delivery of the full bottle of gas to the depot keeper.

The Lean implementation in Belgium will be denoted as the 'second initiative' in this research[70].

[68] Back office processes included in the quick scan were accounts receivable, accounts payable and wages. However, in the final presentation of the quick scan, remarks are only based on the accounts payables process.

[69] The Lean implementation at the container related processes however, was more limited than at the bottle related processes. In the next paragraph, the status of the Lean implementation within both processes is illuminated.

[70] Since both initiatives are still ongoing, the results for Case I in this chapter will show the status of the Lean implementation, MA and MC practice, and overall success of the Lean implementation at the moment the research was conducted, which was until April 2011.

5.2.1 Lean Strategic Implementation

5.2.1.1 Overview Implemented Lean Tools

At both Lean initiatives, some of the Lean tools are implemented more extensively within the firm than only the production and transportation processes for bottles and include office processes such as the after sales process as well. The Lean strategic tools subsequent to both initiatives are depicted in table 5.1[71].

Table 5.1 – Status of Lean Strategic Implementation at Case I

Case I			Initiative I		Initiative II	
			Produc-tion	Office	Produc-tion	Office
Lean Strategy	**Implementation Scope***	Lean implementation at production processes and/or office processes	X	X	X	X
	Customer Value*	Assess customer value				
		Customize products and services to customer needs				
		Integrated customers network				
	Pull*	Customer takt time	X			
		Produce to customer order	X			
		Kanban system to initiate production (steps)	X			
		Training about JIT	X	X	X	X
	Flow*	Organization in manufacturing/value stream cells	X		X	
		Level scheduling				
		Single-piece-flow				
	Employee Training and Empowerment*	Empowered employees that are responsible for entire process and output				
		Work-floor workers that participate in decisions that affect the quality of the product/service	X			
		Employee training on different tasks	X	X	X	X
		Self directed work teams				
	Continuous Improvement*	Program(s) to improve product quality				
		Program(s) to improve process quality	X	X	X	X
		On time delivery	X	X	X	X
		People (workers and management) that are committed to quality training				
		Preventive maintenance programs				
		TQM (PDCA-cyclus) to resolve quality issues	X	X	X	X
		Six-sigma (DMAIC-cyclus) to resolve quality issues	X			
	Supplier Cooperation*	JIT- purchasing				
		Integrated suppliers network				

5.2.1.2 Maturity Lean Strategic Implementation

Although the firm surpassed the pilot stage during the first initiative in 2008 by implementing Lean more extensively within the firm than only on the production process of bottles, the overall maturity of the Lean tools implemented indicate that the firm is still in the early stage of Lean implementation. Analysis of the implemented Lean tools furthermore indicates that subsequent to both initiatives, the implementation of a kanban system to enhance pull is currently the most mature within the production process of bottles in the Netherlands. The main objective within Case I for implementing the kanban system and customer takt time is to stabilize its production process. Nevertheless, the following indicate that basic stability within the production process has not yet been met:

- The kanban system consists of magnets and every magnet represents one cage of bottles. However, there are four variants of cages, with each cage containing different amounts of bottles. Although the

[71] In Appendix X a legend is provided for reading the tables in chapter 5.

bottles are classified into product families, the production time within one production family can fluctuate per kanban.

- The takt time is determined based on forecasts. In some cases, bottles of gas are sold to the end customers by the large dealers. However, due to the fluctuating nature of these customer orders, these orders are not fully included in the takt time.
- The takt time is based on orders from large and small dealer stores. These stores however, place their orders in large batches which influences the variation within the takt time.
- There is no standard procedure for adjusting the takt time. Currently, the takt time is adjusted regularly, but the goal is to adjust the takt time as minimal as possible to keep the production stable.
- The kanban system comprises the types of bottles that need to be produced on a daily basis. There are also types of bottles that need to be produced less regularly, due to a lower demand. For these types, there is no kanban signal to initiate the production. Often, these bottles are produced in between jobs or during lunch breaks and overtime to avoid any disruption in the regular production process.
- The kanban system is currently not in use within the bottle production process in Belgium nor within the container processes.

Within office processes, the daily workload is visually managed. However, the system is not a kanban system, since the main purpose of the system is to divide batch processing of activities among different employees[72].

Besides the efforts to introduce pull, some steps are taken in implementing flow, employee training and empowerment, and CI. Although the level of implementation is similar for both of the initiatives, these Lean tools are less present within the firm. Both of the production halls for bottles in the Netherlands and Belgium are organized into a production cell, whereby the processes of sorting out and filling are brought together to minimize inventory and improve flow. However, a large part of the front office processes and back office processes are still organized vertically with functional responsibility centers. CI efforts mainly focus on improving process quality, such as an improved on-time delivery. Nevertheless, incorporating a CI culture and structure based on the use of a PDCA-cyclus within the daily operations is still in an early stage of development and remains a focus point for 2011. There is also some attention for improving all-roundness of employees, by offering job instructions and training on the job. However, employee empowerment is limited since decision management often takes place at the management level. Despite of the efforts being made, Lean tools for specifying customer value and cooperating with suppliers are currently not present within the firm.

5.2.2 Lean Accounting – Management Control Practice

5.2.2.1 Overview Management Control Practice

Although the first initiative started in 2008, measurable key performance indicators (KPI's) were not formulated from the beginning. The main reasons for the lack of performance measurement in the beginning were the absence of data within systems and the absence of an organization-wide strategic structure. Towards the end of 2009, the first efforts were made to specify and quantify KPI's. Currently, KPI's at the division and department level are formulated on a yearly basis by the management, based on the following four pillars:

- On-time Delivery

[72] A kanban instead, is a signal coming from a downstream activity, whereby the work is pulled by the upstream activity. In this case, it is the other way around, because the work is initiated by activities higher in the value stream.

- Motivation
- Quality
- Profitability

These KPI's are currently measured with the use of underlying performance measures, also formulated by the management. Based on these performance measures, the status of the KPI's is visualized and periodically updated on a so called 'Dashboard', which is an A3-format, placed within the main hall. The performance measures currently in use within Case I are summarized within table 5.2[73]. The reward system subsequent to both initiatives is also depicted in table 5.2.

Table 5.2 – Status of MC practice within Case I

Case I				**Initiative I**		**Initiative II**	
				Produc-tion	**Office**	**Produc-tion**	**Office**
Lean Accounting - Management Control	**Performance Measurement****	**Waste**	Product defects				
			Process defects	X	X	X	X
			Rework				
			Downtime	X		XX	
		Quality	Product/service quality				
			First-time-through (FTT)				
			Customer satisfaction				
			Employee satisfaction				
			Employee education/training				
			Improvement ideas	XX	XX	XX	XX
			Business consequences of improvement(s)				
			On-time delivery	XX	XX		XX
		Operational Performance	Productivity	XX	XX	XX	XX
			Operational equipment effectiveness (OEE)				
			Throughput time				
			Cycle time compared to customer takt time (day-by-the-hour)				
			WIP compared to SWIP	XX			
			Amount of time from material receipt to delivery of the finished product (dock-to-dock)				
			Inventory turns				
			Capacity (non-productive, available)				
	Supplier Performance*		On-time delivery				
			Product quality				
	Reward System*		Reward based on non-financial measures	X	X	X	X
			Reward based on team performance				
			Reward based on process/product quality				

5.2.2.2 Status Management Control Practice

Analysis of the use of performance measures indicates that productivity, on-time delivery and the number submitted and completed improvement ideas are measured frequently and visualized on a dashboard at the work floor. On-time delivery and WIP-to-SWIP however, is not measured anymore in Belgium, since the Manager Operations refused to implement the introduced kanban system. Although some other forms of performance measurements are present within case I, analysis of the use of these measurements results in the following findings:

- The current MC practice shows different ways of measuring quality within case I. Subsequent to both of the initiatives, the number of errors is used to indicate the quality of the office processes, such as the after sales and account receivables processes. Within the production process of bottles, downtime is used to measure quality. Although, errors within the production process of bottles are also measured in

[73] In Appendix X a legend is provided for reading the tables in chapter 5.

the Netherlands and Belgium, this is not done as frequent as downtime. Moreover, except for downtime measurement in Belgium, neither of the process defects nor downtime measurements is made visible on the work floor.

- Errors within after sales are measured by the amount of incoming credit accounts and errors detected by the employees. The detected errors are collected in a red bucket on the work floor, but are not measured or visualized on a dashboard. There is also no standard procedure for the detection, measurement and periodic feedback on the errors made.

  Since within after sales the measurement of errors is based on the credit accounts and submitted errors, this comprises a part of the actual errors made[74].
- Performance measures are interpreted differently within departments, resulting in different ways of calculating the same performance measurement.
- Case I still struggles with the validity of data, due to the use of different systems and the lack of interfaces. This influences the quality of the performance measurements.
- The current MC practice contains several measures that are task related. For example, to indicate the status of employee motivation, the amount of submitted and completed improvement ideas is measured. How these improvements ideas are completed or the results from the implemented ideas are not measured, or made visual.
- Moreover, WIP-to-SWIP is not measured at all within office processes. Tasks to be completed are made visible within the after sales and accounts receivables department with the use of buckets that contain these tasks. However, the workload is not measured or visualized on a dashboard at the office departments.

Although there is a need for including more performance measures that support the Lean initiatives, currently many of these measures are not (or incidentally) measured within the firm. In some cases this has had a negative impact on the progresses being made. For example, the firm has an urgent need to, but struggles in measuring the number of bottles in circulation and the turnover rate of bottles. A reason for this problem is that many of the bottles do not return back to the firm after being used by the customer, or are returned to a different gas supplier. Also, the stock of empty bottles is not measured or visualized and needs to be assessed separately by the gatekeepers. This has the following consequences:

- Often during production, when a shortage in bottles of product type A is noticed, bottles of product type B are filled beforehand to cover the shortages. This causes disruptions in the visual management of inventories and the production process, and production and inventory measurements to be biased, which in the past has led to a failure to deliver on-time. These effects prevented the further development of the kanban system within the production process of bottles.
- Continuous investment is needed in empty bottles, which is a costly operation.
- The firm has no knowledge in the actual numbers of bottles consumed by the end customer.

Analysis of the current reward system indicates that, the pecuniary reward system for the management is in some cases based on non-financial measures that are directly related to the performance measures currently in use on the work floor or to the formulated KPI's. However, not all the non-financial measures in use to reward

[74] Several interviewees estimated that currently approximately 15% of the actual errors made are currently measured.

management performance are directly related to the formulated KPI's. Team performances or process quality improvements are not leading within the current reward system. Employees are evaluated based on individual task related performances, which do not have to be related to the KPI's. When rewarded, this is non-pecuniary and dependent on the evaluating manager.

5.2.3 Lean Accounting – Management Accounting Practice

5.2.3.1 Overview Management Accounting Practice

In table 5.3 an overview of the current MA practices currently in use within Case I is given[75].

Table 5.3 – Status of MA practice within Case I

Case I			Initiative I	Initiative II
Lean Accounting -Management Accounting Practices	Traditional MAP*	Overhead cost allocation	X	X
		Standard costing	X	X
		Use of absorption costing to value inventory	X	X
		Budgeting and variance analysis in performance evaluation and compensation	X	X
		Bill of materials, work orders and MRP system for inventory tracking and schedule production	X	X
		Detailed tracking of inventories and labor	X	X
		Responsibility reporting based on departmental structure	X	X
	Eliminate Waste in MAS*	Backflushing of costs		
		Value stream costing		
		Target costing /Kaizen costing		
		Kanban and visual management to replace MRP	X	X
		Value stream mapping	X	X

5.2.3.2 Status Management Accounting Practice

The current MA practice shows that what researchers often refer to as the traditional accounting system is still the predominant system in use by Case I[76]. Overhead cost allocation and SC are part of the firm's budgeting system and are set using historical data on passed performance. With the use of absorption costing, the costs are allocated to each specific type of bottle.

