Interactions between Lean Practices and Supply Chain Integration

(Favorable conditions for the extension of lean practices across a complex supply chain network)

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Table of Contents

Summary ............................................................................................................................................. 4

1. Introduction ....................................................................................................................................... 7

2. Literature Review & Development of Propositions ........................................................................... 9

3. Methodology ..................................................................................................................................... 18
   3.1 Research Design ............................................................................................................................. 18
   3.2 Data Collection ................................................................................................................................. 18
   3.3 Operationalization ............................................................................................................................ 19
   3.4 Data Analysis .................................................................................................................................... 20
   3.4 Methodological issues ....................................................................................................................... 20

4. Results ............................................................................................................................................... 22
   4.1 Organization and Processes .............................................................................................................. 22
   4.2 Lean (program) ................................................................................................................................. 23
   4.3 Supply chain ..................................................................................................................................... 28
   4.4 Knowledge ......................................................................................................................................... 32
   4.5 Systems ............................................................................................................................................ 33
   4.6 Research Questions ........................................................................................................................... 34

5. Discussion, conclusion and recommendations ................................................................................... 37
   5.1 Discussion & conclusion .................................................................................................................. 37
   5.2 Implications for Practice ................................................................................................................... 40
   5.3 Research limitations and recommendations (future research) ......................................................... 40

References ............................................................................................................................................... 42

Appendix I: Code list ............................................................................................................................. 46
Appendix II: Coding results on Lean ...................................................................................................... 48
Appendix III: Coding results on Supply Chain ....................................................................................... 61
Appendix IV: Coding network and interactions .................................................................................... 70
Appendix V: Final semi-structured in-depth interview script ................................................................. 71
Summary

Problem statement

Pharmaceutical manufacturers operate in a complex environment since their production process involves multiple inter-related steps that use numerous materials from many different suppliers. Mutual interactions between lean practices and supply chain integration across the supply chain network were previously studied, but no studies were found that described the conditions for lean adoption and integration within a complex (pharmaceutical) network. In this research we will investigate a theoretically robust framework. This can increase managers' understanding of the dynamic relations between supply network integration and lean practices within a complex network. It can also support their decision making during the (further) implementation of lean practices. Our research question (problem) is:

What are the favorable interactions and conditions for the extension of lean practices across a complex supply chain network?

Research method

This research involves a case study within a complex supply chain of a pharmaceutical industry. Data was collected from multiple sources to explore the possibilities of lean practices for supply chain integration within a pharmaceutical industry. This research is a case study that is explored from a dyadic perspective. Therefore, both buyers (companies) and suppliers were involved in the research. We identify themes through coding and explain patterns, to generate a new or modify an existing theory. The starting point of this research was an exploratory study that includes research of literature and conducting semi-structured interviews. Ten interviews were conducted. Eight of them were within the multinational pharmaceutical company and two of them were with the suppliers. All interviews were analyzed using a coding analysis method. To make coding of multiple interviews more convenient AtlasTI (CAQDAS program) was used.

Results

The environment in which this research was performed can be called complex. It is a multinational pharmaceutical company that has to use protocols, validations, and registrations if they want to change something in their process. The speed of change is very slow and can be an obstacle to implement lean. The time that is needed to make the changes, implement lean and make it part of the culture can be long (3-4 years). However, if the lean adoption is very well managed and executed in phases, a complex network doesn’t have to complicate the adoption of lean practices. Also, if the right tools (like for example RCA, 8-D method, KAIZEN events, PDCA and SIPOC) are implemented as part of the problem-solving method, the problem/obstacle can be solved more effectively.
The first important aspect to start with implementing lean is the available information. You must know where you are standing as a company. This can then be visualized and measured when the right matrices are in place. The key is to think in processes and choose a right metric. Matrices need to be supporting to what needs to be done. Second important aspect is commitment, both from the employees but most important from the management. Our findings show that there were always dedicated teams at the start of the adoption that were fully committed to the lean program. When KATA was implemented the managers had training themselves and were on the shop floor for a few weeks to experience and learn all the processes that they were about to change. This way as a sponsor they knew exactly what the processes were and what it was about. Real management sponsorship is not done behind a desk but is about understanding and being part of the process.

From our findings, the knowledge transfer seems a very important aspect when it comes to lean adoption and lean integration. In our study we saw that all the knowledge transferred was implied through training sessions.

Suppliers can be involved in lean adoption in several ways. In this case a lot of information was shared and agreements were made. It was obvious that lean implementation was a part of the supply chain strategy. This improved tremendously by setting up a department dedicated to the supplier and their performance/development. There is a lot of collaboration where the focus is on how to get the lower cost but also on improvements and innovation. There is contact between different departments. It is not just one point of contact. The technical knowhow needs to be found at both (supplier and customer). They need to communicate to make the best products. This is only possible when there is trust and a long term relationship with the supplier. The guarantee for the supplier of remaining a partner is; improving their performance, professionality, and their flexibility, preferable through lean adoption.

During our research it became clear that the companies have implemented lean through systems far towards their customers. Most customers have an ERP-system that is linked to the sites system so the visibility is there. At this moment there is no integration of systems on these sites with the suppliers. However, the sites are looking into these opportunities now as a next step towards the lean integration.

Recommendations for practice

All the steps that are taken to accomplish something need to be well thought through. This is what needs to be stated in the site portfolio and be a part of the supply chain strategy. When implementing lean within a complex network we recommend centralizing (standardize) the way of considering this lean principle. It is preferable to start the lean adoption internally and in different predefined streams. Supplier integration can be improved tremendously by setting up a department dedicated to the supplier and their performance/development.
Recommendations for further research

Two subjects that were mentioned were very interesting, but unfortunately could not be investigated due to lack of time and not being in scope of the research. One was the influence of the tender markets on adoption of lean. Suppliers mentioned tender markets as being difficult because they are unstable and therefore have a negative influence on lean adoption. This could be a subject for further research, as this was mentioned in one interview. A supplier also mentioned that listed companies have more difficulties in adopting lean then when a company is not listed (a family business), because their budget needs to be set in advance for the upcoming period and because they are held accountable to their shareholders when it comes to budget. This is also interesting to investigate in more detail. Is there any and if so, what is the difference between a listed company and a not listed one, when implementing lean?

Last but not least, in the discussion there are contradictive findings mentioned regarding the importance of accurate forecast by customers when adopting lean. There is one finding that the forecast can be let go of if a rhythm wheal has been implemented in collaboration with the supplier, and is in alignment with their manufacturing schedule. Because this was only based on one interview this conclusion needs to be taken into account very carefully. Further research on this topic would be an advice.
1. Introduction

Pharmaceutical manufacturers operate in a complex environment since their production process involves multiple inter-related steps that use numerous materials from many different suppliers. (Altria and Carleysmith 2009). Research of Azagedan et al. (2013) has found that the environmental uncertainty affects lean operations and lean purchasing practices. As a result, complex environments make it more difficult to identify, diagnose and respond to problems. Previous researches describe supply chain integration as a competitive resource that manufacturers use to create economic rents and also that this could affect the overall performance positively. Supply chain integration, customer-supplier collaboration and partnership have been the trend in business practice and management across industries. (Shou, Feng et al. 2013)

A new stream of literature tends to show that supplier performance is relationship-driven, what we also see in the case study by Shou, Feng et al. (2013). Lacoste’s and Johnson’s (2015) findings are slightly counter-intuitive. They find in their study that the supplier performance is process-driven. In this case they mentioned that the supply chain integration could have effect on supplier performance from the process driven perspective. One of the process driven tools is Lean supply chain modeling (Lacoste and Johnsen 2015). Lean supply chain modeling and infrastructural manufacturing decisions are two applications mentioned by Shou, Feng et.al (2013) that provides means to improve supply chains and by that supplier's performance. Based on the findings in case study of Lacoste et al. (2015) and Shou et al (2013) we can interpret that Lean supply modeling can be seen as a process-driven tool to improve the supplier's performance. However, in spite of the lean management projects, several companies failed to achieve a superior performance through lean management. (Bortolotti, Boscari et al. 2015).

Earlier study researched the mutual interactions between lean practices and supply network characteristics in order to understand how to create favorable conditions for the extension of lean practices across a supply network. No studies were found that described the conditions for lean adoption and integration within a complex (pharmaceutical) network

Their findings confirm that there is a mutual and recursive influence between supply network characteristics and practices for extending the scope of lean programs to the supply network. They found that supply network characteristics can either facilitate or complicate the adoption of lean practices, but also that the initial match/mismatch state of the supply network characteristics is not frozen and companies can lever on lean practices to modify it toward more favorable conditions. Based on these premises, they classified practices for extending the scope of lean programs to supply networks into four groups: supplier involvement, knowledge transfer, lean program commitment and lean program alignment.
Research Methodology & Research Questions

Proposal for this study is to investigate supply chain integration through lean practices classified by Bortolotti et.al (2016) and the drivers to participate in supply chain integration and collaboration in a complex pharmaceutical network. They suggest testing their results in other sectors and/or with different methodologies. This paper intends to investigate the mutual influence between lean practices and supply networks during the program for the extension of lean to the upstream and downstream network of a pharmaceutical company with a leading position in its supply network.

In this research we will investigate a theoretically robust framework. This can increase managers’ understanding of the dynamic relations between supply network integration and lean practices within a complex network. It can also support their decision making during the (further) implementation of lean practices.

This research involves a case study within the pharmaceutical industry. Data is collected from multiple sources to explore the possibilities of lean practices for supply chain integration within pharmaceutical industry. In this study we will explain the favorable interactions and conditions for the extension of lean practices across a complex supply chain network.

Following research questions will be answered.

RQ1: What is the effect of a complex environment (supply network) on the adoption of lean practices?

RQ2: What is the influence of the connected supply chain partners (supply chain integration and collaboration) on the adoption of lean practices?

RQ3: In what order and by which supply chain partners can the different lean practices be implemented to achieve supply chain integration and collaboration?

RQ4: What are the mutual interactions between lean practices classified in four groups (supplier involvement, knowledge transfer, lean program commitment and lean program alignment) within pharmaceutical industry supply chain?

The remainder of this paper is organized as follows. In this chapter there is an introduction to our research problem followed by four research questions. In chapter 2, the theoretical perspective on supply chain integration and lean management is provided. Based on a review of the literature, the propositions and a model (framework) are developed. Chapter 3 contains the discussion about the used methodology. In chapter 4 results of the empirical research can be found and in chapter 5 our discussion, conclusion and recommendations are presented.
2. Literature Review & Development of Propositions

Complex Environment

Pharmaceutical manufacturers operate in a complex environment since their production process involves multiple inter-related steps that use numerous materials from many different suppliers. Many of these manufacturers have implemented lean practices to reduce waste, cost, cycle time and variability in outputs (Altria and Carleysmith 2009). Reports show that pharmaceutical manufacturers implementing lean have reduced cycle time and improved efficiency of manufacturing and purchasing processes (Altria and Carleysmith 2009). Research of Azagedan et al. (2013) has found that the environmental uncertainty affects lean operations and lean purchasing practices. As a result, complex environments make it more difficult to identify, diagnose and respond to problems. For example, in a complex supply chain it may be harder to diagnose whether a production shortage was due to a quality issue in the raw material, a late delivery from a supplier, or an internal process issue that happened during final assembly. Complex environments also increase the likelihood of operational errors. For instance, organizations in a more complex environment have more suppliers, which increase the chances of errors in forecasting raw material requirements and managing in-bound logistics (Azadegan, Patel et al. 2013). The higher levels of unpredictability and instability in dynamic environments make it difficult for lean operations to synchronize production process and reduce inventory, which undermines the effectiveness of lean operations. (Azadegan, Patel et al. 2013). Previous researches describe supply chain integration as a competitive resource that manufacturers use to create economic rents and also that this could affect the overall performance positively.

Proposition 1: A complex environment complicates the adoption of lean practices.

Supply Chain Integration

Today, firms view supply chain management through integration as a strategic tool to increase their competitive advantage. This strategic view is encapsulated in the concept of the “supply chain strategy” (Qrunfleh and Tarafdar 2013). Supply chain strategy is defined as a set of practices utilized to integrate suppliers, manufacturing, warehouses, and stores so that merchandise is produced and distributed at the right quantities, to the right location, at the right time, in order to minimize system-wide costs while satisfying service level requirements. Supply chain spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption. (Qrunfleh and Tarafdar 2013). Based on the several researches we can conclude that the supply chain strategy represents a set of activities (practices) that accomplish key tasks in support of its supply chain strategy i.e. building relationship with suppliers, eliminating waste, facilitating customization, and sharing information within the supply chain (Li et al., 2005; Li et al., 2006; Wong et al., 2005; Zhou and Benton, 2007). These practices are believed
to represent the most important forms of integration that are employed in supply chains: external integration (which is captured by strategic supplier partnership) and delivery integration (which is captured by postponement) (Frohlich and Westbrook 2001). Strategic supplier partnership refers to the long-term relationship between the organization and its suppliers, which influences the strategic and operational capabilities of individual participating companies to help them achieve significant ongoing benefits (Li, Rao et al. 2005). This kind of partnership requires a high degree of coordination between the organization and its suppliers. It emphasizes a direct association with suppliers, encouraging mutual planning and problem solving efforts, continuous improvement programs, and selection of a few suppliers (Gunasekaran, Patel et al. 2001). The implementation of popular management practices (e.g. Just in time, Lean Six Sigma) facilitates widespread adoption of these practices across the industry; therefore, firms within an industry share similar practices, processes and standards (John, Cannon et al. 2001).

A new stream of literature tends to show that supplier performance is relationship-driven, what we also see in the case study by Feng et al. (2013). Lacoste’s and Johnson’s (2015) findings are slightly counter-intuitive. They find in their study that the supplier performance is process-driven. In this case they mentioned that the supply chain integration could have effect on supplier performance from the process driven perspective. One of the process driven tools is Lean supply chain modeling. Lean supply chain modeling and infrastructural manufacturing decisions are two applications mentioned by Feng et.al (2013) that provides means to improve supply chains and by that supplier’s performance.

As the main aim of the extension of lean programs is to minimize variability in the supply network, all the supply network actors should streamline and align the internal production systems, and connect them by ensuring that suppliers deliver just-in-time (Shah and Ward 2007). As the competitive landscape in manufacturing becomes ever more complex and dynamic, organizations need to better understand the effect on lean practices (Robert Mitchell, Shepherd et al. 2011). Bortolotti et al. (2016) confirm that there is a mutual and recursive influence between supply network characteristics and practices for extending the scope of lean programs to the supply network.

**Proposition 2:** The biggest driver for the network to participate in supply chain integration and collaboration is a positive effect on the supplier performance. Lean supply modeling can be seen as a process-driven tool to improve this supplier’s performance.

**Lean (program)**

Lean can be considered from both a philosophical perspective, related to guiding principles or overarching goals, and from a practical perspective, as a set of management practices, tools, or techniques that can be observed directly (Shah and Ward 2007). The origins of lean thinking can be found on the shop-floors of
Japanese manufacturers and, in particular, innovations at Toyota Motor Corporation (Hines, Holweg et al. 2004). These innovations, resulting from a scarcity of resources and intense domestic competition in the Japanese market for automobiles, included the just-in-time (JIT) production system, the Kanban method of pull production, respect for employees and high levels of employee problem-solving/automated mistake proofing (Hines, Holweg et al. 2004). Lean management is being seen as a powerful managerial approach that is widely recognized as improving the overall operational performance of accompany (Shah and Ward 2007). In fact, any concept that provides customer value can be in line with a lean strategy, even if lean production tools on the shop-floor, such as Kanban, level scheduling, or take time, are not used (Hines, Holweg et al. 2004). Lean as a concept has undergone a significant evolution and expansion beyond its origins in the auto industry, and its narrow definition around shop-floor improvement. Many critics were attacking lean at their respective time, yet often neglected the fact that lean has, and continues to develop (Hines, Holweg et al. 2004). Lean has evolved over time, and will continue to do so. As a result of this development, significant confusion about what is lean, and what is not has arisen – a fact clearly observable at both academic and practitioner conferences in logistics and operations management (Hines, Holweg et al. 2004). Hines et.al (2004) found that the distinction of lean thinking at the strategic level and lean production at the operational level is crucial to understanding lean as a whole in order to apply the right tools and strategies to provide customer value. There are a wide number of ways that managers can become aware of lean, its advantages, challenges faced in its implementation, and how these challenges are being addressed. Such management awareness can be obtained through a variety of external (e.g. professional conferences, use of consultants, visits to plants) and internal (speaking with other managers, lunch and learn sessions) information sources. Yet, despite these sources of lean information, their use by managers involved in lean activities and the overall value of such sources to the lean effort is considerably lacking (Boyle, Scherrer-Rathje et al. 2011).

An important issue in lean management implementation is the adoption of soft practices. Lean management is generally considered as an interrelated system of soft and hard practices (Shah and Ward 2007) and in line with this definition. Lean management practices are referred to as soft and hard. Soft practices concern people and relations, while hard practices refer to lean management technical and analytical tools. Soft practices are crucial for achieving superior performance through lean management (Samson and Terziovski 1999) and sustaining the performance in the long term (Hines, Holweg et al. 2004). It is also vital for lean principles and practices to be spread throughout the whole supply chain to derive the potential benefits of lean management (Womack and Jones 1996). In this respect, one of the main challenges that companies that embark upon lean initiatives are faced with is increased integration with their key suppliers and customers (Perez, de Castro et al. 2010). This is why an analysis of lean management should be addressed from both a company focus and a supply chain focus (Hines et al. 2004; Shah and Ward 2007).
A typical lean implementation involves an initial value stream mapping (VSM) which defines the journey of improvement. Next there is the organizing of the house. This might involve flexible work systems and (especially) 5S (sorting, straightening, systematic cleaning, standardizing, and sustaining). Thereafter other specific tools are implemented as relevant. These include standard work, single minute exchange of dies (SMED), total productivity maintenance (TPM), and mistake proofing (Jidoka). Further advancements might involve supply and demand, through just in time (JIT) pull systems and Heijunka (level scheduling) (Rivera and Chen 2007). According to Pearce and Pons (2013) is the integration between lean and production planning and control systems such as materials resource planning (MRP) also relevant. Specifically, lean is implemented in stages over time, by selecting tools that are appropriate to the organization at that point in time. It may be wiser to first implement simpler methods with the view of engagement and acceptance of staff as opposed to attempting to immediately introduce the more complex lean tools. Employees need to be engaged to support a difficult method (like JIT) (Pearce and Pons 2013).

**Figure 1 Lean Methods or Tools: A Selection of Some (Not All) of Lean Methods (Pearce and Pons 2013)**

**Supplier Involvement**

First of the practices studied by Bortolotti et al (2016) to extend the lean program is supplier involvement. Recently there has been renewed attention towards lean manufacturing, and in particular, Just-In-Time (JIT) practices, that are usually considered a powerful tool to reduce waste and inefficiency, speed up production processes, and increase delivery performance (Danese, Romano et al. 2012). Green et al (2014) also claim in their recent study that one advanced strategy (Huang, Qu et al. 2012) that has stood the test of time in fostering competitive advantage at the supply chain level is Just-in-Time or JIT (Green Jr, Inman et al. 2014). Recent work by Schoenherr and Swink (2012) confirmed that firms can significantly benefit from being strategically interconnected and aligned with their supply chain partners. External integration suggested by Green et al. (2014) via JIT-information and JIT-
sells can reduce uncertainties and enable better performance capabilities (Schoenherr and Swink 2012). Internal integration, e.g., purchasing, planning, manufacturing, logistics like suggested by Green et al. (2014) via JIT-production and JIT-purchasing, can benefit delivery and flexibility performance (Schoenherr and Swink 2012).

The definition of JIT is by Green et al (2014) defined in more detail than by other authors and they describe JIT as ‘total system JIT’ consisting of four elements: JIT-production, JIT-purchasing, JIT-selling, with the addition of an important new element, JIT-information (Green Jr, Inman et al. 2014). Danese et al (2012) and Romano et al. (2012) have found in their research that JIT production practices positively affect both efficiency and delivery. When efficiency is the priority, companies should direct their efforts on JIT production. However, when their aim is to maximize delivery, they should invest in both JIT production and JIT supply (Danese, Romano et al. 2012). Results found by Danese et al. (2012) advice managers to implement some JIT supply practices during the early stages of JIT production programs, because the total absence of any JIT linkages with suppliers can limit JIT production benefits on delivery performance.

Knowledge Transfer

The second practice studied to extend the lean program is knowledge transfer. In this study we will focus on Lean knowledge transfer and support in particular. (Flynn, Sakakibara et al. 1995), (Cua, McKone et al. 2001) and (Shah and Ward 2007) extended their lean model by including internal-related practices (e.g. Kanban, 5S, continuous flow, setup time reduction and employee involvement, and supplier-and customer-related practices, such as JIT deliveries, and supplier and customer involvement (ShahandWard,2007). Besides that Flynn et al. (1995) and Cua et al. (2001) emphasized the importance of human related practices in conducting continuous improvement programs, such as top management leadership for quality, small group problem solving, and employee training.