The monthly management reports are based on financial performance measures, such as revenue, cost and profit. In the previous section, it is explained that performances within the different levels at Case I are related to four KPI's, one of which is profitability. Moreover, the system in use to reward management performance includes one component that is based on financial measures, such as profit. The financial measures used in the management reports, to evaluate the profitability KPI as well as to reward management performances are all derived from the same MA system. Based on a variance analysis, the actual performances are evaluated on a monthly basis. Therefore, the financial performance measures derived from the MA system are used to support decision making within the management as well as to evaluate and reward management performance. Currently, non-financial measures discussed in the previous sections are not included in the monthly management reports. Although some efforts were made to initiate this process within the Netherlands, up until now, no steps have been taken to streamline the accounting processes. The MRP system is still leading for the transport schedule and the daily production schedule for bottles. Nevertheless, steps are taken to reduce production scheduling of bottles based on MRP, by monitoring and adjusting the daily production schedule with the use of kanbans.

[75] In Appendix X a legend is provided for reading the tables in chapter 5.
[76] In Appendix VI the MA practice that is referred to as the traditional accounting system is described in detail.

During both initiatives, the current and future state of VSMs are drawn from the processes that are included. When doing so, the departmental structure within the firm was leading.

5.2.4 Overall Success Lean Implementation

5.2.4.1 Overview Financial Performance and Management Support

In table 5.4 the change in financial performance subsequent to both Lean initiatives is summarized[77]. Also an overview is given of the status of (top) management involvement in implementing Lean.

Table 5.4 – Overall Success Lean Implementation at Case I

Case I			**Initiative I**		**Initiative II**	
			Produc-tion	**Office**	**Produc-tion**	**Office**
Overall Success Lean	**Financial Performance*** **	Increased Net Sales during Lean implementation				
		Increased Return on Sales during Lean Implementation				
		Increased Market Share / Customer orders Lean implementation				
		Increased Profit during Lean Implementation				
		Decreased Raw Materials, WIP, Finished goods balance during Lean Implementation	X		X	
	(Top) Management Involvement** **	(Top) management involvement in coaching employees				
		(Top) management involvement in initiating change programs				
		(Top) management involvement in implementing Lean strategy	X	X		X
		(Top) management involvement in continuing Lean implementation	X	X		X
		(Top) management involvement in continuing business	XX	XX	XX	XX

5.2.4.2 Status Overall Success Lean Implementation

Top management has expressed the need to assess the financial benefits leading from the Lean initiatives. Up until now, some improvements within the operational performance were visible concerning productivity and the amount of inventories. Although efforts are made to translate the operational benefits in to financial benefits, the firm still struggles in indicating the financial benefits leading from the Lean initiatives.

The firm and also the transition is led top-down, whereby decision management and control takes place at the management level. This causes the success of the Lean initiatives to be highly dependent on management support. Within the current organizational structure, there is less room for coaching employees in realizing daily improvements within operations. Since the beginning of the first initiative in 2008, the overall decrease in management support was moderate. However, (top) management is still in support of continuing the initiatives. Especially, the value stream manager is highly involved in monitoring and coordinating the initiatives.

5.2.5 Conclusions Case I

Since the start in 2008, the implementation of Lean tools has been more widespread within the firm than only the production process. Nevertheless, the maturity of the implemented Lean tools indicates that the firm is still in the early stage of Lean implementation. Although kanbans and customer takt time are used within the production process of bottles, the concepts of pull and basic stability have not yet been met. During the second initiative, the firm failed to implement kanban due to resistance from the manager operations. Since 2008, creating a CI culture and structure has also remained as an important focus point within both Lean initiatives. Nevertheless, a CI culture and structure with the use of a PDCA-cyclus have still not been embedded within the daily operations.

[77] In Appendix X a legend is provided for reading the tables in chapter 5.

Creating operational stability and a CI culture and structure remain as the focus for 2011. Despite of the efforts to introduce flow, employee training and empowerment, processes have still been organized within functional departments and employee empowerment has been limited.

Towards the end of 2009, KPI's were formulated by the management to evaluate the Lean progresses being made. Analysis of the underlying performance measures show that only two of the four KPI's are measured frequently and visualized on the work floor. The current MC practice also shows different ways for measuring quality, whereby a standard procedure for measurement and periodic feedback is missing. Due to the lack of system interfaces and procedures on how to interpreter and measure performances, Case I also struggles with the validity and comparability of measured performances. Findings furthermore state that many of the performance measures that support the Lean initiatives are not (or incidentally) measured within the firm. In some cases this has had a negative impact on the progresses being made.

The profitability KPI is measured on the finance department and directly derived from the MA system. Management performance is evaluated and rewarded based on non-financial as well as financial measures. The non-financial measures are is some cases related to the formulated KPI's. Performance measures that underlie the non-financial KPI's however, are not included in the monthly management reports. The financial measures used in the management reports, to evaluate the profitability KPI and to reward management performance are all derived from the MA system. Analysis of the MA practice shows that the traditional accounting system is in use by Case I. Currently, no steps are taken to streamline the accounting processes. (Top) management has expressed the need to assess the financial benefits leading from the Lean initiatives, but the firm struggles in making financial benefits visible. Although management support is slightly decreasing, overall management is still supportive of continuing the Lean initiatives.

5.3 Case II

Case II began its first Lean initiative in 2004 at the Collections and Credit Management (CCM) department in the Netherlands. The firm struggled with the collection of outstanding receivables. After a proposal for a re-design of the process that was submitted to the manager CCM, the firms started focusing on implementing Lean within a pilot cell at one of the CCM locations. In order to do so, 100,000 clients were selected at randomly from the total client base and FTE's were selected in the same relative proportion of the total. CCM employees were selected from both of the CCM locations to join the pilot team. After a period of three months the first improvement was presented to the top management, which leads to the decision to implement Lean throughout the entire CCM organization as soon as possible. Eventually, Lean was implemented at six teams within CCM. Within this research, the total implementation within the six CCM teams will be denoted as the 'first initiative'.

Despite of the improvement efforts, the amount of outstanding receivables longer than 60 days continued to grow significantly. In August 2007, the firm started a second initiative within the CCM department that focused on reducing this amount of outstanding receivables. In order to do so, 175,000 clients with an outstanding amount longer than 60 days were selected and separated from the regular operations and brought in under a

project. The project was largely outsourced to third parties and located on a different location[78]. The project was completed in June 2008[79]. Within this research, this project will be denoted as the 'second initiative'.

5.3.1 Lean Strategic Implementation

5.3.1.1 Overview Implemented Lean Tools

During both initiatives, Lean changes were implemented at the office. The Lean changes subsequent to both initiatives are depicted in table 5.5[80].

Table 5.5 - Status of Lean Strategic Implementation at Case II

Case II			Initiative I		Initiative II	
			Produc-tion	Office	Produc-tion	Office
Lean Strategy	**Implementation Scope***	Lean implementation at production processes and/or office processes		X		X
	Customer Value*	Asses customer value				
		Customize products and services to customer needs				
		Integrated customers network				
	Pull*	Customer takt time		X		
		Produce to customer order				
		Kanban system to initiate production (steps)		X		
		Training about JIT		X		
	Flow*	Organization in manufacturing/value stream cells		X		
		Level scheduling				
		Single-piece-flow				
	Employee Training and Empowerment*	Empowered employees that are responsible for entire process and output		X		
		Work-floor workers that participate in decisions that affect the quality of the product/service				
		Employee training on different tasks		X		
		Self directed work teams		X		
	Continuous Improvement*	Program(s) to improve product quality				
		Program(s) to improve process quality		X		
		On time delivery				
		People (workers and management) that are committed to quality training				
		Preventive maintenance programs				
		TQM (PDCA-cyclus) to resolve quality issues				
		Six-sigma (DMAIC-cyclus) to resolve quality issues				X
	Supplier Cooperation*	JIT- purchasing				
		Integrated suppliers network				

5.3.1.2 Maturity Lean Strategic Implementation

Although the firm surpassed the pilot stage in 2004 and started implementing Lean throughout CCM, the overall maturity of the Lean tools implemented during the first initiative indicate that the department was still in the early beginning of Lean implementation.

Efforts were made to cross train people, by offering them training on the job. People within CCM were also trained according to basic Lean principles. Decision management however, often took place by the team leader and external project manager within the daily operations, or by the management. The activities within the pilot,

[78]Other than where the CCM departments were located.
[79] Officially, the first initiative was still ongoing. But the second initiative became leading in the work environment to such a degree, that the start of the second initiative will be denoted as the completion of the first initiative. Therefore, this section shows the status of the lean environment subsequent to the first initiative as was present in august 2007.
[80] In Appendix X a legend is provided for reading the tables in chapter 5.

and later on the other teams within CCM, were organized according to process sequence. The rest of the processes within CCM and the firm were still organized vertically with functional responsibility centers.

With the use of kanban-cards and schedule boards, the activities to be completed are visualized on the work floor. With the system a basis was set for introducing pull, since within the process itself, upstream activities in the process were pulled by the employee when all downstream activities were completed[81]. However, batch processing of activities still took place within the system. Although periodic gathering moments were introduced to evaluate the process, a CI structure was missing in order to use submitted improvement ideas effectively. Lean tools for specifying customer value and cooperating with suppliers were not present.

It is noticeable that during the second initiative an opposite movement within Lean development has been effected. Analysis of the Lean tools subsequent to the second initiative shows that neither of the Lean tools implemented during the first initiative were present. The project-team was functionally organized into eight teams, whereby each team was responsible for a specific task. Tasks were assigned to the employees by the team leader and pushed downstream the process after completion.

5.3.2 Lean Accounting – Management Control Practice

5.3.2.1 Overview Management Control Practice

In the beginning, the main focus within the first initiative was set on reducing the days of outstanding receivables[82] and preventing it to exceed the 60 days. Except for the amount of outstanding receivables that were collected within 60 days, no other performance was measured to evaluate the progresses being made. Also, no measurable objectives were formulated during the first initiative.

As a reaction to the large amount of receivables outstanding for longer than 60 days, the firm started the second initiative. The following project related KPI's were formulated, measured and periodically reported to the management:

- Amount accounts receivables (> 60 days)
- Number of collected accounts
- Quality
- Customer satisfaction
- Customer dissatisfaction
- Budget

The performance measurements in use within Case II are presented in table 5.6[83].

[81] In practice, the system failed to introduce kanban and pull effectively during the first initiative. This problem will be elaborated on in the next section.
[82] Also referred to as days sales outstanding
[83] In Appendix X a legend is provided for reading the tables in chapter 5.

Table 5.6 – Status of MC Practice within Case II

Case II				Initiative I	Initiative II
Lean Accounting - Management Control	Performance Measurement**	Waste	Product defects		
			Process defects		
			Rework		
			Downtime		
		Quality	Product/service quality		XX
			First-time-through (FTT)		
			Customer satisfaction		X
			Employee satisfaction		
			Employee education/training		
			Improvement ideas	X	
			Business consequences of improvement(s)		X
			On-time delivery		
		Operational Performance	Productivity		XX
			Operational equipment effectiveness (OEE)		
			Throughput time		X
			Cycle time compared to customer takt time (day-by-the-hour)		
			WIP compared to SWIP		XX
			Amount of time from material receipt to delivery of the finished product (dock-to-dock)		
			Inventory turns		
			Capacity (non-productive, available)		
	Supplier Performance*		On-time delivery		
			Product quality		
	Reward System*		Reward based on non-financial measures		
			Reward based on team performance		
			Reward based on process/product quality		

5.3.2.2 Status Management Control Practice

During the first initiative, except for the number of submitted improvement ideas, no performances were measured on the work floor. Analysis shows the following negative effects of the lack of performance measures on the progresses being made during the first initiative:

1. The main objective of the schedule boards containing the kanbans was to visualize the workload and introduce pull. However, the workload on the schedule boards was not measured and updated by the system in use, although activities were performed and logged within the system. Therefore, the boards became unable to visualize the actual workload and effectively regulate pull, which caused disruptions within the daily operations:
    - The schedule board could contain kanbans for one activity, which turned out to have been already finished at another activity, when this was checked in the system. For example, when an employee noticed that a client had become bankrupt, the kanban-card was removed from the board. However, the other kanbans from the same client were not removed, leading to unnecessary work done by another employee. The visual boards therefore, created a lot of rework.
    - The visual boards gave no insight in the status of clients, the performed activities or the process.
    - Validity of the kanbans on the board could not be assessed.
    - Because of the lack of control, employees could choose not to perform an activity.
    - The lack of control led to a lack of responsibility by team leaders as well as employees.
2. The decision made by the management to implement Lean throughout the entire CCM organization was based on a short term increase in the percentage of accounts receivables collected within 60 days. Due to the lack of additional performance measures, the process is implemented at other teams before being stabilized.

3. There was no focus on the outstanding receivables that could not be collected within 60 days. While implementing Lean throughout CCM, the group of receivables outstanding longer than 60 days continued to grow significantly.

Besides focusing on reducing the amount of receivables outstanding longer than 60 days, the second initiative focused on implementing and visualizing performance measurements on the work floor to support the changes in the work environment. The KPI's were measured and visualized on the work floor with the use of the so-called 'bakplaat' and 'PEK-model'. With the 'bakplaat', the workload, productivity, process flow and accounts receivable balance was measured per work team and frequently visualized on an A3-format within the department. With the 'PEK-model', the following performances were measured and visualized:

- Productivity, measured with the number of treated clients.
- Effectiveness, measured with the collected amounts.
- Quality, measured by monitoring the quality of the client conversations.

Although productivity and effectiveness were measured weekly, quality was measured less frequently since the project struggled with its level of subjectivity. Analysis of the reward system shows that during both initiatives, non-financial measures were not coupled to the pecuniary reward system in use by the firm.

5.3.3 Lean Accounting – Management Accounting Practice

5.3.3.1 Overview Management Accounting Practice

In table 5.7 an overview is given of the MA practice in use within Case II[84].

Table 5.7 – Status MA Practice within Case II

Case II			Initiative I	Initiative II
Lean Accounting - Management Accounting Practices	Traditional MAP*	Overhead cost allocation	X	X
		Standard costing	X	X
		Use of absorption costing to value inventory		
		Budgeting and variance analysis in performance evaluation and compensation	X	X
		Bill of materials, work orders and MRP system for inventory tracking and schedule production	X	X
		Detailed tracking of inventories and labor	X	X
		Responsibility reporting based on departmental structure	X	X
	Eliminate Waste in MAS*	Backflushing of costs		
		Value stream costing		
		Target costing /Kaizen costing		
		Kanban and visual management to replace MRP		
		Value stream mapping	X	

5.3.3.2 Status Management Accounting Practice

The MA practice shows that overhead cost allocation and SC are part of the firm's budgeting system and are set using historical data on past performance. Based on a variance analysis, the actual performances are evaluated periodically.

The amount of accounts receivables, which is a returning objective within both initiatives, is derived from the MA system. The evaluation and pecuniary reward system for the management within CCM is based on financial measures, of which the amount of accounts receivable is one as well. The amount of accounts receivable is also part of the financial measures used in the monthly management reports. Therefore, the amount of accounts

[84] In Appendix X a legend is provided for reading the tables in chapter 5.

receivable is used to support decision making within the management as well as to evaluate and reward management performance.

Although during the first initiative, the current and future state of VSM were drawn for the process, this was not updated or in use during the second initiative. Up until now, no steps have been taken to streamline the accounting processes.

5.3.4 Overall Success Lean Implementation

5.3.4.1 Overview Financial Performance and Management Support

In table 5.8 the change in financial performance subsequent to both Lean initiatives is summarized[85]. Also an overview is given of the status of (top) management involvement in implementing Lean.

Table 5.8 – Overall Success Lean Implementation at Case II

Case II			Initiative I	Initiative II
Overall Succes Lean	Financial Performance***	Increased Net Sales during Lean implementation		
		Increased Return on Sales during Lean Implementation		
		Increased Market Share / Customer orders Lean implementation		
		Increased Profit during Lean Implementation		
		Decreased Raw Materials, WIP, Finished goods balance during Lean Implementation		
	(Top) Management Involvement****	(Top) management involvement in coaching employees	X	
		(Top) management involvement in initiating change programs	XX	
		(Top) management involvement in implementing Lean strategy	XX	
		(Top) management involvement in continuing Lean implementation	XX	
		(Top) management involvement in continuing business	XX	XX

5.3.4.2 Status Overall Success Lean Implementation

Due to the second initiative, the amount of accounts receivables longer than 60 days has decreased. This has also resulted in lower allowance needed for receivables, which had a positive effect on the profit. However, this is not made visible within the financial reports since the realized space is used for other purposes.

Although the management, especially the manager CCM, started out very enthusiastic, management support in Lean decreased as the management could not notice any improvements in the performances, especially in the amount of collected accounts receivables. During the second initiative, the management support in continuing the Lean implementation decreased substantially within the project, CCM, as well as in the rest of the organization[86].

5.3.5 Conclusions Case II

Since the pilot in 2004, Case II started implementing Lean at several teams within CCM. The overall maturity of the Lean tools implemented during the first initiative indicates that the department was in the early beginningof Lean implementation. Efforts were made to install a kanban system to visualize the work load. Although batch processing still took place, a basis for pull was set as upstream activities were pulled by the employee after finishing downstream activities. Activities were also organized within process sequence and periodical evaluation moments on the work floor were introduced. However, the processes were still organized within functional departments and the firm struggled with using improvement ideas effectively. Despite of the efforts to

[85] In Appendix X a legend is provided for reading the tables in chapter 5.
[86] Another Lean initiative in development failed due to a lack of (top) management support.

train and empower employees, decision making rights by the employees were limited. During the first initiative, performance measurement was focused on the amount of outstanding receivables collected within 60 days. The lack of additional performance measures caused for the kanban system to be unable to accurately visualize the workload and regulate pull, which caused for the process to be unstable. Moreover, decision making based on the collected receivables within 60 days led to the implementation of the process throughout CCM before being stabilized, which has resulted in the significant growth of outstanding receivables longer than 60 days.

Due to the problem with this growing amount of receivables, management support in implementing Lean decreased substantially and this led to the start of the second initiative. During the second initiative, an opposite movement within Lean development has been effected; after completion, neither of the Lean tools that were implemented during the first initiative was present. During the second initiative also project related KPI's were formulated and underlying performance measurements were visualized on the work floor with the use of the 'bakplaat' and 'PEK-model'. However, the formulated KPI's and performance measures were not included in the management reports or related to the pecuniary reward system in use by the firm. An exception was the amount of accounts receivables, which was a returning measure within both initiatives and used to evaluate and reward management performance. Due to the decrease in the amount of outstanding receivables longer than 60 days, the second initiative is considered to be a success by the (top) management.

5.4 Case III

Case III started its Sales 2.0 improvement initiative in 2009 within the sales and after sales processes of one of its customer segments. The firm struggled with the timeliness and accuracy of invoicing and customer service.

After a proposal was submitted to the management, containing an overall scan of the processes and identification of bottlenecks, an implementation report was composed, containing the objectives, improvement schedule and expected results. The Sales 2.0 program officially started when the implementation report was submitted to the management. The implementation report divided the program in to two phases, whereby the first phase would focus on the description and implementation of standardized work to stabilize the processes and the second phase would focus on the CI of the implemented processes. According to the implementation report, the program would have ended at the end of 2009. However, due to resistance from the management team as well as team leaders, the actual program schedule was as follows:

- Phase I: Description of standardized work, including job instructions and process mapping
- Phase II: Implementation of standardized work

The Sales 2.0 program was finished in August 2010.

During the first phase of the Sales 2.0 program, a complementary initiative is started, which was referred to as 'Resultaatgericht-werken'. The main focus within this program was on creating a CI culture within the management. The initiative ended in June 2010. Within this research, both of the initiatives within Case III will be denoted as the Sales 2.0 program and will be the subject of research for Case III[87].

[87] Remarkable facts within the Resultaatgericht Werken initiative will be discussed separately though.

5.4.1 Lean Strategic Implementation

5.4.1.1 Overview Implemented Lean Tools

Within the Sales 2.0 program, changes were implemented within the office environment. In table 5.9, an overview is given of the Lean tools implemented during the Sales 2.0 program[88].

Table 5.9 – Status of Lean Strategic Implementation at Case III

Case III			Initiative I	
			Produc-tion	Office
Lean Strategy	**Implementation Scope***	Lean implementation at production processes and/or office processes		X
	Customer Value*	Asses customer value		
		Customize products and services to customer needs		
		Integrated customers network		
	Pull*	Customer takt time		
		Produce to customer order		
		Kanban system to initiate production (steps)		
		Training about JIT		
	Flow*	Organization in manufacturing/value stream cells		
		Level scheduling		
		Single-piece-flow		
	Employee Training and Empowerment*	Empowered employees that are responsible for entire process and output		
		Work-floor workers that participate in decisions that affect the quality of the product/service		X
		Employee training on different tasks		
		Self directed work teams		
	Continuous Improvement*	Program(s) to improve product quality		
		Program(s) to improve process quality		X
		On time delivery		X
		People (workers and management) that are committed to quality training		X
		Preventive maintenance programs		
		TQM (PDCA-cyclus) to resolve quality issues		
		Six-sigma (DMAIC-cyclus) to resolve quality issues		X
	Supplier Cooperation*	JIT- purchasing		
		Integrated suppliers network		

5.4.1.2 Maturity Lean Strategic Implementation

The overall maturity of the Lean tools implemented indicates that when the Sales 2.0 program was finished, the firm was still in the early beginning of Lean implementation. Analysis furthermore shows that the implementation of Lean tools was mainly focused on realizing improvements within the processes. At both phases, project teams consisted of work floor employees and a team leader[89]. During the program, processes within sales and after sales were mapped and re-designed based on process improvements. Efforts were mainly focused on improving process quality, such as the ability to deliver the service on-time. However, the improvements were based on the organization's own perception of quality, which did not include any input from the customer. Towards the end of the program, the DMAIC-cyclus became the basic method to support the improvement efforts. Although employees could make contributions to the re-design of the process, decision management and control still took place within the management. Moreover, managers and team leaders struggled with the empowerment of their employees and were used to the top-down assigning of tasks.

[88] In Appendix X a legend is provided for reading the tables in chapter 5.
[89] While during the first phase the project teams were led by external team leaders, during the second phase the project teams were led by team leaders from the internal organization.

Efforts were also made to train people within the organization according to Lean principles and Six-sigma techniques. However, this was limited to the training of senior-employees and the management. Other Lean tools were not present within Case III subsequent to the improvement program.

5.4.2 Lean Accounting – Management Control Practice

5.4.2.1 Overview Management Control Practice

Preliminary to the start of the Sales 2.0 program, the following objectives of the program were formulated by the management:

1. 97% of invoices sent on-time
2. 97% of invoices sent correctly
3. Average throughput time of 11 days for answering customer questions
4. Maximum throughput time of 30 days
5. Data collection and import is done correctly

During the Sales 2.0 performance measures were also in use to evaluate the performance of the individual processes. The performance measures in use during the Sales 2.0 program are presented in table 5.10[90].

Table 5.10 – Status of MC Practice within Case III

Case III				**Initiative**
Lean Accounting - Management Control	**Performance Measurement****	**Waste**	Product defects	
			Process defects	
			Rework	
			Downtime	
		Quality	Product/service quality	
			First-time-through (FTT)	
			Customer satisfaction	
			Employee satisfaction	
			Employee education/training	
			Improvement ideas	
			Business consequences of improvement(s)	
			On-time delivery	X
		Operational Performance	Productivity	
			Operational equipment effectiveness (OEE)	
			Throughput time	X
			Cycle time compared to customer takt time (day-by-the-hour)	
			WIP compared to SWIP	
			Amount of time from material receipt to delivery of the finished product (dock-to-dock)	
			Inventory turns	
			Capacity (non-productive, available)	
	Supplier Performance*		On-time delivery	
			Product quality	
	Reward System*		Reward based on non-financial measures	
			Reward based on team performance	
			Reward based on process/product quality	

5.4.2.2 Status Management Control Practice

Analysis of the MC practice shows that the amount of performance measures in use was very limited within Case III. The following KPI's concerning throughput time and on-time delivery are formulated to evaluate the performance of the individual processes

[90] In Appendix X a legend is provided for reading the tables in chapter 5.