Improvement (lean) programs to transfer the operational knowledge among plants can be defined as ‘the systematic process of creating, formalizing and diffusing better operational practices in the intra-firm production network’ (H. Netland and Aspelund 2014). According to the previous studies both social mechanisms (e.g., social interactions among lean experts of different plants) and standards (e.g., lean knowledge codified in manuals) are generally important for sharing and improving lean practices in multi-national corporations (Boscari, Danese et al. 2016). Scholars agree that the effectiveness of mechanisms to transfer knowledge depends on whether the transferred knowledge is explicit or tacit, as explicit knowledge is easily codifiable and can be shared by means of documents, while tacit knowledge is difficult to codify and hard to convey without interaction between parties (Kogut and Zander 1993). This is in line with described findings of Boscari et al (2016) that the knowledge is shared by standards (explicit) or social mechanisms (tacit). Teamwork
and collaboration between plants (social mechanisms) are important to identify right directions for modifications and develop effective adaptations, as well as to avoid that unnecessary or detrimental modifications were made (Boscari, Danese et al. 2016). Also close interactions among experts of different plants can also help to improve lean knowledge over time (Ferdows, 2006). When we talk about teamwork then we also talk about the social aspect of it or in other words, the social mechanism. Social mechanisms can be used for training employees, thus creating lean cultural values (Shook, 2010). For example, teams can be created among lean experts of different plants to train employees (Ferdows, 2006; Netland et al., 2015). Moreover, training can be performed via ICT, such as by creating a shared database where plants can upload standardized documents on lean implementation to facilitate mutual learning (Bruun and Mefford, 2004). This last example is an example of explicit knowledge transfer. Unlike the other authors Dombrowski and Mielke (2014) claim that the leaders do not determine whether a process should be designed according to Kanban, 5S or whichever lean model. It is rather important to develop the employee and its process toward the desired target conditions. Self-development and qualification should be supported with standardized problem-solving routines, that aim on systematic and ritualized use of Plan-Do-Check-Act (Dombrowski and Mielke 2014).

Literature also provides evidence on the relevance of pressure, i.e., forcing the adoption of new practices and controls their implementation over time. When there is incongruence between knowledge and adopters' contextual conditions, pressure helps avoiding regressions in a program and triggers cultural change (Canato, Ravasi et al. 2013). Formal audits are a way to perform pressure: teams involving headquarters' lean experts visit subsidiaries and assess their maturity of lean implementation (Netland and Ferdows 2014).

**Lean Program Commitment**

The third practice to extend the lean program is lean program commitment. Boyle et al (2011) believe that managers need to continuously scan the internal and external conditions and set productivity and quality objectives and reinforce a culture of continuous improvement. Subsequently, it is expected that management commitment to lean will have a significant impact in overall lean success. Lean commitment is captured by the allocation of an industrial engineer for change, employee training, ensuring a sufficient number of employees are available to undertake lean improvement activities, providing employees time for learning and testing new techniques and processes, committing the necessary monetary investments and providing active supervisory management support (Boyle, Scherrer-Rathje et al. 2011). Reinforcing of the culture of continuous improvement can be managed by task support. Task support has a similarly positive influence on commitment. Task support is provided by co-workers, team members and supervisors to perform tasks and meet production and quality standards (Angelis, Conti et al. 2011).
Throughout a two-year study, Johnston and Staughton (2009) defined strategic relationships as long-term commitments of mutual co-operation, shared risks and benefits with much greater parity and power sharing between the parties as opposed to transactional relationships. On the other hand Guimaraes and Carvello (2013) refer relationships not to tasks but activities and processes and reflect the need for greater supplier control and dependency even for low criticality activities; partnerships now include critical tasks in a narrow scope but involving a great deal of trust; and finally, alliances are the most comprehensive outsourcing relationship, entailing high levels of criticality and scope involving high commitment, trust, risk and investment in resources and relationship management (Guimarães and Carvalho 2013).

The lean literature’s focus shifting from “how to go lean” to “how to stay lean” (Hines 2010) suggests that once the technical part of lean deployment is solved it is necessary to understand lean sustainability factors. The main reason pointed out in the literature for the failure of lean programs is the absence of work on the soft side, the relational aspects of lean deployment such as communication and the leadership that is essential for building a lean culture (Hines, Found et al. 2011). Working the soft side achieves people’s involvement through mutual respect and team work (Badurdeen, Wijekoon et al. 2011).

Popular trends of our time such as lean manufacturing and JIT production, improving optimization techniques, shortening of product life, extending of transportation networks but shortening of lead times all expose supply chains to more risks (Kırılmaz and Erol 2016). Risk identification is the first and the most important stage of the risk management. For an efficient risk management, supply chain must be divided into elements such as suppliers, manufacturers, warehouses, distribution channels etc. and the risks associated with each element should be examined and identified specifically and elaborately. This is called supply chain mapping and risk registering (Kırılmaz and Erol 2016)

**Lean Program Alignment**

Lean program alignment can be accomplished by sharing of proprietary information on internal processes and costs so as to allow counterparts in supply networks to align their processes and operational performance. Vanpoucke et al (2014) explain that to stay ahead of competition, a firm must share information with suppliers; set up systems and procedures to create smooth supply flows, which in turn help resolve every day supply problems; and ensure that buyers and suppliers both develop innovative supply chain projects to support long-term, cooperative objectives (Vanpoucke, Vereecke et al. 2014).

In buyer–supplier relationships, an integration sensing capability results from information sharing practices that inform partners about current and future physical flows (Vanpoucke, Vereecke et al. 2014). (Zhou and Benton 2007) show that such integration sensing significantly enhances supply chain practices (i.e., seizing). The
information exchanged might include inventory, replenishment, planning, forecasting and tracking data. A successful information exchange should be frequent, bidirectional, informal and non-coercive, so that it reduces bullwhip effects and supply chain costs (Vanpoucke, Vereecke et al. 2014). Then, by using the shared information, each partner can make better decisions about ordering, capacity allocation and production/material planning to optimize supply chain dynamics. Access to this information enables the buyer to sense what is happening in the supply chain and determine when and how to react by making changes to the supply chain (Gunasekaran and Ngai, 2004; Harland et al., 2007). Several studies describe that there needs to be some kind of supply chain strategy.

Alignment can also be monitored through performance measurement. The purpose of measuring organizational performance according to Gunasekaran and Kobu (2007) is to identify success; identify whether customer needs are met; help the organization to understand its processes and to confirm what they know or reveal what they do not know; identify where problems, bottlenecks, waste, etc. exist and where improvements are necessary; ensure decisions are based on facts and not on supposition, emotion, faith or intuition; and show if planned improvements actually happened (Gunasekaran and Kobu 2007). There is extensive literature on supply chain management that deals with performance management metrics. For effective performance evaluation, measurement goals must represent organizational goals and the metrics selected should reflect a balance between financial and non-financial measures that can be related to strategic, tactical and operational levels of decision making and control (Gunasekaran, Patel et al. 2004). Likewise, it is important to reduce many of the established performance metrics to a relatively low number that are more effective for performance evaluation (Arif-Uz-Zaman and Ahsan 2014).

**Classified Practices**

Based on paragraph 2.4 through 2.7 the classified practices for extending the scope of lean programs to supply chain into four groups are: supplier involvement, knowledge transfer, lean program commitment and lean program alignment. Based on the literature there are two propositions that capture the findings from the previous paragraphs.

**Proposition 3:** The classified practices for extending the scope of lean programs to supply networks are: supplier involvement, knowledge transfer, lean program commitment and lean program alignment.

**Proposition 4:** There is interaction between the lean practices classified in four groups within an integrated supply chain.
Research Model

A previous research by Bortolotti et al (2016) confirms that there is a mutual and recursive influence between supply network characteristics and practices for extending the scope of lean programs to the supply network. Based on this research and other case studies we designed the following conceptual model (framework).

![Conceptual Model](image)

**Figure 2 Conceptual model**
3. Methodology

In this chapter the methodology of this research will be described. The starting point of the study includes research of the literature and conducting semi-structured interviews.

3.1 Research Design

This case study will explore a research topic within a pharmaceutical network. The multiple-case study method is used to analyze supply chain integration using lean programs applied to three different companies within a pharmaceutical network.

We have chosen for an abductive approach where we will be collecting data from multiple sources to explore the possibilities of lean practices for supply chain integration within pharmaceutical industry. We will identify themes and explain patterns, to generate a new or modify existing theory.

3.2 Data Collection

This research is a multiple case study that will be explored from a dyadic perspective. Therefore both buyers (companies) and suppliers will be involved in the research. Seawright and Gerring (2008, pp 295-296) claim that the selection of cases has the same objectives as random sampling in that what is desired is a representative sample and useful variation on the dimensions of theoretical interest. However, given the difficulties of getting a representative case, on both practical and theoretical grounds, they suggest that purposive sampling may be more appropriate (Seawright and Gerring 2008). A selective, purposive sample was chosen from the network. This pharmaceutical network has multiple sites over the whole world. In the Netherlands there are three sites that are completely different from each other from different perspectives. They have different core business and different suppliers and in this case will be seen as multiple cases. For an overview of the analyzed network see table 1.
<table>
<thead>
<tr>
<th>Core business</th>
<th>Employees</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>Manufacturing and packaging of Human Health products and Active Pharmaceutical ingredients (API’s)</td>
<td>1500</td>
</tr>
<tr>
<td>Beta</td>
<td>Headquarter Netherlands, Human Health Packaging of Human Health products. Other products than in Case 1.</td>
<td>1100</td>
</tr>
<tr>
<td>Delta</td>
<td>Manufacturing and packaging of Animal Health products.</td>
<td>1400</td>
</tr>
<tr>
<td>Global Network</td>
<td>Product categories include diabetes, cancer, vaccines and hospital acute care.</td>
<td>69 000 (as of March 31, 2017)</td>
</tr>
<tr>
<td>Supplier Alpha</td>
<td>Specialized in packaging solutions for the branded and healthcare markets</td>
<td>1000-5000</td>
</tr>
<tr>
<td>Supplier Beta</td>
<td>Manufacturer of high-quality folding boxboard cartons for its customers in the pharmaceutical industry</td>
<td>51-200</td>
</tr>
</tbody>
</table>

Table 1: Members of the supply network analyzed and their characteristics

Semi-structured interviews will be conducted from both parties (buyers and suppliers) to collect the data. In this study we use the key informant method, interviewing a limited number of participants who all have knowledge of and experience with the use of lean practices.