- Average throughput time
- % processed within 4 working days
- % not processed after 10 working days

However, the following indicates that Case III struggled with measuring and evaluating performance:

- The KPI's were not measured until week 13 of 2010 for a period of ten weeks. Moreover, only the performances of 10 of the 22 implemented processes were measured[91].
- The norms set were different for the individual processes:
  - The norm for the average throughput time could differ from 1 till 10 working days
  - The norm for the maximum throughput time could differ from 4 till 30 working days

  This made it difficult to compare and consolidate performances of individual processes.
- The overall objectives set for the Sales 2.0 program were not specified and difficult to measure.
  - The objectives were the result of multiple individual processes of which some were not included in the program. The first two objectives for example concerned the quality and timeliness of invoices, while the invoicing processes were not included in the Sales 2.0 program.
  - Although two objectives were related to quality, performance measures to indicate quality were not measurable within the system.

    Eventually, the amount of credit accounts was used to measure the amount of incorrect invoices. However, Case III struggled in tracing these back to the amount of correct invoices sent. Furthermore, on-time import of data is used to measure the quality of the data import.
- Analysis showed different ways for measuring throughput time. For some processes the amount of working days was used, while for others the amount of calendar days was used.
- The individual KPI's formulated for the processes were not related to the overall objectives of the Sales 2.0 program. Management had expressed the need to assess the progresses being made within the Sales 2.0 program. Therefore, efforts were made to consolidate the individual KPI's, in order to relate performances of the individual processes to the overall objectives of Sales 2.0. However, due to the mentioned difficulties, this was not realized at the end of the program.

A so called 'dashboard' was developed, which was an A4-format on which the consolidated KPI's, and individual KPI's were reported. Although the dashboard was accessible for the management, it was not visually displayed at the work floor. Analysis of the reward system of management shows that the formulated non-financial measures were not in use to evaluate and reward management performance.

5.4.3 Lean Accounting – Management Accounting Practice

5.4.3.1 Overview Management Accounting Practice

In table 5.11 the MA practice within Case III is presented[92].

[91] For the 7 processes which were not implemented yet at the end of the program, the performances were also not measured.
[92] In Appendix X a legend is provided for reading the tables in chapter 5.

Table 5.11 – Status MA Practice within Case III

Case III			Initiative
Lean Accounting - Management Accounting Practices	Traditional MAP*	Overhead cost allocation	X
		Standard costing	X
		Use of absorption costing to value inventory	X
		Budgeting and variance analysis in performance evaluation and compensation	X
		Bill of materials, work orders and MRP system for inventory tracking and schedule production	
		Detailed tracking of inventories and labor	X
		Responsibility reporting based on departmental structure	X
	Eliminate Waste in MAS*	Backflushing of costs	
		Value stream costing	
		Target costing/Kaizen costing	
		Kanban and visual management to replace MRP	
		Value stream mapping	X

5.4.3.2 Status Management Accounting Practice

Analysis shows that what often researchers refer to as traditional accounting system was still in use by Case III[93]. Costs were allocated to the customer based on the determined allocation rate per customer segment. Subsequently all costs were allocated to the customers, including the costs of after sales. The financial measures used to evaluate and reward management performance were derived from the MA system and were not related to the Sales 2.0 program[94].

5.4.4 Overall Success Lean Implementation

5.4.4.1 Overview Financial Performance and Management Support

In table 5.12 the change in financial performance subsequent to both Lean initiatives is summarized[95]. Also an overview is given of the status of (top) management involvement in implementing Lean.

Table 5.12 – Overall Success Lean Implementation at Case III

Case III			Initiative
Overall Succes Lean	Financial Performance***	Increased Net Sales during Lean implementation	
		Increased Return on Sales during Lean Implementation	
		Increased Market Share / Customer orders Lean implementation	
		Increased Profit during Lean Implementation	
		Decreased Raw Materials, WIP, Finished goods balance during Lean Implementation	
	(Top) Management Involvement****	(Top) management involvement in coaching employees	
		(Top) management involvement in initiating change programs	
		(Top) management involvement in implementing Lean strategy	
		(Top) management involvement in continuing Lean implementation	
		(Top) management involvement in continuing business	X

5.4.4.2 Status Overall Success Lean Implementation

The program struggled with the lack of management support, which has had negative effects on the progresses being made. The implementation of new processes within after sales especially struggled with the lack of management involvement. Because management performance was not evaluated based on achievements within the program, difficulties were experienced in confronting management with their responsibilities. Although a complementary initiative was started to increase management support within a CI environment, the initiative

[93] In Appendix VI the MA practice that is referred to as the traditional accounting system is described in detail.
[94] Indirectly these financial measurements, such as the days-sales-outstanding, were expected to be affected by the Sales 2.0 program. However, these effects did not translate to the MA reports.
[95] In Appendix X a legend is provided for reading the tables in chapter 5.

ended without any visible results. The Sales 2.0 program is ended before the overall objectives of the program or the consolidated KPI's were measured and realized. In the submitted proposal before the start of Sales 2.0, the relation between the objectives of Sales 2.0 and objectives on the Balanced Score Card indicated that financial measures would improve after completing Sales 2.0. However, financial benefits have not been made visible, while (top) management expressed the need to assess the financial benefits from the initiative. In August 2010 the program has been ended by the management.

5.4.5 Conclusions Case III

The maturity of the Lean tools subsequent to the Sales 2.0 program show that Case III was mainly focused on realizing process improvements within a short amount of time. Although in the meanwhile some Lean tools were implemented, the DMAIC-cyclus became the basic method to support the improvement efforts. Even though employees were involved in the re-design of the processes, decision management and control often took place within the management. Moreover, only senior-employees and management were trained according to Lean and Six-sigma tools.

The MC practice shows that the amount of performance indicators supportive of the Sales 2.0 program was limited. Case III also struggled with measuring and evaluating performances of individual processes as well as the overall progresses made within Sales 2.0. This was because objectives were not inter-related and the formulated performance indicators were difficult to measure within the system. Management performance was evaluated and rewarded based on financial measures, which were derived from the MA system and were not related to the Sales 2.0 program. The MAS in use failed to translate improvement efforts in to visible operational or financial benefits, which has had a negative effect on the degree of management support. Due to insufficient management involvement, the program struggled in making progress. As the program failed to overcome these problems, the management decided to end Sales 2.0 in August 2010.

5.5 Case IV

At the end of 1999 Case IV got ordered by its parent company to double its production at both locations within 5 years, without increasing any floor space. After having been consulted by the Porsche Consulting Group, Case IV started implementing Lean at both of its locations. Although beforehand some improvements were made within the production processes, Case IV began its Lean transition at the end of 2000. At that time, the firm started a series of kaizen workshops. At the production plant in Buinen, 23 workshops have been held within the production processes of boilers, including sub parts, and spare parts. The year 2004 is considered to be the year when Lean in its most mature form is practiced at this location. The Lean initiative at the production plant in Buinen will be the subject of research for case IV.

5.5.1 Lean Strategic Implementation

5.5.1.1 Overview Implemented Lean tools

As illuminated in the previous section, the Lean implementation at Buinen was focused on the production processes. Besides, the production plant in Buinen did not contain any office departments, except for a limited amount of employees employed part-timely from the headquarters in Deventer. However, these services were

not included in the Lean implementation. In table 5.13 below, the Lean tools implemented within the production processes are summarized[96].

Table 5.13 – Status of Lean Strategic Implementation at Case IV

Case IV			Initiative	
			Produc-tion	Office
Lean Strategy	**Implementation Scope***	Lean implementation at production processes and/or office processes	X	
	Customer Value*	Asses customer value		
		Customize products and services to customer needs		
		Integrated customers network		
	Pull*	Customer takt time	X	
		Produce to customer order	X	
		Kanban system to initiate production (steps)	X	
		Training about JIT	X	
	Flow*	Organization in manufacturing/value stream cells	X	
		Level scheduling	X	
		Single-piece-flow	X	
	Employee Training and Empowerment*	Empowered employees that are responsible for entire process and output	X	
		Work-floor workers that participate in decisions that affect the quality of the product/service	X	
		Employee training on different tasks	X	
		Self directed work teams	X	
	Continuous Improvement*	Program(s) to improve product quality	X	
		Program(s) to improve process quality	X	
		On time delivery	X	
		People (workers and management) that are committed to quality training	X	
		Preventive maintenance programs	X	
		TQM (PDCA-cyclus) to resolve quality issues	X	
		Six-sigma (DMAIC-cyclus) to resolve quality issues		
	Supplier Cooperation*	JIT- purchasing	X	
		Integrated suppliers network		

5.5.1.2 Maturity Lean Strategic Implementation

Although the Lean initiative was limited to the production processes, the overall maturity of the implemented Lean tools indicate that Case IV has reached an advanced level of Lean strategic implementation within its production processes. Analysis of implemented Lean tools furthermore shows that each Lean principle within the production processes, except for identifying customer value, has reached a mature stage of Lean development.

Analysis also indicates that the Lean principles were the most mature within the production process of boilers. During the workshops, the production plant changed from containing seven different production lines, to one production line where all 7 product families, with each family containing over 30 product types, were produced interchangeably. At the production line, all activities were lined up in process sequence and could be performed immediately adjacent to each other. Towards the end of the transition, Case IV was able to produce in a single-piece-flow where each boiler was produced and moved at the same time with minimal interruptions. By achieving single-piece-flow, a kanban system within the production process of boilers became unnecessary. The production of subs however, was coupled to the production line of boilers and pulled by a kanban system. As one bin of subs got empty, a kanban signal went to warehouse for the replenishment of subs.

A so called 'kaizen trainer' was assigned to the location by the management, who led the kaizen workshops. Joined by employees from the work floor and occasionally by the management, major improvements of the processes were made at these workshops. During the workshops, decision management often took place by the

[96] In Appendix X a legend is provided for reading the tables in chapter 5.

workshop-members, whereby decision control took place by the management. Also, small improvement projects were initiated during the daily operations, by detecting and preventing interruptions according to a PDCA-cyclus. Work floor employees were empowered to stop the production line from working when errors did occur. Besides coordinating the CI efforts, the kaizen trainer also focused on training employees according to Lean principles and tools[97]. Within the production process, employees were cross-functionally assigned to different activities to improve all-roundness and stability.

The production plant managed to produce boilers according to customer takt time. The production plant however, struggled in stabilizing its production processes because of periodic variations in the takt time[98]. The takt time was also based on orders from the dealer stores, instead of the end customers, due to the lacking tools for identifying customer value. The production plant did manage to cooperate with suppliers, although support from the purchasing department in Deventer was lacking[99]. Key suppliers were selected and certified based on their performances and trained by the kaizen trainer according to Lean principles and tools[100]. Key suppliers could deliver based on received kanbans or deliver the stock needed for four hours production to a warehouse managed by a third party. In the latter case, the supplier became responsible for the inventory costs made.

Although a workshop was held for improving the processes for spare parts, the Lean implementation here was more limited than for the production process of boilers. The warehouse contained stock of 150,000 different parts. Efforts were made to improve the MRP-based forecasts and to synchronize the picking, making and delivering of ordered parts in order to reduce the throughput time. Due to the fluctuating nature of these customer orders and the inability to have direct contact with its customers, kanban or takt time has not been implemented here.

5.5.2 Lean Accounting – Management Control Practice

5.5.2.1 Overview Management Control Practice

Case IV started its Lean initiative with the focus to double its production at both locations within 5 years, without increasing any floor space. Targets set during workshops mainly focused on reducing floor space, inventories, throughput time and non-value adding time, such as the unnecessary movement of people.

During the sixth workshop in 2001, the following KPI's are formulated for the locations in Buinen and Deventer and specified for each department to evaluate the Lean progresses within the daily operations:

- On-time delivery
- Motivation
- Quality
- Productivity

The KPI's were measured with underlying performance measurements, which were also formulated during the workshop. The performance measures used within Buinen are depicted in table 5.14 below[101].

[97] Before starting the first kaizen workshops, the management team, including the kaizen trainers of both locations, got an intensive Lean training for a week long by Porsche.
[98] The reasons for the variation in the takt time will be illuminated in section 5.5.3.2 of this research.
[99] Issues surrounding the cooperation with the purchasing department will be addressed in section 5.5.3.2 of this research.
[100] The selection and certification of suppliers is further illuminated in section 5.5.2.1 of this research.
[101] In Appendix X a legend is provided for reading the tables in chapter 5.