3.3 Operationalization

In order to increase the reliability of the research we used a validated case study protocol (script) from a previous research (Appendix V), where data collection instruments, procedures and general rules for carrying out the case studies were formalized (Yin 1994). It also includes issues analyzes through case studies, developed on results of the literature review and improved through discussion and research with managers involved in a previous study. Therefore no additional testing of the protocol was needed.

The protocol covers:

- state of the supply network characteristics at the beginning of the lean program
- lean practices adoption, their implementations mode and supply network characteristics addressed; other actions activated, if any, and their objectives.
- state of the supply network after the adoption
3.4 Data Analysis

The prime sources of data were semi-structured interviews and findings of the researcher as an employee of the company. In the period between April 2017 and August 2017 eleven employees of several departments within the three sites and two suppliers were interviewed. Each conducted interview ranged from 60 to 90 minutes and was recorded and transcribed by the researcher. All interviews were analyzed using coding analysis method. To make coding of multiple interviews more convenient AtlasTI (CAQDAS program) was used.

To codify is to arrange things in a systematic order, to make something part of a system or classification, to categorize. Coding is a cyclical act. Rarely is the first cycle of coding data perfectly attempted. The second cycle of recording further manages, filters, highlights, and focuses the salient features of the qualitative data record for generating categories, themes, and concepts, grasping meaning and/or building theory. Coding is thus a method that enables you to organize and group similarly coded data into categories because they share same characteristics-the beginning of a pattern (Saldaña 2009).

First cycle coding was started with a few predefined codes that were based on the research questions and literature research. After the coding of the first interview more structure was needed. For this a second cycle coding was performed where existing codes were more structured and codes were added / changed. See appendix I for the full code list.

Through pattern matching and categorization a number of categorizes were formulated. Categories are Lean, Organization, Process, Knowledge, Supply Chain and Systems.

3.4 Methodological issues

Whether the case study is designed to be exploratory or explanatory, it must demonstrate that its means of measuring are valid. The primary concerns for case studies are construct validity (basically, whether the measurements reflect the phenomena they are supposed to) and internal validity (basically, the validity of the relationships B whether the conjectured relationships actually exist, as opposed to outcomes resulting from spurious relationships) (Stuart, McCutcheon et al. 2002).

Internal validity is the extent to which we can establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships (Yin 1989). To enhance internal validity, Yin suggests the researcher do “pattern matching”. Conducted interviews were summarized and pattern matching logic through coding was sufficient in this particular research.
To ensure construct validity the researcher must look for multiple sources of evidence for each of the important elements or variables in the propositions, using the important technique of *triangulation* (Jick 1979). In addition to interviews and direct observations, researchers own experience with the company (primary sources), companies' documents, reports and web resources were analyzed (secondary sources). Data analysis involved two steps: within-case analysis, and cross-case analysis. The within-case analysis makes it possible to compare practices implemented in the three case companies and cross-case analysis was done by looking into two most important suppliers of these companies.
4. Results

In total there were 10 interviews conducted and transcribed. Interviews are held in the period from April 2017-August 2017. Through coding analysis method the following results were found.

4.1 Organization and Processes

The MSD (Netherlands) was established in 2009, after a fusion of MSD and Schering Plough. In 2007 Organon Biosciences (Organon, Intervet and Nobilon) was taken over by Schering-Plough. Because of the fusion in 2009 Organon Biosciences became a part of a bigger multinational network MSD. MSD, in the United States and Canada operating under the name Merck & Co Inc., supplies a large part of the world with medicines and vaccines on several therapeutic fields. The headquarters is stationed in the United States and in 1954 the first site in the Netherlands (Beta) was established. When we look into organization that is described in several interviews, there are some relevant changes and improvements mentioned that were parts of the lean program.

A relevant change was setting up a department that is focused on supplier performance and development (SDPM). This organization is considered as an extension of lean to the supplier.

We saw some differences from one site to another. There are sites that lean management is more present in the culture and other sites where JIT or reductions of the lead times equals / less than some other sites. It is really what the sites drive is, what we drive to our suppliers (D 4 - 4:4)

Organization Improvements

A few improvements were mentioned although they were not all initiated by lean adoption, but for several different reasons. There is a new global operating model: Pull principal that changed the way they are working with their customers.

Rapid response will give us insight in our end to end inventory levels. From scratch to customer, so that is really helping in making the improvement and taking all those in between stocks that you don’t want to have (D 5 - 5:84). The supplier structure is being formed within global departments (corporate social responsibility) (D 3 - 3:5) Internal (waste) functions have been discontinued. Lean was adopted through this reorganization. In 2013 there was a new purchasing organization established (D 7 - 7:2).

Tier structure was set up were the focus is on evaluation of the processes at all levels in the organization. Tier 2 was improved a lot (D 7 - 7:16)
Processes

When we look into the processes (figure 3), the focus was mostly on the lead times (11) and standardization (11). These are also part of the manufacturing (6) process as a whole. There was some focus on quality (8). And based on the very low number of quotations about sustainability (2) of the processes and the sourcing (1) the focus on these topics was very small.

4.2 Lean (program)

From several interviews it is noticed that the lean adoption was not something that was optional for the several sites. It was centrally decided to implement lean through the whole global network of the company.

Structure (MPS) has been adopted from the mother company based on the Toyota production system (D3-3:1). They looked into the Toyota lean production system and started to adopt that. With adopting that they also started to change it because the pharmaceutical industry is different from the automotive in some respect (D5-5:14).

For site Beta this started in 2007 and for both site Alpha and Delta it started in 2010. Suppliers that were interviewed had their own lean program.

Lean adoption first started internally and was focused on three streams (phases). These streams were Org. Design, Line Design and Shop floor. Also what is very clear that there were several aspects that favored the adoption but also obstacles to adopt lean. The drivers to implement lean are very divers but the most important seem the cost reduction and performance. There is some alignment with the suppliers when it comes to lean adoption but this is not as far as the companies would like it to be.
As we look to lean adoption several aspects that go with it are mentioned in the interviews. In this chapter these aspects and the findings are summarized. More detail of coding analysis can be found in Appendix II.

Adoption

Shop-floor (stream 1)

In this phase introduction of standardized work, problem solving tool, visual management and communication processes (tier) took place.

We went to the shop floor and showed people how easy it would be and then you have this kind of upwards push that people in the shop floor really like (D5-5:56). If you can manage to get the operators more engaged into their work than the quality will increase (D8-8:8). In the last 5 – 6 years they accomplished that the manufacturing process became the core business.

The tier process is all about the manufacturing operation and the focus is on problem solving (D1-1:62). But what it also does it gives ownership to the operators. The operator really could drive their line and they could improve their own lines (D5-5:58).

The key is to think in processes and choose a right metric. Matrices need to be supporting to what you are doing. You need to work together with the people on the floor. You sometimes need to follow your feelings and do those things very subtle (D2-2:9).

Line Design (stream 2)

Line design (planning concepts, flow lanes, introduction of the rhythm weal) (D 1-1:36). First you have to bring order into your internal processes and get your internal flow better to be able to act fast on your surroundings (D 6 - 6:65)

When we look into the line design there are three subjects that were mentioned the most. That was planning, flow (rhythm weal) and sourcing.

Org. Design (stream 3)

Org Design (factory in factory models (IPT’s), less layers, span of control). How can we design our organization so that the lean manufacturing is being supported? (D 1-1:38). In 2012 reorganization took place, where the main focus was on the organization structure (D 7- 7:1)

Adoption-Tools

It comes down to using the right tools. Every company and every situation need a certain tool to use. What sometimes works for one supplier it doesn’t work for another. It depends on the situations (D 8 - 8:66). During several interviews a few tools that have been used during adoption, and are still being used, were mentioned (figure 4).
Adoption-Favored

What the company did very well is that they centralized the way that they were looking into this lean principle. There was one structure and everybody needed to work within that structure (D 5 - 5:53). There is willingness, because you are getting better as a company (D 8 - 8:72). If you understand that you gain certain profit by solving a problem then lean can be very subtle. That is my driver to implement lean here (D2 - 2:5).

We had program that was called “inclusion”. With this project we trained people how to get included more into their daily business and with other colleagues (D 2 - 2:13).

You need to have a future state in your mind when you want to change something. If you don’t have a future state in your head than you can’t be a good sponsor. Some leaders are not good sponsors because they only think about the production progress (D 2 - 2:8).

Most important thing to start with implementing lean is your available information. You have to know where you are standing as a company. What is je score, what is your waist, what is your output and your yield? This information was easy available and of very good quality in our company, so that was a good start (D10 - 10:10).

When we look into the number of quotations than knowledge is the biggest what favored the adoption. Several benefits and sponsorship are the other aspects that favored the adoption the most.

Adoption-Obstacles

There are many (if not the most) quotations about obstacles (figure 5). A few have been subcategorized to get a better insight about the obstacle details.
Forecast and Environment have most quotations. Resistance and Speed of change have also a high number of quotations but slightly less than the previous two. Lowest number of quotations is found for Culture and Resources.

However, when we look closely into the quotations themselves the sites experience the company culture and resistance as the biggest obstacle. As third and fourth big obstacles the forecast and speed of change were mentioned.

From several interviews (both sites and suppliers) it is very clear that lean adoption takes a couple of years until it is fully implemented. It depends on how far are they already. If you have to start from scratch, it takes 3-4 years (D8 - 8:52).

You see a lot of changes and you have to be careful with changing a lot at the same time. You have to recover from some changes (D6 - 6:104).

Adoption-Power

Power has not been directly part of the research but it was mentioned several times and enough to dedicate a code to it.

It was not that one site decided to introduce the Merck Production System (MPS), which is the variant of Lean Six Sigma that we have. It is more that centrally it was decided that all production sites should change over (D 5 - 5:15). Our plant director wanted someone there to push the lean principles to make it happen. It is change management (D 5 - 5:62). This is the plan and this is what we are going to do. Resistance was not an option (D 6 - 6:74).

Drivers

There are several drivers to adopt lean (figure 6). For the sites it was centrally decided but from several interviews it became clear what the drivers behind this decision were. Also from suppliers perspective the drivers are the same and also named as most important.
It is very clear that cost reduction, performance and lead time reduction by far are the biggest drivers to adopt lean. The most pressure comes from the market and costumers. This is the same for both, the companies and their suppliers.

**Management**

Lean is a part of the company strategy and it is integrated into the company DNA. The most important change in lean management was the decision to manage the manufacturing through “make to stock” principal instead of “make –to-order”. The performance is being managed through matrices.

All the steps that are taken to accomplish something need to be well thought. This is what you do in your site portfolio. (D 6 - 6:62). Think about every step .You have to know where you want to be in about 5 years (D 6 - 6:63). This program was changed from direction a few times because of the several causes along the way. Sometimes we took another turn than first thought, in some cases as a pilot (D 6 - 6:80). You see a lot of changes and you have to be careful with changing a lot at the same time. You have to recover from some changes. (D 6 - 6:104).