Table 5.14 – Status MC Practice within Case IV

Case IV				Initiative
Lean Accounting - Management Control	Performance Measurement**	Waste	Product defects	XX
			Process defects	XX
			Rework	X
			Downtime	XX
		Quality	Product/service quality	XX
			First-time-through (FTT)	
			Customer satisfaction	
			Employee satisfaction	
			Employee education/training	XX
			Improvement ideas	XX
			Business consequences of improvement(s)	XX
			On-time delivery	XX
		Operational Performance	Productivity	XX
			Operational equipment effectiveness (OEE)	XX
			Throughput time	XX
			Cycle time compared to customer takt time (day-by-the-hour)	XX
			WIP compared to SWIP	XX
			Amount of time from material receipt to delivery of the finished product (dock-to-dock)	
			Inventory turns	
			Capacity (non-productive, available)	XX
	Supplier Performance*		On-time delivery	XX
			Product quality	XX
	Reward System*		Reward based on non-financial measures	X
			Reward based on team performance	
			Reward based on process/product quality	

5.5.2.2 Status Management Control Practice

Analysis of the use of performance measures shows that measurements were often visualized at the work floor. The status of the actual production compared to the planned production, but also the part of the production line that caused interruptions was visualized on an andon board at the work floor. After the detected defects, such as downtime and defective units during or after production, had been processed and analyzed by the quality service, an employee was assigned to improve the process. The improvement cycle within the daily operations was therefore supported by the andon board and the measurements.

Based on the underlying performance indicators, the status of the KPI's was also visualized on an A0-format, which was referred to as the 'Quality Centre'. These measurements include the amount and reasons for defects, on-time delivery, productivity, employee training, improvement ideas and cycle time compared to takt time. The status of KPI's were also summarized on an A4-format and reported to the management. Moreover, the status of small improvement projects and workshops were visualized on an A4-format, which was referred to as the 'Kaizen-Krant', and included on the quality centre. Besides the status of activities within the workshops, also the operational results from the workshops, such as the used and available floor space, inventories, throughput time and non-value adding time, were measured and compared to the targets set. Moreover, the operational benefits were also translated into financial benefits and compared with the accompanied costs, as the results of completed workshops were presented to the management. However, when the production line became active, the production plant stopped measuring throughput time within the production process of boilers as it became constant.

With the use of a so called 'supplier-pyramid', suppliers were rated according to their performance. In order to do so, supplier performance was also measured based on its on-time delivery and the quality of its delivered products. The quality is derived from its ability to deliver according to the right quantities and/or within the right packages. The supplier-pyramid was visible within the production plant, but also reported monthly to the

suppliers. Key suppliers were selected and certified based on their performance and occupied the top of the pyramid.

Analysis of the reward system used within the production plant shows that employees were also financially rewarded based on their submitted improvement ideas. In order to do so, an improvement idea was reviewed based on several criteria such as its originality and financial effect. The pecuniary system however, is in 2008 replaced by a non-pecuniary credit points system. Analysis of the management reward system furthermore shows that except for profitability, the formulated KPI's were not related to the reward system in use by the firm.

5.5.3 Management Accounting Practice

5.5.3.1 Overview Management Accounting Practice

In table 5.15 an overview is given of the current MA practice at the production plant in Buinen[102].

Table 5.15 – Status MA Practice within Case IV

Case IV			Initiative
Lean Accounting - Management Accounting Practices	Traditional MAP*	Overhead cost allocation	X
		Standard costing	X
		Use of absorption costing to value inventory	
		Budgeting and variance analysis in performance evaluation and compensation	X
		Bill of materials, work orders and MRP system for inventory tracking and schedule production	X
		Detailed tracking of inventories and labor	X
		Responsibility reporting based on departmental structure	X
	Eliminate Waste in MAS*	Backflushing of costs	
		Value stream costing	
		Target costing/Kaizen costing	
		Kanban and visual management to replace MRP	
		Value stream mapping	X

5.5.3.2 Status Management Accounting Practice

Within Case IV, overhead cost allocations and standard costs were part of the firm's budgeting system. The overhead rate was determined on yearly basis by the headquarters in Deventer, based on historical data on past performance. During the Lean transition some of the logistic costs, previously treated as overhead costs, were partly made direct. However, the change was limited and VSC was not practiced. Although the product families were produced interchangeably at the same production line, different costs were specified to each product type according to the determined rates. Periodically, the actual performances of the production plant were evaluated based on a variance analysis. The system of data collection and reporting, including the periodic variance analysis, created challenges during the Lean transition. When the production plant started to produce to customer order, the plant seemed to be under-producing and not maximizing the use of its resources. This has led to many discussions between the financial department in Deventer and production plant in Buinen. The production plant in Buinen therefore decided to develop a complementary MA report to make financial benefits from the Lean efforts visible[103]. The production process has also proposed to simplify the process of data collection and reporting, as it was time consuming. However, the financial department, supported by the management, has refused to change the MA system.

[102] In Appendix X a legend is provided for reading the tables in chapter 5.
[103] How the financial benefits were reported is also mentioned in section 5.5.3.2 of this research.

Although efforts were made to initiate the production process with kanban signals from the warehouse in Deventer, the plant struggled in cooperating with the sales department in Deventer. The sales department was used to working with the MRP-based production planning. As a result, the takt time was determined by the sales department based on the monthly MRP-based forecasts of customer orders and production schedule. The sales targets also contradicted the Lean transition in Buinen. The production plant wanted the sales department to work with stable sales schedules, by selling small quantities more frequently. However, the financial targets derived from the MA system stimulated to maximize revenue by selling as much boilers as possible, which often led to boilers being sold in large batches. The use of the MRP-system and the sales schedule caused variations in the takt time, making it difficult to stabilize the production. To minimize the variations in takt time as much as possible, the production plant managed to convince sales to provide a fixed production schedule for four weeks. This way, the takt time was adjusted every fifth week.

The production plant also struggled in cooperating with the purchasing department. The production plant wanted to introduce JIT-purchasing at some of the suppliers. This meant purchasing small quantities more frequently according to the right quantities and packages. By focusing on purchasing large batches of inventory in order to get any discount, the purchasing department hindered the Lean transition in Buinen. Moreover, as the deliveries according to right quantities or within packages did not contribute to the financial targets to be met, the purchasing department did not take these elements into account when negotiating with suppliers. Nevertheless, the production plant eventually did manage to cooperate directly with its suppliers in order to start JIT-purchasing.

5.5.4 Overall Success Lean Implementation

5.5.4.1 Overview Financial Performance and Management Support

In table 5.16, the change in financial performance and management involvement subsequent to the Lean transition is depicted[104].

Table 5.16 – Overall Success Lean Implementation

Case IV			**Initiative**
Overall Success Lean	**Financial Performance*** **	Increased Net Sales during Lean implementation	
		Increased Return on Sales during Lean Implementation	
		Increased Market Share / Customer orders Lean implementation	X
		Increased Profit during Lean Implementation	
		Decreased Raw Materials, WIP, Finished goods balance during Lean Implementation	X
	(Top) Management Involvement** **	(Top) management involvement in coaching employees	XX
		(Top) management involvement in initiating change programs	XX
		(Top) management involvement in implementing Lean strategy	X
		(Top) management involvement in continuing Lean implementation	X
		(Top) management involvement in continuing business	

5.5.4.2 Status Overall Lean Success

The operational benefits led from the lean transition concerned a stock value decrease of over 6 million euro, a stabilized throughput time, an increased output of 8%, a 50% decrease in used floor space, eliminated changeover times, while the amount of worked hours reduced[105]. During the implementation, operational results from kaizen workshops were constantly translated into financial results which were presented to the (top)

[104] In Appendix X a legend is provided for reading the tables in chapter 5.
[105] These are the value in 2004 compared to the year 2000 when the company started its Lean implementation.

management. In 2000 for example a net financial result of over 600,000 euro was reported. The overall management support in implementing Lean was moderate, especially in the beginning. Some managers were actively trying to hinder the Lean transition, while others were highly supportive of the Lean implementation. It is believed that without making the financial benefits visible, the Lean transition would have stopped in 2000.
The firm started its Lean initiative with the main focus on doubling its production without increasing the floor space. However, the production plant in Buinen did not manage to use the freed up floor space to double its production by building a second production line. Nor did the financial benefits translate back to an increased profit within the financial reports. The management support declined substantially in 2009, when the parent company decided to close down the production plant in Buinen. The location in Deventer however remained open.

5.5.5 Conclusions Case IV

Since the start in 2000, the Lean strategic implementation within the production processes of boilers reached an advanced level of maturity. Employees were empowered to initiate major improvements during the 23 kaizen workshops held within the production plant. The workshops resulted in a production line where all products families were produced interchangeably in a single-piece-flow according to customer takt time. During the daily operations, also small improvements were initiated to prevent interruptions according to a PDCA-cyclus. Employees were also trained according to Lean principles and cross-functionally assigned to different activities. In 2001, KPI's are formulated to evaluate the Lean progresses within the daily operations. Analysis shows that the underlying performance measures were often visualized on the work floor. Andon boards and A0-formats are used to communicate the status of performance measures and improvement projects to the people at the work floor, while the status of the KPI's are summarized on an A4-format and communicated to the management. Moreover, operational benefits from workshops were also translated to financial benefits and compared with the accompanied costs and presented to the management. This way the status of the production process was visible for everyone within the production plant and management.
However, the Lean transition was limited to the production process as the MAS in use created challenges to implement Lean more extensively. While the production plant wanted to initiate JIT-purchasing from suppliers, the financial targets stimulated the purchasing department to purchase larges batches of inventory and to negotiate purely on prices instead of including the quality of deliveries and packaging. The production plant failed in implementing a kanban system to initiate production, as the sales department insisted on using the MRP-system for determining the production schedule. The financial targets moreover stimulated the sales department to often sell boilers in large batches in order to maximize revenue. The use of the MRP-system and the sales schedule caused variations in the takt time, making it difficult to stabilize production. The firm's budgeting system and periodic variance analysis caused many discussions between the financial department and the production plant, as operational Lean improvements seemed to be translated in under-production and un-maximized resources within the financial reports. The proposal to simplify the process of data collection and reporting was also rejected by the financial department.
The struggles in cooperating with the supporting departments had a negative impact on the Lean progresses being made. Nevertheless, the production plant had often find ways to partly overcome these difficulties. By this means, complementary MA reports were developed to translate operational benefits from Lean into financial benefits. These reports were periodically presented to the (top) management and it is believed that without these

reports, management would have stopped the Lean transition earlier. However, although operational benefits were made visible, the financial benefits did not translate back to an increased profit within the financial reports. In 2009, the management support declined substantially, leading to the closing down of the production plant in Buinen.

5.6 Overall Conclusions

In this chapter, an analysis is made of the status of Lean strategic implementation, MA and MC practice, financial performance and overall management support subsequent to the Lean initiatives at the four selected cases. In order to evaluate the relations among these variables as proposed by the ex ante framework[106], the organizational architecture of the four cases is analyzed.

5.6.1 Status MA and MC practices

Analysis of the overall status of MC and MA practices subsequent to the Lean initiatives has indicated that the use of performance measures was limited within the first three cases. Whereas Case I and III used several performance measures to evaluate Lean progresses being made, the performance measurement during Lean implementation within Case II was limited to one financial measure. Although Case II extended its number of performance measures used and visualized them on the work floor during its second initiative, these were not included in the management reports or used to evaluate and reward management performance. Case I and III also struggled with the validity and reliability of measured performances due to several issues, among which were system related issues. Case III specifically struggled with strategic objectives not being interrelated, causing difficulties in measuring underlying performances. Case I used financial as well as non-financial measures to evaluate the Lean progresses being made and in some cases the non-financial measurements were also used to evaluate and reward management performance. Analysis of the MA practice within all four cases furthermore showed that the financial measures used in management reports and to evaluate and reward management performance were derived from what researchers often refer to as the traditional accounting system. These financial measures were in most cases not related to the Lean strategic objectives been set, except for the profitability measure within Case I. Within all cases non-financial measures were also not included in the management reports, which were derived from the traditional MA system. Furthermore, analysis showed that within Case II and III measured performances were not made visible at the work floor. Within Case I, except for process defects, measured performances were visualized on the work floor. Moreover, analysis of all four cases showed that an MRP system was leading in scheduling production.

The status of MA and MC practice within Case IV leads to different conclusions, as here a large amount of performance measures was in use to evaluate and visualize the Lean progresses being made at different levels within the organization. Moreover, complementary MA reports were developed in order to translate operational benefits from Lean into financial benefits, which were presented to the management.

5.6.2 Status and overall success Lean strategic initiative

Analysis of the maturity of the implemented Lean tools indicates that Case I was in the early stage of Lean implementation, even though the implementation of Lean tools was more widespread within the firm. The

[106] The ex ante framework is provided in figure 4.1 in chapter 4 of this research.

maturity of the implemented Lean tools at Case II and III indicate that these firms were only in the early beginning of Lean implementation. Case IV however, reached an advanced level of Lean maturity, although this was limited to the production process of boilers.

Analysis also showed that the MAS in use within Case I and II caused difficulties in achieving some level of control during the daily operations on the work floor. Although at both cases a kanban system was installed to achieve basic stability within the processes, the lack of performance measures caused for the kanban system to be unable to accurately visualize the workload and regulate pull, which resulted in unstable processes. These effects have had negative effects on the Lean progresses being made within both cases.

Because the initiatives at the three cases were led top-down with limited employee empowerment, this caused for the initiatives being highly dependent on management support. Despite of their efforts to do so, due to the MAS in use, management within the first three cases was unable to correctly assess the financial benefits from Lean. Within Case III, management was also unable to assess operational benefits from the initiative, due to the difficulties in measuring performances as described in the previous section. At these three cases this has led to management shirking the effort to coach their employees and initiate change programs, which resulted in a CI culture and structure that has not been embedded within the firms. Within Case I, resistance from the manager operations was even the cause for the failure to implement a kanban system during the second initiative. Although management support at Case I has been slightly decreasing, overall management is still supportive of continuing the Lean initiatives. As management decision making within Case II was based on one financial measure, the process was implemented throughout the organization without being stabilized, which resulted in a deterioration of a related financial measure. This resulted in a substantial decrease in management support in implementing Lean, as a second initiative was started that removed all of the implemented Lean tools. The MAS in use within Case III caused for the management to focus on realizing process improvements in a short amount of time, but as benefits leading from the initiative were not captured, management shirked to support the initiative. Due to insufficient management involvement, the initiative struggled in making progress. As the initiative failed to overcome these problems, the management decided to end the initiative.

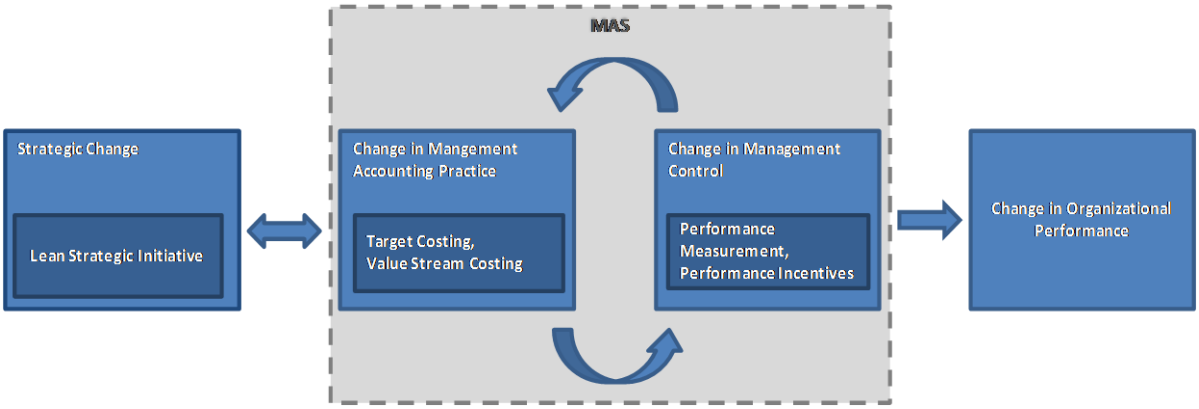
The performance measurement system within Case IV led to the achievement of a high level of control during the daily operations at the production floor, which has had positive effects on the Lean progresses being made. The reward system in use within the purchasing and sales department led to behavior that counteracted the Lean transition at the production plant. As a result, Case IV struggled with difficulties in further stabilizing its production processes and initiating JIT-purchasing from suppliers. The MA practice in use within Case IV caused for the operational improvements from Lean to be translated in under-production and un-maximized resources within the financial reports. Although Case IV developed complementary MA reports to overcome these difficulties and gain management support, the financial benefits did not translate back to an increased profit within the financial reports. This resulted in a substantial decline in top-management support, as the production plant was closed down.

5.6.3 Development of an Ex Post Model

The evidence from the four cases studied is used to develop a revised theoretical model, which is presented in figure 5.1. Unlike the ex ante framework, a bidirectional relationship is observed between MA and MC practices. This means that the MA practice in use to provide information for decision making within firms also serves as input for measuring, evaluating and rewarding performances. Similarly, strategic objectives which are set and

measured to evaluate and reward performances also lead for MA practices to develop ways to report these measures. Although evidence supported the direct relationship between a Lean strategic initiative and the MAS in use by the firm, it showed a bidirectional relationship instead of a unidirectional relationship as was proposed by the ex ante framework[107]. The evidence also supported the unidirectional relationship between the MAS in use by the firm and the level of organizational performance being assessed by the firm. The findings showed that the four cases each struggled in their own way with adjusting the MAS to the implemented Lean strategy. The findings also demonstrated that when the MAS is inadequately adjusted to a Lean business strategy, the MAS fails to capture the benefits leading from the Lean initiative and even counteracts the implementation of the Lean business strategy, as it hinders in achieving some level of control during daily operations, creates short-term objectives and discourages the creation of excess capacity, leading in management to reject Lean in the long term.

Figure 5.1 Theoretical Ex Post Framework



[107] Baines and Langfield-Smith (2003) already stated specifically in their research that one of the limitations of their proposed model was the assumption of unidirectional relationships between variables.

6. Conclusions and Discussion

Despite the widely held assumption that Lean enhances organizational performance, the empirical evidence is decidedly mixed (Fullerton and Mcwatters 2001, 2002; Womack and Jones 2003; Taylor and Wright 2003; Callon, 2005; Becker, 2007; Maskell and Kennedy 2007; Kennedy and Widener 2008; Fullerton and Kennedy 2009). Several studies have suggested that one explanation for these inconclusive results is that benefits from Lean are dependent on complementary changes in the firm's MAS (Green, Amenkhienan and Johnson, 1992; Sprinkle, 2000; Fullerton and McWatters 2002; Baines and Langfield-Smith 2003; Nicolaou 2003; Callen 2005; Kennedy and Widener 2008; Fullerton and Kennedy, 2009). Although empirical studies provide evidence for the central role of a MAS in the successful implementation of a Lean business strategy, the MAS practice shows to be reluctant to change (Green et al., 1992; Johnson, 1992; Ittner and Larcker, 1998; Fullerton and McWatters 2002, 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009). Researchers state that the traditional MAS, which is currently prevalent within Lean environments, fails to capture the benefits and even counteracts the successful implementation of the Lean business strategy (Kaplan, 1983; Lee, 1987; Johnson and Kaplan, 1989; Green et al., 1992; Johnson, 1992; Ittner and Larcker, 1998; Fullerton and McWatters 2002; 2004; Womack and Jones 2003; Maskell and Baggaley, 2004, 2006; Maskell and Kennedy, 2007; Solomon and Fullerton, 2007; Fullerton and Kennedy 2009).

Given that a MAS is a primary source for decision making and control, and the need for MAS to change to support managers' new information requirements within a new strategy, the reluctance to adjust the MAS to a Lean business strategy could have significant consequences for the success of a Lean business strategy. For this reason, the main purpose for conducting this research has been to examine the role of MAS in implementing Lean business strategy. A broader purpose is to examine and map the development of LA in organizations and environments that have adopted Lean and to develop a framework that advances theory.

To conduct this research properly, firstly the main tenet of Lean and LA is highlighted. An overview is given of the literature that discusses the relationship between the implementation of a Lean business strategy, complementary changes in the MAS and organizational performance. The discussion surrounding the current MAS practice within a Lean environment is thoroughly analyzed, whereby an ex ante framework is provided. With the use of the case study method, four different cases of firms that started a Lean strategic initiative are examined. By doing so, the relations among Lean strategic implementation, MA and MC practice, organizational performance as provided in the ex ante framework and overall management support are analyzed. Based on the overall findings an ex post framework is developed and the evidence both consistent and inconsistent with the ex ante model is presented.

A theoretical implication is that a bidirectional relationship is observed and discussed between MA and MC practices, whereas the ex ante framework suggested a unidirectional relationship between these variables. An important theoretical implication is that a bidirectional relationship between a Lean strategic initiative and the MAS is demonstrated and discussed, instead of a unidirectional relationship as was proposed by the ex ante framework. This means that the MAS is not only directly affected by a Lean strategic implementation, but the degree of Lean strategic implementation is also directly related to the MAS. The findings furthermore showed that the change in MAS subsequent to a Lean strategic initiative is moderate and the traditional MAS is still the

predominant accounting system in use, as was suggested by extant literature. Congruent with prior empirical research, the findings also demonstrated that when the MAS is inadequately adjusted to a Lean business strategy, the MAS fails to capture the benefits leading from the Lean initiative. This results in Lean benefits incorrectly being assessed by the management when evaluating the Lean progressions made.

Moreover, the findings demonstrated that the use of standards and variance reporting for performance evaluation within the traditional MAS had created short-term objectives and discouraged the creation of excess capacity, as the operational improvements were translated into under-production and un-maximized resources, which was suggested by researchers and yet to be empirically supported. The analysis also showed that when the MAS is inadequately adjusted to a Lean business strategy, the degree of Lean implementation is directly influenced as the MAS hinders in achieving some level of control during daily operations and causes for the management to shirk the effort to support the strategic implementation, leading in management to reject Lean in the long term. The proposed theoretical framework therefore suggests that the reluctance to adjust an entrenched traditional accounting system has significant consequences for the success of a Lean business strategy.

The results of this research provides motives for further research and discussion surrounding this subject, as still little empirical research is done to analyze the necessity of having a supportive MAS for the successful implementation of Lean. First, further empirical research should be done to provide evidence that supports in further developing the theoretical framework. Moreover, analysis of cases where more changes were noticeable within the MAS could also contribute to the further development of the theoretical framework. Also, a more in-depth empirical research could be conducted to provide evidence of the underlying cause and effect relations suggested by the ex post framework. It could for example be possible that a bidirectional relationship exists between organizational performance and the change in MAS or degree of Lean implementation. Congruent with findings by Fullerton and Kennedy (2009), the limitations of this study ask for additional research to analyze this relationship. Furthermore, a large-scale statistical multivariate analysis could be conducted to generalize these results to other companies.

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Appendix I – DBH Report (example)

Date and Time		Shift		Team		+ / -	Shift change comments	
{Date}		{Shift #}		{Team Designation}				
Start	Stop	Schedule	Actual	Total Schedule	Total Actual		Problems and Issues	Action
7:00am	8:00am							
8:00am	9:00am							
9:10am	10:10am							
11:10am	12:10am							
12:40pm	1:40pm							
1:40pm	2:40pm							
2:50pm	3:50pm							
TO FIGURE SCHEDULE (TAKT TIME) = TOTAL AVAILABLE PRODUCTION TIME IN SECONDS / CUSTOMER DEMAND								
TO FIGURE ACTUAL (CYCLE TIME) = ACTUAL SHIFT PRODUCTION TIME IN SECONDS								

Appendix II – WIP-to-SWIP Report

SWIP = 10 units			
Day	Status	Difference	Reason
Monday Jan 8			
Tuesday Jan 9			
Wednesday Jan 10			
Thursday Jan 11		12	
Friday Jan 12		14	
Monday Jan 13			
Tuesday Jan 14		8	
Wednesday Jan 15			
Thursday Jan 16			
Friday Jan 17			

	WIP equals SWIP
	WIP is significantly higher than SWIP
	WIP is significantly lower than SWIP

Appendix III – Support Cell Measurements

Set-up Times

The measurement of machine downtime is a relatively important step in the first stage of Lean implementation. Downtime is often caused by the set-up or changeover of machines and has influence on the achievement of takt time. Lean therefore focuses on minimizing machine set-up times to ensure that the product is made at the right rate to maintain the continuous flow of products and services throughout the cell. For this reason, machine set-up times within the lean cell are sometimes tracked by the people operating the machines.