**Alignment**

Based on the interviews there is some alignment and information sharing with the supplier.

However, it was also mentioned that a lot of information is company critical. The suppliers don’t want to share company Information (D 8 - 8:22).

The work sessions with the vendors were mostly about the costs, variable versus fixed costs (D 1 - 1:50). With the top suppliers we share the “on time in full” and “first pass quality” (D1-1:97).There are KPI’s in place for the suppliers and if a supplier shows a very bad performance and we don’t want to get rid of this supplier. Then we look into how we can get the supplier to improve (D 8 – 8:25). There is intention to
look into the possibility of providing the suppliers with our planning and they plan and supply the packaging materials, also from the order to stock perspective (D 1 - 1:94).

**Commitment**

Several interviews show that there were always dedicated teams at the start of the adoption that were fully committed to the lean program.

Everybody has to stand in front of the car and pull it together. And it is OK if you go and sit on the car for a while and are not pulling but resting. But walking behind the car with you heals in the ground is not acceptable. In past, we kept those people but now we have to say goodbye. Feel the pain and go on (D 10 - 10:56). What we need to make sure is that we don’t stop to change and keep going (D 6 - 6:106)

Also it is very clear that all the management had training themselves in how to manage and implement lean, but also they made sure that they understand the processes that they were changing.

For the management, there was “lean leadership training” (D 77:12). When we implemented the Kata, I and another leads took the training ourselves and have been on the shop floor for a few weeks to see and learn all the processes that we were about to change (D 6 - 6:81)

If you want to implement something, this needs to be done top-down. You have to have your buy-in from your manager. I call it rather buy-in than sponsorship but in fact it is the same (D 8 - 8:55)

4.3 Supply chain

In this case we looked into the supply chain as a whole. We looked into the interactions of the companies with their suppliers, but also with their customers. This was done from perspectives, customers and suppliers.

**Customer (markets)**

Sites that were interviewed have integrated lean management far towards the customers, but there is almost none lean implementation upstream towards the suppliers. There were several programs where this multinational company completely reorganized the way that they are working with the customers. The demand has been split off in 5 regions. That is different from before. At the customers end there were changes in structure like introduction of local sales organization.

If you look into the way in how the relationship was built in the last couple of years we saw that first we had this department centralized in one country that dealt with all the customers interregional and they were kind of mailman doing all this communication and now we are dealing with this more directly and we have this
communication matrix (per region and country) so people really understand who to talk too directly if they need to (D 5 - 5:73).

The customers are being involved into the standardization activities where there is the explanation given so they understand what the benefits are there for them. In the case of the supply chain towards the customer the main focus was on the order management, lead time and inventory management.

The most of the sites within this multinational network were managed by “make to order” principal and now they are implementing the “make to stock” principal. For make to order orders the customer is the one that owns the batch and the process so they need to create the delivery and for the “make-to-stock” orders, which are being pushed by the supplying site, they do the delivery creation because they are pushing out (D 5 - 5:72). Order management was done very poorly by the regions and we saw a lot of times that supplying sites tried to make the delivery but the order wasn’t clean (credit blocks). And then you had a large e-mail correspondence. So, we change the way we did that (D 5 - 5:70).

They build the forecast and put it into the system. So that really has also changed a quite a bit because now they are driving that more by looking into the statistical forecasting instead of the historical forecasting (D 5 - 5:75)

What is also interesting and contradictory to other findings is that the site (Beta) that has the “make-to-order” principle doesn’t focus on the forecast any more for certain products. The orders were made 3-5 days before the start of production. They had to make the internal changes first to be more responsive towards the customers. We didn’t do this by telling the customer to be better at forecast or change anything. We decided to not be sensitive to this and let go of the forecast (D 6 - 6:66).

Collaboration and Performance measurement

The focus of lean management implementations was very internally focused and there were services offered to make the lean integration possible by the suppliers and the company only had to accept it. These services were not initiated by them directly but by the suppliers. For example the vendor managed inventory of the safety gear has been initiated by the supplier.

There is a department established in 2012 that is fully dedicated to the supplier development and their performance. Supplier Development and Performance Management (SDPM) are connected to the procurement department. This organization is being seen as an extension of lean to the supplier. At first they were working on supplier interruptions and supplier issues. They visited the suppliers to solve the issues and help develop the suppliers. Now they are working together with the supplier to have a better performance.
The biggest change that was mentioned a few times is that the supplier portfolios are getting smaller. Every supplier that you can get rid of is a cost reduction according to both the sites and the suppliers.

There is a lot of collaboration where the focus is on how to get the lower cost but also on improvements and innovation. An example is an introduction of a rhythm weal with supplier at site Beta. We chose together for a rhythm weal of a week. We order on a fixed day and they start production also on a fixed day. The schemes of ordering and reducing have been aligned with each other. In this way they could be more efficient and site Beta could also be more efficient (D 6 - 6:24). What you see at our biggest supplier that they are also moving along with us (D 6 - 6:34).

Improvements and innovations that are looked into together as a new improvement are for example digital printing and incoming inspection. Digital printing is expensive to implement, but the benefit is that there is no setup time, like in classic printing and a specific amount (also small) can be bought per each. Classic printing is interesting when you have a lot of orders (about 5000) and digital printing is more interesting for smaller order amounts (D 6 - 6:57).

Also specification release at the supplier has our focus. We are testing the goods but the supplier is testing also. The specifications are not exactly the same, but this is possible to implement. Suppliers outgoing inspection is for 85% the same as incoming inspection at the sites. Their production can be faster if the release is at the source (supplier). Waiting time is less if the product can be released based on the release of the supplier (D 9 - 9:33).

From the supplier perspective there are also interesting quotes made regarding to the tender market in association with lean adoption. Tender market has a lot of influence on the suppliers that are involved in the tender markets.

For a tender you have to give your lowest price. Than Ixion can come along and they try to get the price even lower. Sometimes they go so far that you price is lower than your cost price and then you have to choose because if you lose those packages it is also dangerous. So, you go on otherwise you can lose your business but you are delivering under your cost price so you are losing money. In this case you have to reach out to improve your business and reach out to your network to make the improvements together, so you don’t lose your money to this tender (D 10 - 10:45).

**Supplier Involvement**

Suppliers can be involved in lean adoption in several ways. In this case there was a lot of information sharing and agreements were made. If there are issues there is direct contact and they solve these together by discussing them.

There has been some involvement into inventory management. The driver was that we wanted to get rid of the inventory in our warehouse. Together with the suppliers
we came up to the idea to receive goods from supplier per order (customer). For a few components we have introduced VMI (D 6 - 6:13)

We are looking into “what buttons” can be pushed. Where can we do something on this part? First one is the certification of our suppliers. The more suppliers get certified as “certified supplier” the sampling is less. This is an advantage. By certifying our biggest supplier we reduced our lead time of the packaging materials from 10 to 5 days (D 2 - 2:41).

This research shows very clear that there were no resources involved from the supplier into the lean adoption of the several sites. There were only a few work sessions. Their role was very limited because the lean implementation was focused on internal company processes (D 1 - 1:44).

What you see is that the way we source is pretty classic. We want to have the cheapest product, lowest price and long pay term. That is what we do and we could do a lot better if we would integrate that more and give suppliers insight in our planning and really make sure that they are part of our process and we don’t do that yet (D 5 - 5:38).

Suppliers’ performance is being measured and managed through an assessment. TCA is some kind of questionnaire that is being sent to the supplier to do a self-assessment D 8 - 8:24.

A few future lean implementations are mentioned:

Also, there were initiatives to set the TQA (Technical Quality Agreement) up differently. The tests that are being performed for the release of, for example, packaging materials are the same at release by the vendor as at release by our site (D 7 - 7:6)

JIT deliveries is a future state what we would like to implement (D 7 - 7:33)

**Partnerships**

Long term relationship and trust is most important in the strategic partnership with the supplier. Biggest strategic partner of this multinational company delivers to the 16 sites (D 3 - 3:38). They are also working with other suppliers to become strategic partners (D 3 - 3:39).

From the suppliers perspective it is also very important to build partnerships with these sites.

We like to share our knowledge with our customers to come up with mutual projects to get a better performance. If we work together we are being a better partner and for us that is a better guarantee than a contract (D10 - 10:17)
In both situations, your guarantee of staying a partner is improving your performance, professionalism and your flexibility. If we didn’t come along with lean adoption and improved than we wouldn’t exist anymore or be so successful (D 10 - 10:58)

When you build a partnership you “click in”. I call that “clicking in” because you have to click in on several levels. You click in with procurement, you click in with quality. You make agreements with logistics and manufacturing. You have to make agreements on every level and you are being audited. (D 10 - 10:59)

**Relationships**

There are enough points of contacts. When you look into supply, customers, quality and manufacturing there is contact between different departments. It is not only one point of contact. The technical knowhow needs to be found at both (supplier and customer). They need to communicate to make the best products. This is very important. This is only possible if you have a long term relationship with the supplier. You have to be open to each other if you want to grow together (D 9 - 9:27).

This company’s focus is on top-40 critical suppliers. There is structure to manage the strategical relationship (D 1 - 1:84). We look for Win-win situations in our relationship with vendors (D 6 - 6:30).

You have to build a good relationship and have to trust each other. There a lot of vendors that we have built this. We share information. If there are issues there is direct contact and we solve these together by discussing them (D 6 - 6:37). There is frequent communication and information sharing about design and engineering activities attitude towards quality and problem solving (D 9 - 9:28). Sometimes we need to make small changes in our production to make your production better (D9 - 9:23)

What is also mentioned by one of the suppliers is that building a long term relationship with a listed supplier is more difficult than building a relationship with a “family” business.
For a listed company that is not so easy. The management changes often, if they not perform well. So every time a new management you have to start over again with building that relationship (D 10 - 10:3).

**4.4 Knowledge**

**Supply chain: training**

There were several knowledge transfers from the sites to their suppliers and their customers in order to make lean adoption possible. The training is provided by the SDPM department to the suppliers.

We have sent our LSS engineers to them to introduce Lean and think together (D 6 - 6:36).
If the supplier want to change and adopt lean at their company, than we are on a whole another level. They can get custom made training programs. We do this a lot. For example 5S courses (D 8: - 8:34). As an example I give black belt membership training at one of our suppliers. These members than can train others in their company (D 8 - 8:87).

**Employee training**

On staff level there was a lot of communications about MPS (work shop/ training). For the employees there was an introduction program (1 week) where MPS and lean were explained to all employees. These training sessions were about lean and lean tools. Also the yellow belt program has been rolled out. Every employee needs to have a lean six sigma yellow belt. For the management there was “lean leadership training”. At the start they had officers who were hired from Toyota and automotive industry, to adopt that way of working. Lean knowledge is now in the training system so everybody gets the training. MPS room has been set up for the meetings with the employees.

Parallel to the lean program at site Beta their biggest supplier also started with the lean introduction and training of the employees.

**Resources**

You had international MPS team, global MP team and European MPS team and then you had MPS teams on the sites and they were really driving the changes but also driving the knowledge on the sites. There was yellow-, green- and black belt program (D 5 - 5:54).

At the start there was a dedicated team of people, and after a while this was more because of the integration in the organization. The total duration of the program was 1, 5 years. There was a go life period of 6 months (D 7 - 7:9).

Now there are Improvement engineers in every business unit (IPT) (D 7 - 7:13).

**4.5 Systems**

Most customers have an ERP-system that has been linked to the sites system so the visibility is there. At this moment there is no integration of systems on these sites with the suppliers. Other site (Belgium) is further in this and they are implementing this this year. They have an EDI (Electronic Data Interchange) system with supplier Alpha.

There has been program (Day Light) that is still intact that manages some sort of VMI (Vendor managed inventory). This program is a platform that is in place in between our IT-systems. It looks daily/weekly into your system for a forecast. I puts this data into out IT system and this calculates what need to be produced and when (D 9 - 9:31)
Site Alpha is looking into this opportunity. It is now possible for site Alpha to look into this kind of integration because they have just implemented a whole new IT-landscape where ERP-system is managing everything.

**Data Accuracy**

To be able to have the systems work properly the data needs to be very accurate. That is what has been mentioned a lot.

If there is already an ERP-system in place the changes need to be made there also. For example the delivery lead times need to be in line with the ERP-system data. That is what the customer wants. Release of a product should be within those lead times.

Implementing a whole new IT-landscape in a global network is very complex.

### 4.6 Research Questions

This paper intends to investigate the interactions between lean practices and supply chain integration. What are the favorable interactions and conditions for the extension of lean practices across a complex supply chain network?

**RQ1: What is the effect of a complex environment (supply network) on the adoption of lean practices?**

A multinational company and their complex supply network were investigated. We see some differences from one site to another. There are sites that lean management is more present in the culture and other sites where JIT or reductions of the lead times equals / less than some other sites.

It was centrally decided to implement lean through the whole global network of the company. They looked into the Toyota lean production system and started to adopt that. With adopting that they also started to change it because the pharmaceutical industry is different from the automotive in some respect. What they did very well is that they centralized the way that they were looking into this lean principle. There was one structure and everybody needed to work within that structure. Lean adoption first started internally and was focused on three streams (phases). These streams were Shop floor, Line design and Org. design. There was a lot of interaction with VCM (Value Chain Management, global). They have an oversight of the whole supply chain. Downstream oriented but from the raw materials all through to the patients.

How far the site is with the integration with their suppliers is dependent on how far the sites are with their lean improvements themselves.

From several interviews (both sites and suppliers) it is very clear that lean adoption takes a couple of year until it is fully implemented. It depends on how far are they already. If you have to start from scratch, it takes 3-4 year.
RQ2: What is the influence of the connected supply chain partners (driver, supply chain integration and collaboration) on the adoption of lean practices?

The focus of lean management implementations was very internally focused and there were services offered to make the lean integration possible by the suppliers and the company only had to accept it. These services were not initiated by them directly but by the suppliers. There is a department established in 2012 that is fully dedicated to the supplier development and their performance. Supplier Development and Performance Management (SDPM) are connected to the procurement department. This organization is being considered as an extension of lean to the supplier. At first they were working on supplier interruptions and supplier issues. They visited the suppliers to solve the issues and help develop the suppliers. Now they are working together with the supplier to have a better performance. There is a lot of collaboration where the focus is on to get the lower cost but also on improvements and innovation.

RQ3: In what order and by which supply chain partners can the different lean practices be implemented to achieve supply chain integration and collaboration?

Most important thing to start with implementing lean is your available information. You have to know where you are standing as a company. What is je score, what is your waist, what are your output and your yield?

All the steps that are taken to accomplish something need to be well thought. This is what you do in your site portfolio. Think about every step. You have to know where you want to be in about 5 years. This program can changed from direction a few times because of the several causes along the way. Sometimes the sites took another turn than first thought, in some cases started projects as a pilot. There are a lot of changes and you have to be careful with changing a lot at the same time. You have to recover from some changes before you go on with a new change.

Lean adoption first started internally and was focused on three streams (phases). These streams were Shop floor, Line design and Org.design. Also what is very clear that there were several aspects that favored the adoption, but also obstacles, to adopt lean.

This research shows that there were no resources involved from the supplier into the lean adoption of the several sites. There were only a few work sessions. Their role was very limited because the lean implementation was focused on internal company processes. However, there was some alignment with the suppliers when it comes to lean adoption.

Several interviews show that there were always dedicated teams at the start of the adoption that were fully committed to the lean program. Also it is very clear that all the management had training themselves in how to manage and implement lean, but also they made sure that they understand the processes that they are changing. If
you want to implement lean, this needs to be done top-down. You have to have sponsorship from your manager.

**RQ4: What are the mutual interactions between lean practices classified in four groups (supplier involvement, knowledge transfer, lean program commitment and lean program alignment) within pharmaceutical industry supply chain?**

Interactions that were found between the lean practices classified are shown in the figure below (figure 7). However, there are more findings about this topic that will be discussed in the next chapter. For a more complex network (Interactions) of lean adoption and integration see Appendix IV.

![Figure 7 Interactions between classified practices](image)

**What are the favorable interactions and conditions for the extension of lean practices across a complex supply chain network?**

Based on our findings we found a new model (figure 8) that is slightly different but it is an addition to the previous research model.

![Figure 8 Revised model](image)
5. Discussion, conclusion and recommendations

5.1 Discussion & conclusion

The main goal of this study is to investigate supply chain integration through lean practices and the drivers to participate in supply chain integration and collaboration within a complex pharmaceutical network. What are the favorable interactions and conditions for the extension of lean practices across a complex supply chain network?

Pharmaceutical manufacturers operate in a complex environment since their production process involves multiple inter-related steps that use numerous materials from many different suppliers (Altria and Carley Smith 2009). When we consider the environment in which this research was performed, it can be called complex. It is a multinational pharmaceutical company where the changes that need to be made, need to be done through protocols, validations and registrations. The speed of change is very slow and can be an obstacle to implement lean. The time that is needed to make the changes, implement lean and make it part of the culture can be long (3-4 years). However, if the lean adoption is very well managed and executed in phases a complex network doesn’t have to complicate the adoption of lean practices. Reports show that pharmaceuticals manufacturers implementing lean have reduced cycle time and improved efficiency of manufacturing and purchasing processes (Altria and Carley Smith 2009). Our empirical findings are supporting this. Literature study also implicates that the complexity of the environment makes it more difficult to identify, diagnose and respond to problems (Azadegan, Patel et al. 2013). Our findings are slightly contradictive to these studies. We find that if the right tools like for example RCA, 8-D method, KAIZEN events, PDCA and SIPOC are implemented as a part of the problem solving tools the problem/obstacle can be solved more effectively. According to the literature study complex environments also increase the likelihood of operational errors. For instance researchers like Azadegan et al (2013) are implicating that the organizations in a more complex environment have more suppliers, which increase the chances of errors in forecasting raw material requirements and managing in-bound logistics. Our study does not support this completely. We found that when lean is being implemented in phases where one of the phases is Line design, than these kinds of operational errors can be reduced if not eliminated.

Another important obstacle that was found in our research but not found in our literature study is the forecast of the manufacturing company/market. The forecast needs to be accurate to be able to implement JIT together with the supplier. However, within our study there are also contradictive findings about this topic. We found that it is possible to integrate the supply chain through rhythm wheal introduction, where the rhythm wheal of ordering of certain materials is aligned with
the production scheme of the supplier. In this case the forecast is not important and is not an obstacle.

Strategic supplier partnership influences the strategic and operational capabilities of individual participating companies to help them achieve significant ongoing benefits (Li, Rao et al. 2005). This kind of partnership requires a high degree of coordination between the organization and its suppliers (Gunasekaran, Patel et al. 2001). Suppliers can be involved in lean adoption in several ways. In this case there was a lot of information sharing and agreements were made. It was very obvious that lean implementation was a part of the supply chain strategy. This improved tremendously by setting up a department dedicated to the supplier and their performance/development. There is frequent communication and information sharing about design and engineering activities attitude towards quality and problem solving. There is a lot of collaboration where the focus is on how to get the lower cost but also on improvements and innovation.

There is contact between different departments. It is not only one point of contact. The technical knowhow needs to be found at both (supplier and customer). They need to communicate to make the best products. This is only possible if there is a long term relationship with the supplier. A good relationship and needs to be built and there needs to be trust. The guarantee for the supplier of staying a partner is improving their performance, professionality and their flexibility, preferable through lean adoption.

Alignment can be monitored through performance measurement. The purpose of measuring organizational performance according to Gunasekaran and Kobu (2007) is to identify success. We found that one of the important aspects to start with implementing lean is the available information. You have to know where you are standing as a company. This can be visualized and measured when the right matrices are in place. The key is to think in processes and choose a right metric. Matrices need to be supporting to what needs to be done. Corresponding to a previous study by Arif-Uz-Zaman and Ahsan (2014), it is important to reduce many of the established performance metrics to a relatively low number that are more effective for performance evaluation.

Second important aspect is commitment, both from the employees but most important from the management. Subsequently, according to Boyle et.al (2011) it is expected that management commitment to lean will have a significant impact in overall lean success. Also literature study shows that the lean commitment is captured by the allocation of an industrial engineer for change, employee training etc. Our findings support this and show that there were always dedicated teams at the start of the adoption that were fully committed to the lean program. When KATA has been implemented the leads had training themselves and have been on the shop floor for a few weeks to see and learn all the processes that they were about to change. This way as sponsor they knew exactly what the processes were and what it
Real management sponsorship is not something behind a desk but understanding and being part of the process. The commitment by the employees is being favored by the introduction of TIER-process. The TIER-process is all about the manufacturing operation and the focus is on structural problem solving. The tools are helping but the biggest change is the mindset of the people to put manufacturing processes first. It gives ownership to the operators.