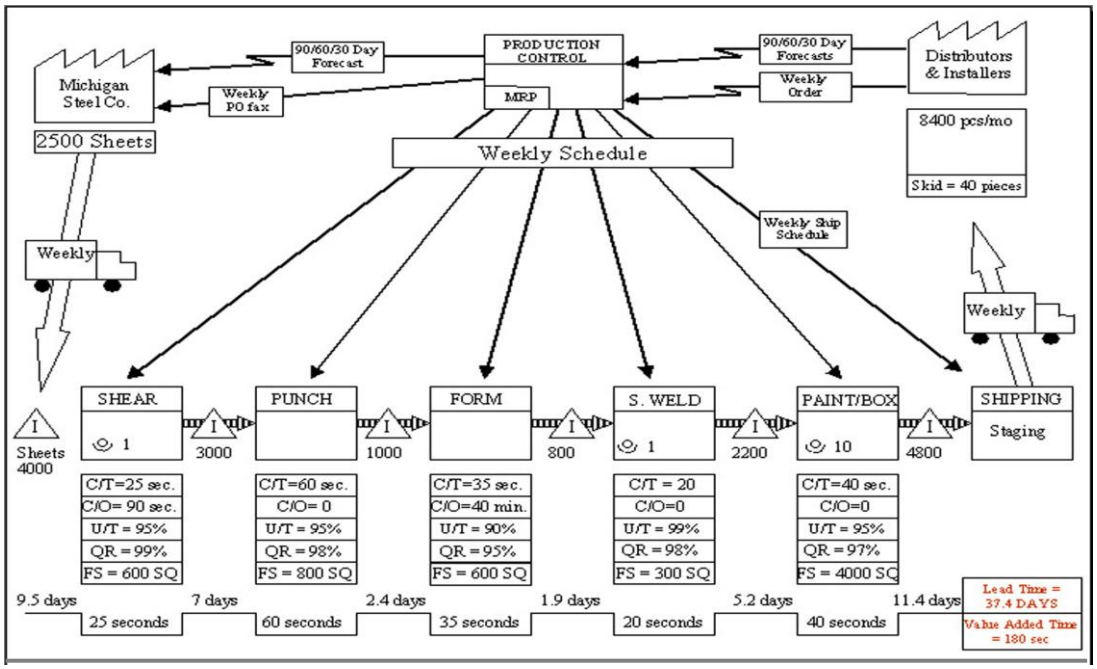
Safety Cross Calendar Chart

The safety cross shows the days of a month and indicates for each day if it was free of any accidents or injuries, had a reported accident or injury without any time being lost, or an accident or injury whereby time is lost (waste). The safety cross can be composed for an individual cell or for the firm's entire value stream. If for each cell the safety information is tracked, then the value stream safety cross will be the sum of the individual cell safety information.

Cross Training Chart

In order to improve the value stream flow, Lean also advances cross training of people within the value stream. In the first stage of Lean implementation this will only comprise the Lean pilot cell. The cross training chart measures the level of cross training among the cell team members. The chart lists people within a cell together with the tasks and methods they must be trained in over time. Often the first set of topics includes tasks required to make the products. The second set of topics includes skills for preventive maintenance, problem solving and improvement. The third set of topics consists of tasks required to support other cells. Finally the fourth set of topics comprises skills in facilitating CI teams (Maskell and Baggaley, 2004). In the first stage of Lean implementation, only the first two sets of skills on the cross training chart will be relevant. When a person receives training, this is recorded on the cross training chart. Often firms also register the levels of skills. For example, the shape of the mark can indicate if the person is just trained, certified, or trainer her/himself.

Appendix IV – Current State VSM (example)



(Rother and Shook, 1999)

Appendix V - Box Score (example)

		Last Week	This Week	Next Week	Change from Current State	Long Term Future State	Change from Current State
OPERATIONAL	Dock-to-Dock Days						
	FTT						
	On-time Delivery						
	Floor Space						
	Units per Person						
	Average Cost per Unit						
RESOURCE CAPACITY	Productive						
	Non-Productive						
	Available Capacity						
FINANCIAL	Revenue						
	Material Costs						
	Conversion Costs						
	Value Stream Profit						
	Value Stream ROS						

Appendix VI - Paradigms within Management Accounting

A.1 Introduction

In chapter four of this research references are made to the so called traditional accounting system. In this appendix, the management accounting paradigms that are associated with the traditional MAS are highlighted. First, the subject of cost allocations will be addressed. Then absorption costing, variable costing, budgeting, variance reporting and analysis will be described. Due to the large content and complexity of these paradigms, only the central concepts and constructs are discussed.

A.2 Cost Allocation

Whether and how overhead costs are allocated to products is a common problem in product costing (Zimmerman, 2006). Overhead costs, also called common cost, are costs shared by multiple cost objects and are therefore not directly traceable to one specific cost object. Cost objects are processes, departments or often products that firms wish to cost. Financial reporting rules require that inventory (of materials, WIP and finished products) be stated at total cost, including both direct labor, material and overhead cost. Therefore, overhead costs are allocated to products for external reporting purposes.

But, the calculation of product costs, especially the allocation of overhead to products, is a central issue in MAS as well. Cost allocations are often used by firms to set sales prices. This so called cost-plus pricing is a common pricing method used by firms. With this method, the sales price of a product is set by the firm by first determining the total average internal costs and then adding up a profit margin, which is a markup percentage of the calculated costs. This gives the following pricing formula: Cost + Profit = Price, where profit = markup percentage * costs. The cost-plus pricing method seems to ignore the demand and price sensitivity of consumers, as price determination includes internal cost accounting numbers and does not include customer demand. Another way that cost allocations are often used for decision making and control, is by being part of the firm's budgeting system and performance evaluation system (Zimmerman, 2006). These systems are part of a firm's MAS, whereby decision rights are partitioned and performance is measured and rewarded. As cost allocations have a reversed influence on reported profits, cost allocations are used to influence decision making behavior of people with decision rights (managers). The following paradigms in management accounting address the issues concerning product costing and overhead costs allocations.

A.3 Absorption Costing

Absorption costing (AC) is a cost allocation system that allocates all manufacturing costs, composed of direct labor, direct material, fixed and variable overhead, to the products made. AC therefore, considers products as being the cost objects. Costs are allocated to products based on an allocation base. An allocation base is a measure of an activity to allocate overhead costs. Within AC, either labor hours, or machine hours are often used as an allocation base. AC is often been referred to by researchers as the traditional cost accounting system (Maskell and Baggaley 2004, 2006; Zimmerman, 2006; Maskell and Kennedy, 2007; Fiume et al., 2007; Fullerton and Kennedy, 2009), since it has been used widely for over 100 years, and some elements have been

traceable to the beginning of the Industrial Revolution (Zimmerman, 2006). Nowadays, AC systems are still the predominant systems in use by firms. The AC system comprises two methods for allocating costs to products:

1. Job Order Costing

   When production output can be separated in to distinct jobs or batches, this method is used to allocate overhead costs to the jobs or batches. With AC, all manufacturing costs are allocated to either cost of goods sold expense account, or WIP and finished products inventory accounts: direct materials, direct labor and overhead are allocated to the WIP inventory account for each job, using equivalent units. For example, if 100 units are in WIP at the end of the period and are considered 80% complete, the equivalent production is 800 units. As the products are completed, the costs are transferred from the WIP account to the finished products inventory account. Finally, when the products are sold, the costs are transferred from the finished goods inventory account, to the cost of goods sold expense account.
2. Process Costing

   This method is used when production is in continuous flows and distinct batches do not exist (oil refinery for example). This allocation method is very similar to job order costing, whereby costs are averaged over large number of productions units that are assumed to be identical[108]. However, the information provided is often less useful for decision making as the costs for individual jobs are not available and can not be used to evaluate cost trends (Zimmerman, 2006).

A.4 Variable Costing

Variable costing (VC) is a cost allocation system that allocates the variable manufacturing costs to the products made. Variable costing is also known as Direct Costing (DC) since the variable manufacturing costs include direct material, direct labor and variable overhead. The variable manufacturing costs are allocated similar to the job order costing method within AC, namely either to WIP and finished products inventory accounts, or cost of goods sold expense account. The variable manufacturing costs are expensed when the products are sold.
However, fixed costs are not allocated to products and do not flow through the inventory accounts. VC treats all fixed manufacturing costs as period costs (instead of product costs), to be expensed in the period incurred. An important measure within VC is the contribution margin, which is the amount of sales revenues remaining after the variable manufacturing costs have been deducted, to cover fixed costs and profit.

A.5 Budgeting

It is explained how AC and VC focus on product costing and on the issue of whether and how overhead costs are allocated to the products made. With both methods, overhead costs are allocated at the end of the year using an overhead rate. The overhead rate is calculated by dividing the overhead costs by the total volume of the chosen allocation base. For both AC and VC, labor hours or machine hours are often used as an allocation base. However, if overhead would be charged to different jobs based on the actual numbers, the cost of each job would be unavailable until the end of the year. Therefore, forecasted overhead rates, known as budgeted (or predetermined) overhead rates, are set at the beginning of the year by using a flexible budget. Budgets are forecasts of all transactions expected to occur, using historical data on past performance. Budgets support

[108] For a detailed explanation of this costing method, read p. 443-450 Zimmerman (2006).

decision management, by communicating knowledge and partitioning decision rights to managers. Furthermore, budgets support decision control, as budgets are used for performance evaluation by comparing the actual results with the budget (Zimmerman, 2006). Overhead cost allocations are an important part of the firm's budgeting and performance evaluation system. As cost allocations have a reversed influence on reported profits, cost allocations are used to influence decision making behavior of people with decision rights (managers), especially concerning their use of common resources. The flexible budget comprises the budgeted annual overhead costs which are composed of the budgeted fixed overhead (BFO) costs and the budgeted variable overhead (BVO) costs. The variable overhead costs are budgeted at the beginning of the year by multiplying the budgeted overhead rate with the estimated volume of the chosen allocation base. This gives the following flexible budgeting formula:
Flexible budget = budgeted annual overhead = BFO + BVO, whereby BVO = budgeted overhead rate * estimated allocation base volume.

With the budgeted overhead rate set by the flexible budget, it is possible to apply incurred costs to the WIP and finished products inventory accounts during the year using either AC or the VC method. However, the overhead costs are applied to the WIP and finished products inventory accounts during the year using the actual amount of allocation base. So, there is a difference between the budgeted overhead costs at the beginning of the year and the applied overhead costs during the year.

A.6 Standard Costing

Standard costs represent the estimated cost of a product. With SC, objectives are set, which are used for planning and budgeting direct labor and direct material. For each type of direct labor and each type of direct material a standard quantity and a standard price per unit are determined. Information from the BOM and routing sheets is used to estimate the required materials and labor. In addition, the predetermined overhead rate is incorporated in the calculation of standard costs of the product. Standard costs are usually set at the beginning of the year and are part of the firm's budgeting and performance evaluation system. SC supports both decision management and decision control with the same reasons as explained for budgeting; cost budgets are communicated to lower level managers with the use of standard costs, sales prices set by firms using the cost-plus pricing method are often based on standard costs, as the standard costs represent the estimated internal cost of the product[109], and standard costs provide benchmark information for decision control to evaluate actual performances concerning the costs. Variance analysis is often used by firms to compare actual costs against the standard costs. SC is a form of top-down control, since usually the accounting department or top management has the decision rights to set or change the standard (Zimmerman, 2006).