From our findings the knowledge transfer seems a very important aspect when it comes to lean adoption and lean integration. In our study we saw that all the knowledge transferred was tacit (Kogut and Zander 1993), through training sessions. At the start the training was provided by hiring external parties specialized in lean practices. The employees were also trained (Yellow belt, Green belt and Black belt) to give the training themselves internally. Yellow belt training is part of the employee development program and is mandatory for all the employees. There are no findings that support the explicit knowledge transfer while adopting lean within these companies and by their suppliers. There have been several knowledge transfers from the sites to their suppliers and their customers in order to make lean adoption possible. The training was/is provided by the dedicated department (SDPM) to the suppliers.

During our research it became clear that the companies have implemented lean far towards their customers. Most customers have an ERP-system that has been linked to the sites system so the visibility is there. At this moment there is no integration of systems on these sites with the suppliers. However, the sites are looking into these opportunities now as a next step towards the lean integration. To be able to have the systems work properly the data needs to be very accurate and this is also associated with accurate forecast.

**Conclusion**

What are the favorable interactions and conditions for the extension of lean practices across a complex supply chain network?

We have found that lean needs to be adopted and integrated in phases and not by changing everything at the same time. Important aspect is commitment, both from the employees but most important from the management (sponsorship).

The tacit knowledge transfer seems a very important aspect when it comes to lean adoption and lean integration. Training session, by dedicated teams that were fully committed through the adoption and after the adoption of lean, favored the adoption.

The involvement of suppliers can improve by setting up a department within a company dedicated to managing the supplier portfolio and helping them to develop and achieve better performance through lean adoption. This can be accomplished through information sharing but also knowledge transfer. The next step to fully integrate the supply chain is through the ERP-systems.
5.2 Implications for Practice

Most important thing to start with implementing lean is the available information and knowledge transfer. You have to know where you are standing as a company. All the steps that are taken to accomplish something need to be well thought. This is what needs to be stated in the site portfolio and be a part of the supply chain strategy. When implementing lean within a complex network we recommend centralizing the way of looking into this lean principle. One structure needs to be created and everybody needs to work within that structure. It is preferable to start the lean adoption internally and in different predefined streams. The streams that we recommend are Shop floor, Line design and Org. design. If the lean adoption and integration is very well managed and executed in phases a complex network doesn’t have to complicate the adoption of lean practices. RCA, 8-D method, KAIZEN events, PDCA and SIPOC can be implemented as a part of the problem solving tools. When using these tools the problem/obstacle can be solved more effectively. Supplier integration can be improved tremendously by setting up a department dedicated to the supplier and their performance/development. Also from our findings the tacit knowledge transfer, through training sessions, seems a very important aspect when it comes to lean adoption and lean integration.

5.3 Research limitations and recommendations (future research)

There are some limitations that occurred during this research. For example because of the time that was available for this research only one pharmaceutical multinational company and its complex network were researched. There are several sites within the network that have been involved, but it was within the same network. However, the sites were different legacy sites so there were some differences in how the sites were setup originally, before the lean adoption.

Also we made a choice to research only two biggest suppliers (long term relationship) that were in the network for this research and this could have been more if there was more time. Although, the expectation is that this would not have given different results than found now.

What is also observed that it was in favor of the research that the researcher is an internal employee of one of the sites, so the interviewee were very open in their interviews and gave a lot of information. This was also a pitfall for both interviewee and the researchers because the interviews were very long and a lot of “chit chat” has been going on. However, this also worked in favor because a lot of information that has not been asked was revealed and was interesting for this research.

There were two subjects mentioned that were very interesting, but because of lack of time and not being in scope of the research couldn’t been investigated more deeply. One was the influence of the tender markets on adoption of lean. Suppliers mentioned tender markets as being difficult because they are unstable and therefore
have a negative influence on lean adoption. This could be a subject for a further research, as this has been mentioned in one interview and therefore not enough evidence that this true. A supplier also mentioned that listed companies have more difficulties in adopting lean than when a company is not listed (a family business), because of their budget that needs to be set in advance for the upcoming period and because they are accountable to their shareholders when it comes to budget. This is also interesting to investigate in more detail. Is there any and if so, what is the difference between a listed company and a not listed one, when implementing lean?

Last but not least, in the discussion there are contradictive findings mentioned regarding the importance of accurate forecast by customers when adopting lean. There is one finding that the forecast can be let go of if a rhythm wheal has been implemented in collaboration with the supplier and is in alignment with their manufacturing schedule. Because this was only based on one interview this conclusion needs to be taken into account very careful. Further research on this topic would be an advice.
References


Interview transcripts (documents) references:

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## Appendix I: Code list

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### Appendix II: Coding results on Lean

#### LEAN

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| **Adoption**   | 19                   | D 3- 3:1 Structure adopted from Merck (Mother Company) based on the Toyota production system (Merck production system).  
D 5- 5:14 They looked into the Toyota lean production system and started to adopt that. With adopting that they also started to change it because the pharmaceutical industry is different from the automotive in some respect.  
D 5- 5:29 Oss started in 2010 and Haarlem was working on that since I think 2007.  
D 1- 1:51 Lean management implementation was focused on three streams.  
D 10 - 10:29 I think that after a year we were on track, but it was not yet imbedded in the genes. It was still some pushing and pulling. It takes a long time until it is fully embedded in your organization. I think that you need about 3 years to be fully adopt it and embed this in your company. |
| **Adoption-Org Design** | 12               | D 1- 1:38 Stream 3: Org Design (factory in factory models (IPT’s), less layers, span of control). How can we design our organization so that the lean manufacturing is being supported?  
D 5 - 5:59 I was part of the MPS team that did the Org design.  
D 7- 7:1 In 2012 a reorganization took place, where the main focus was on the organization structure. |
| **Adoption-Line Design** | 45 (total)       | D 1- 1:36 Stream 2: Line design (planning concepts, flow lanes, introduction of the rhythm wheal).  
D 8- 8:51 The most important part of this is the feedback arrow. As soon as we start to give feedback about a process than we are starting to improve. This can take time. It is not a project for three months. To be able to get something like this into a company in an efficient and effective way it takes about 4 years.  
D 1 - 1:79 End to end planner is responsible for the network and makes decisions for the network. Longer term planning is the responsibility of the end to end planner.  
D5 - 5:65 What you saw there is that where we already had shipping calendars for trucking we speeded those up for the... |
larger countries in Europe

D 6 - 6:17 They are ordered (per lot) every week and are delivered within that week. We have a buffer of 3 days before it needs to be on the line for packaging.

D 6 - 6:25 We chose together for a rhythm wheal of a week. We order on a fix day and they start production also on affix date. The schemes of ordering and producing have been aligned with each other.

D 1 - 1:40 These were focused on economic order quantities based on introduction of rhythm wheals and flow lanes.

D 5 - 5:13 They started a few years ago with something that is called SMED (Single Minute Exchange of Die. It comes from the automotive industry and it really narrows down the change over time in the production lines. That was the start.

D 6 - 6:7 What you is that we defined a lot of things to make a better flow in the company and reduce cycle times. We had 6 weeks of lead time within production and this has been reduced to 2 weeks.

D 6 - 6:65 First you have to bring order into your internal processes and get your internal flow better to be able to act fast on your surroundings.

D 6 - 6:87 In my opinion you don’t go to your supplier’s first but look into your own business first and start the changes. As long as your internal flow has a too long lead time (8 weeks) you don’t need to look outside.

D 9 - 9:12 In this case we have to have some lean management as there is as less as possible movement. Flow of the production has to be a straight line.

D 2 - 2:16 We have to change our processes to be able to get our stock levels down. You need a metric where it is visual that somebody has ordered something, we put it in our warehouse, and then the time that is needed to take that certain material into production. You would like to have this consumed within a week or 3 days.

D 4 - 4:9 We have some suppliers shipping from US to Haarlem and that is the opposite from lean management and that is what we are trying to fix and align with our business strategy.

D 6 - 6:28 After this we had a big program to innovate and implement the VMI.

Adoption-Shop floor

21

D 1 - 1:35 Stream 1: Shop floor (standardized work, problem solving tool, tier process e.g.)

D 1 - 1:62 In the last 5 – 6 years we accomplished that the manufacturing process became the core business. The tier process is all about the manufacturing operation and the focus is on problem solving.

D 2 - 2:9 The key is to think in processes and choose a right metric. Matrices need to be supporting to what you are doing. You need to work together with the people on the floor. You sometimes need to follow your feelings and do those things very subtle.
D 5 - 5:56 We went to the shop floor and showed people how easy it would be and then you have this kind of upwards push that people in the shop floor really like.

D 5 - 5:58 But what it also does it gives ownership to the operators. The operator really could drive their line and they could improve their own lines. They could really see what they can improve there.

D 2 - 2:31 Make life easier for everyone!
I think that because of the tier structure our communication became better. Everybody is able to tell their story in a TIER on every level.

D 7 - 7:18 The tier process is all about the manufacturing operation and the focus is on structural problem solving. The tools are helping but the biggest change is the mindset of the people to put manufacturing processes first.

D 8 - 8:8 If you can manage to get the operators more engaged into their work than the quality will increase.

D 10 - 10:12 Employees come weekly together with their leads. The leads also share information with each other in presence of the production director, weekly. What we discuss there is how did the week go? What is good and what are the issues? What projects are there? What changes are there? On several moments there are picture made on the shop floor if something occurs and also this is discussed.

**Adoption-Tools**

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| 1:45 | Additional question (interviewer): Did you also discussed or implement something like a pull system or JIT? Yes, for our not order specific materials. |
| D1 | 1:46 Partnership with our supplier of Safety gear is vendor managed inventory. |
| D 1 | 1:54 A few tools were implemented. Tier processes, problem solving tools, flow and pull introduction. |
| D 2 | 2:25 Visual management is the most important in my opinion. We have a MPS-room where everything about the project is made visual. |
| D 2 | 2:39 What you see is that we have a lot of matrices. For me the SIPOC is the most important to manage. It should always be in the lead. That is your process. Management need to look into to their processes (input and outputs) and manage that. We must not become the matrix managers. |
| D 3 | 3:28 RCA’s / CAPA’s methods. Root cause analysis and the actions followed. Those two are most powerful tools of lean that have been implemented here. |
| D 8 | 8:19 We use an 8-D method. This is a form. If you have a complaint you can manage this through 8 steps as a mini project. First step is to find out what the real problem is. Do we know what the problem is? What is the scope? For this there is a tool called “5W2H” (What, who, when, where, why, how, how many?). |
A 5S tool that has been explained as an example is the "shadow board". For examples for tools needed in the production. Every tool has its own place.

Also here it comes down to using the right tools. Every supplier and every situation needs a certain tool to use. What sometimes works for one supplier doesn't work for another. It depends on the situations.