A.7 Variance Reporting and Analysis

With variance reporting and analysis the difference between budgeted, applied and actual costs are monitored, evaluated and compared. Seven types of variance analysis are used within firms:

1. Overhead variance analysis:

[109] Read section A.2 of this research.

- Variable spending variance: the variable overhead at actual versus budgeted overhead rate is compared.
- Variable efficiency variance: the variable overhead at actual versus estimated volumes is compared.
- Fixed budget variance: the actual fixed overhead is compared with the BFO.
- Fixed volume variance: the fixed overhead at estimated volumes versus actual volumes is compared.
- Over/under applied overhead: overhead costs are applied to WIP and finished products inventories during the year using the budgeted overhead rate, the actual overhead is allocated to the products using the actual overhead rate. Costs are over applied when the applied overhead exceeds the actual overhead and vice versa.

2. Direct labor and direct material variance analysis:
   - Wage variance: direct materials or direct labor cost at actual versus estimated standard prices.
   - Efficiency variance: direct materials or direct labor cost at actual versus estimated volumes.

Variance reporting and analysis is part of the performance evaluation system within the firm's MAS. With variance analysis the level of business control is assessed by using financial measures. Standard costs and variances are designed with the purpose to create incentives for managers to control their use of common resources and costs. At lower actual volumes, the variance analysis shows negative performance. An underlying assumption of variance reporting is that a firm can maximize its profitability by maximizing the use of its labor, machine and overhead resources. The variance analysis does not address operational measures such as customer quality, lead times, productivity and so on.

Budgeting of overhead costs, SC and variance analysis are often used in combination with AC and are part of what researchers frequently refer to as the traditional accounting system (Maskell and Baggaley 2004, 2006; Zimmerman, 2006; Maskell and Kennedy, 2007; Fiume et al., 2007; Fullerton and Kennedy, 2009). Management accounting practices show that the traditional accounting system is still the predominant systems in use by firms.

A.8 Conclusion

Currently, different paradigms within management accounting are established. Many of the paradigms on cost accounting are concerned with product costing and the allocation of overhead costs to the products and support both decision management and decision control within the firm. AC allocates all manufacturing costs to the products made. With the job order costing method or the processing cost method, all manufacturing costs are either allocated to the WIP and finished products accounts or the cost of goods sold expense account as the products are sold. VC allocates the variable manufacturing costs to the products made. The costs are allocated similar to the job order costing method within the AC system. Fixed costs are treated as period costs and therefore expensed as they are incurred. To be able to allocate overhead during the year, flexible budgeting is used to estimate the budgeted overhead rate. The budgeted overhead rate is used to allocate overhead costs during the year and to estimate the annual fixed and variable overhead, which is used for decision management and decision control purposes. Standard costs are also part of the firm's budgeting system. Standard costs are objectives used for planning direct labor and direct material. The predetermined overhead rate is also included in

the calculation of the standard costs of a product. Standard costs support the firm's performance evaluation systems by providing benchmark information for variance analysis. Variance analysis is often used by firm to compare actual costs against the standard costs to assess the level of business control by using financial measures.

Current management accounting practices show that the traditional accounting systems, consisting of the AC systems supported by flexible budgeting, SC and variance analysis, is still the predominant system in use by firms.

Appendix VII – List of participants

Table A.1 List of participants within the selected cases

#	Case I[110]	Case II	Case III	Case IV
1	Value stream manager Benelux	Manager CCM	Manager Q&P	Lean coordinator
2	Controller Benelux	Commercial controller	Manager Planning and Control	Independent researcher[111]
3	After sales manager NL	Project manager	Head Business/Project Control	
4	Project leader transition team NL and B	Project leader	Controller Services	
5			Controller Sales	
6			Program manager of initiative	
7			Project leader during initiative	
8			Project advisor of initiative	

[110] Within table 4.1, 'NL' stands for the Netherlands and 'B' stands for Belgium.

[111] An independent researcher, who has conducted multiple studies on other subject surrounding the Lean transition within Case IV, was in the possession of a lot of official company documents prepared during the transition. These documents have been made available for studying purposes.

Appendix VIII – Formulated Interview Questions

A. Introduction:

Firm Characteristics:
Position interviewee within firm:
When did the firm begin its Lean initiative?
The Lean implementation was initiated at which process(es)?
Position interviewee during Lean implementation:

B. Lean strategy:

Has your firm and to what extent implemented the following Lean tools?

1. Customer Value:
   - Asses customer value and needs (Womack and Jones, 2003; Maskell and Baggaley, 2004)
   - Customize products and services to customer needs (Baines and Langfield-Smith, 2003)
   - Integrated customers network (Womack and Jones, 1996; 2003; Maskell and Baggaley, 2004)

2. Pull:
   - Customer takt time (Callen et al., 2005)
   - Production to customer order (Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008)
   - Kanban system to initiate production (steps) (Fullerton and McWatters, 2002; Callen, 2005; Fullerton and Kennedy, 2009)
   - Training about JIT (Callen, 2005)

3. Continuous flow:
   - Organization in manufacturing/value stream cells (Fullerton and McWatters, 2002; Callen, 2005; Fullerton and Kennedy, 2009)
   - Level scheduling (Fullerton and McWatters, 2002; Callen, 2005; Fullerton and Kennedy, 2009)
   - Single-piece-flow (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)

4. Employee training and empowerment:
   - Empowered employees that are responsible for entire process and output (Fullerton and McWatters, 2002; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
   - Work-floor workers that participate in decisions that affect the quality of the product/service (Fullerton and Kennedy, 2009)
   - Extended employee training on different tasks (Fullerton and McWatters, 2002; Callen, 2005; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
   - Self directed work teams (Fullerton and Kennedy, 2009)

5. Continuous improvement/Kaizen:
   - Program(s) to improve product quality (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003; Callen, 2005; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
   - Program(s) to improve process quality (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003; Callen, 2005; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
   - On time delivery (Baines and Langfield-Smith, 2003)
   - People (workers and management) that are committed to quality training (Fullerton and Kennedy, 2009)
   - Preventive maintenance programs (Fullerton and McWatters, 2002; Callen, 2005)
   - TQM (PDCA-cyclus) to resolve quality issues (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
   - Six-sigma (DMAIC-cyclus) to resolve quality issues[112]

6. Supplier Cooperation:

[112] Six-sigma is a methodology that is often used in combination with Lean tools. The methodology is therefore included in the formulated interview questions, however will not be used to determine the degree of Lean implementation. In Appendix IX, the Six-sigma methodology is briefly described.

- JIT- purchasing (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003)
- Integrated suppliers network (Womack and Jones, 1996; 2003; Maskell and Baggaley, 2004; Callen, 2005)

B. Lean Accounting - MC - Performance Measurement

Has your firm and to what extend (how often) implemented the following Lean Accounting tools?

1. Visual Management:
    - Bottom up performance measures collected and maintained on the work floor (Fullerton and McWatters, 2002; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
    - Bottom up performance measures displayed frequently on the work floor (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
    - Examples?

How important are the following performance measures and which are provided on the workfloor and/or management (top, middle, first-line supervisors)? Examples?

2. Waste/Inefficiency:
    - Product defects (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003; Fullerton and Kennedy, 2009)
    - Process defects (Fullerton and McWatters, 2002)
    - Rework (Fullerton and McWatters, 2002)
    - Downtime (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003)

3. Quality:
    - Product/service quality (Fullerton and McWatters, 2002)
    - First-time-right (FTR) (Maskell and Baggaley, 2004)
    - Customer satisfaction (Baines and Langfield-Smith, 2003)
    - Employee satisfaction (Baines and Langfield-Smith, 2003)
    - Employee education/training (Baines and Langfield-Smith, 2003; Kennedy and Widener, 2008)
    - Improvement ideas (Maskell and Baggaley, 2004)
    - Business consequences of improvement(s) (Fullerton and McWatters, 2002)
    - On-time delivery (Baines and Langfield-Smith, 2003)

4. Operational Performance - Non-financial
    - Total productivity = total output/total input (Callen, 2005; Fullerton and Kennedy, 2009)
    - Labor productivity = total output/labor (Callen, 2005; Fullerton and Kennedy, 2009)
    - Operational Equipment Effectiveness (OEE) (Maskell and Baggaley, 2004; Baines and Langfield-Smith, 2003)
    - Throughput time (Fullerton and McWatters, 2002)
    - Cycle time compared to customer takt time (day-by-the-hour) (Maskell and Baggaley, 2004)
    - WIP compared to SWIP (Maskell and Baggaley, 2004)
    - Amount of time from material receipt to delivery of the finished product (dock-to-dock) (Maskell and Baggaley, 2004)
    - Inventory turns (Fullerton and Kennedy, 2009)
    - Capacity (productive, non-productive, available) (Maskell and Baggaley, 2004)

5. Supplier Performance:
    - On-time delivery (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003)
    - Product quality (Fullerton and McWatters, 2002; Baines and Langfield-Smith, 2003)

B. Lean Accounting - MC - Reward system

How important are these performance measures in determining compensation for middle management, first-line supervisors and work floor employees? (Fullerton and McWatters, 2002)

1. Non-financial measures
2. Team performance
3. Process/product Quality

C. Lean Accounting - MA - Accounting Practices

Has your firm and to what extent implemented the following Lean Accounting tools?

1. Backflushing of costs (Maskell and Baggaley, 2004)
2. Value stream costing (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
3. TC /Kaizen costing (Baines and Langfield-Smith, 2003; Fullerton and Kennedy, 2009)
4. Kanban and visual management to replace MRP (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
5. Value stream mapping (Baines and Langfield-Smith, 2003)

D. Traditional Management Accounting

Does and to what extent the firm use traditional accounting techniques?

1. Overhead cost allocation (Fullerton and McWatters, 2002; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
2. Standard costing (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
3. Use of absorption costing to value inventory (Kennedy and Widener, 2008)
4. Budgeting and variance analysis in performance evaluation and compensation (Fullerton and McWatters, 2002; Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
5. Bill of materials, work orders and MRP system for inventory tracking and schedule production (Kennedy and Widener, 2008; Fullerton and Kennedy, 2009)
6. Detailed tracking of inventories and labor. (Maskell and Baggaley, 2004)
7. Responsibility reporting based on departmental structure. (Maskell and Baggaley, 2004)

E. Overall success Lean implementation

How is the degree of success of the Lean implementation measured within the firm?

How have the following changed during Lean implementation?

1. Net Sales (Baines and Langfield-Smith, 2003; Fullerton and Kennedy, 2009)
2. Return on Sales (Fullerton and Kennedy, 2009)
3. Market Share / Customer orders (Baines and Langfield-Smith, 2003; Fullerton and Kennedy, 2009)
4. Profit (Fullerton and Kennedy, 2009)
5. Raw Materials, WIP, Finished goods (Callen, 2005; Fullerton and Kennedy, 2009)
6. (Top) Management involvement in (Fullerton and Kennedy, 2009):
    - Coaching employees
    - Initiating change programs
    - Implementing Lean strategy
    - Continuing Lean implementation
    - Continuing business

Appendix IX – Six Sigma

Motorola developed the Six-sigma methodology in 1986 to realize improvement goals within its production and supporting activities. Six-sigma focuses on achieving a quality standard of 99,9996%, which allows 3.4 defects within 1 million cases. The six-sigma improvement methodology emphasizes the use of statistical tools and the so-called DMAIC-cyclus to improve processes. The DMAIC-cyclus is an improvement cyclus, which constitutes the following phases: Define, Measure, Analyze, Improve and Control. Six-sigma is often used in combination with Lean tools. Lean advocates advance the use of Six-sigma for processes which are already brought under control and non-value-adding activities categorized as type two muda are eliminated, in order to eliminate type one muda (Marschwinsk, Shook and Schroeder, 2008).

Appendix X – Legend for reading the tables within chapter 5

*	Possible Results:	The firm has not implemented the tool	
		The firm has implemented the tool	X
**	Possible Results:	The performance measure is not or incidentally measured	
		The performance measure is measured and maintained	X
		The performance measure is measured, maintained and visually displayed on the work floor	XX
***	Possible Results:	This financial effect was not observed	
		This financial effect was observed	X
****	Possible Results:	(Top) management involvement is low	
		(Top) management involvement is medium	X
		(Top) management involvement is high	XX