We have set up a KAIZEN room where we had weekly meetings with all employees.

The tools are helping but the biggest change is the mindset of the people to put manufacturing processes first. A few years ago manufacturing was not defined as most important.

We still have practice Lean in the company, it was a total mindset change. Lean is now embedded deep in the core of the company.

The tools are helping but the biggest change is the mindset of the people to put manufacturing processes first.

Then, somebody from external comes in and explains it to them. Based on that they understand and want to change. The changes were very practical, but they understood and wanted to enter the change journey.

Lean manufacturing is a mindset. The door needs to be opened to each other (supplier/customer). We see here some changes. In the past it was impossible for supplier to look into the production process of the customer. Now we are being invited to see the production and issues, so we can look for a solution or a design together. Sometimes we need to make small changes in our production to make your production better. This was a mindset change.

If you talk about SCM than I think we didn't use lean principles enough in the last couple of years but that has changed with adoption of the rapid response and the Darwin team. So, then we really looked in how we could improve our way of working in the SC.

Well, I think what MSD did very well is that they centralized the way that they were looking into this lean principle. There was one structure and everybody needed to work within that structure.

There is willingness, because you are getting better as a company

If you understand that you gain certain profit by solving a problem then lean can be very subtle. That is my driver to implement lean here.

If we would step back from that way of sourcing and do it in the way that I just said that in the end the benefits, also in the terms of costs, are much better than what we do now.
D 8 - 8:71 If a supplier is open to the change and they see the benefits they change. In this case you have a win-win situation.

D 10 - 10:37 We didn’t allocated a certain budget for this. We said, we are going to do this fully committed and the benefits are going to be much bigger than the costs. We think about the costs, but we are not limited by them.

D 2 - 2:13 We had program that was called “inclusion”. With this project we trained people how to get included more into their daily business and with other colleagues.

D 4 - 4:6 So, we use what Haarlem implemented with our suppliers, aligned with procurement of course to the other sites.

D 6 - 6:99 Take an active role and understand, for example what triggers their reimbursement. Discussion with the governments: what triggers their notifications? If you don’t understand this you can’t make changes.

D 8 - 8:41 When someone external comes to your company, especially for you, to help you to get your company to a higher level and you need to give a presentation to this person while your manager is also there, that totally another setting. When you do this internally you will not accomplish same results.

D 10 - 10:10 Most important thing to start with implementing lean is your available information. You have to know where you are standing as a company. What is your score, what is your waist, what are your output and your yield? This information was easy available and of very good quality in our company, so that was a good start.

D 10 - 10:15 There were at the beginning also projects that didn’t go as expected. We had to start over and had to take some extra training on lean because we didn’t do the things right away. But, that is also a learning curve that we have experienced together with all the employees. For that reason it is now anchored in our genes.

D 2 - 2:8 You need to have a future state in your mind when you want to change something. If you don’t have a future state in your head than you can’t be a good sponsor. Some leaders are not good sponsors because they only think about the production progress.

D 6 - 6:73 Sponsorship!!! We had a burning platform and sponsorships.

D 6 - 6:82 This way we as sponsor knew exactly what the processes were and were it is about. You see often that the sponsorship is often available, but from behind the desk but in fact real sponsorship is something else. It is understanding and being part of the process.

D 8 - 8:54 In this case there are three answers: management, management and management.

D 10 - 10:52 I think the enthusiasm and the vision of our production director, together with our Quality manager, have been very important. But also the commitment of myself and our whole MT.
### Adoption-Obstacles

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Count</th>
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<tbody>
<tr>
<td>Culture</td>
<td>10</td>
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<tr>
<td>Environment</td>
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<tr>
<td>Forecast</td>
<td>18</td>
</tr>
<tr>
<td>Resistance</td>
<td>15</td>
</tr>
<tr>
<td>Resources</td>
<td>5</td>
</tr>
<tr>
<td>Speed of change</td>
<td>15</td>
</tr>
<tr>
<td>(total)</td>
<td>90</td>
</tr>
</tbody>
</table>

D 6 - 6:32 What you also see is that we often think to know how processes work at the supplier without looking into it more deeply and find out that it can be done differently.

D 10 - 10:40 What you also see is that our company is a listed company (a family business) in contradiction to the supplier. They are not so flexible in spending money. Everything is budgeted in advance. That is very frustrated. Because when such a project starts, you have to keep feeding it, you have to make and keep your people enthusiastic and not have to stop because of the low budget. That is killing for this kind of projects.

D 1 - 1:65 Internal: cultural aspect was the biggest change and gave biggest obstacle.

D 6 - 6:105 You see changes where people need to be trained or they forget the rules or need to get used to the new rules (procedures).

D 8 - 8:38 The management is trying to get the operators to change and to implement new things but the operators have their own company culture. They don’t want to change nor understand.

D 10 - 10:14 In fact, you are working on a culture change. This takes a long time, it doesn’t happen fast and from day to another.

D 1 - 1:100 When we look to the obstacles: - global, local and regional decisions. Who? What? When?

D 3 - 3:14 Those philosophies of lean are known for a very long time but we as a pharmaceutical company are our own break on this topic.

D 5 - 5:30 In 2009 MSD took over Schering-Plough and there you see a big split between the SP network and you have Organon there somewhere, and the MSD network. Up until 1 or 2 years ago people talked about the two networks (red and the green heritage).

D 5 - 5:79 In the last couple of years the sites really attend to want to decide for themselves also in logistics. If you look from wider perspective and from a company like MSD I think that you can’t look into logistics from site by site but look into it internationally.

D 7 - 7:19 Roles and responsibilities had been changed significantly. It took a long time for people to settle and get used to the new roles and take responsibility for that.

D 10 - 10:18 In the meantime we also have a lot of problems with the tender market. We all know that a tender is very bad. The forecast and the information are very unreliable.

D 10 - 10:23 Pharmaceutical industry don’t like changes because if they want to change they need to do that through protocols, registrations, validation and so on.
D 2 - 2:21 To be able to manage it in this way we need to get stable internally. Our forecast and our production.

D 4 - 4:10 to make it happen (lean management) we need accurate forecast form each site (customer) otherwise it is not possible.

D 6 - 6:48 The challenge was how we manage this increased incoming flow with the same amount of people.

D 6 - 6:68 We are very slow in the supply chain, because of the long lead times. Because of these long lead times it is not possible to have a more accurate forecast than 60%.

D 7 - 7:25 At some point there was more sales than forecast, so more pressure in the production.

D 9 - 9:8
The next step would be forecast sharing. This is difficult because a certain discipline needed on site to setup a reliable forecast and maintain it. The basic principle of a site like Oss to become more lean and integrated is to get the forecast reliable. Forecast, forecast, forecast.

D 5 - 5:55 There was a lot of mistrust from Organon people towards MSD. MSD I pretty metric focused and the want to know the details have everything calculated. There was a lot of resistance.

D 6 - 6:76 We always have a reason why not to change.

D 8 - 8:65 Further, when you get into each layer of the organization you come across different obstacles. When you have a group of 10 people, 8 of them want to change, 1 of them is very enthusiastic and 1 doesn’t feel like doing it.

D 10 - 10:55 None, that we couldn’t over win. We had resistance from some employees but those left the company. And some employees had to leave because they couldn’t come along in this new situation. There were employees that didn’t want to change but there were also some that didn’t came along and we had to say goodbye very carefully to the both groups.

D 3 - 3:23 One example is a supplier that is too expensive and gives a lot of problems is still our supplier, while we can have a better supplier. The one that already supplies to another MSD site and is very reliable. Because of the lack of resources and time, this change has still not been made.

D 8 - 8:42 When you do this internally you will not accomplish same results. There is no time, another priorities etc., so the change project doesn’t start or has progress.

D 6 - 6:85 You have to look into your issues and parallel how many resources you need to solve them. Some issues can be solved fast and some need to have a project based approach. You just have to start!!

D 3 - 3:16 There are a lot of initiatives to integrate and optimize the supply chain, but we are our own break. We as a site are not so good in executing these initiatives. Internally the changes are managed through change management systems, so this change has been requested at the Technical Department and they declined the request because of lack of resources (no time for this).
D 3 - 3:17 Speed of change is a problem in this company. Changes take too long.

D 6 - 6:43 In my opinion implementation went to slow so I decided to take the Kata Approach.

D 6 - 6:64 What you see is that companies often take the steps to implement lean at first line suppliers or customers to fast.

D 6 - 6:104 You see a lot of changes and you have to be careful with changing a lot at the same time. You have to recover from some changes.

D 8 - 8:52 It depends on how far are they already. If you have to start from scratch, it takes 4 year.

Adoption-Power 10

D 5 - 5:15 So, it was not that one site decided to introduce the Merck Production System (MPS), which is the variant of Lean Six Sigma that we have. It is more that centrally it was decided that all production sites should change over.

D 5 - 5:62 Our plant director wanted someone there to push the lean principles to make it happened. It is change management.

D 6 - 6:74 This is the plan and this is what we are going to do. Resistance was not an option.

D 8 - 8:78 I explain that if they don’t do it they will lose their business and then they have to do it. Because they feel force in the first place it is not a fun job to do.

D 10 - 10:27 Of course, you can start a project and hire a black belt and start. But then it is a project that is being pushed and forced and this needs to get slowly into your genes.

Drivers 99 (total)

D 11:30 Because of the takeover of the company by Merck it was not a choice in the first place. We had to follow Merck in its lean introduction for our site.

D 5 - 5:70 Order management was done very poorly by the regions we saw a lot of times that supplying sites tried to make the delivery but the order wasn’t clean. And then you had a large e-mail correspondence. So, we change the way we did that.

D 6 - 6:50 The challenge now is how do we get the ordered pallet directly into the production area and don’t have to put it somewhere else first.

D 10 - 10:38 Yes, but the costs are not the main factor where we base our decision on. We look more into the automation. That is a goal by itself. Of automation makes you more flexible and according the calculations your payback time is 8 years, we still go on with the project. Also if you can be more sustainable by doing improvement, we don’t talk about money. Costs is never a driver to not to go on with improvements.

D 4 - 4:2 We are really here to set the strategy to work on what you are mentioning which is Increase agility of our sites through our suppliers. Reduce the lead time, reduce the minimum of the quantities and we should find plans to help the sites to get that agility and flexibility.
<table>
<thead>
<tr>
<th>Drivers-Cost reduction</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D 1</strong> - 1:31 However, pharma industry in general has a focus on efficient production, cost reduction, customer focus.</td>
<td></td>
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<tr>
<td><strong>D 1</strong> - 1:32 There is a lot of pressure from financial perspective (lower costs) and regulatory perspective to produce more and better.</td>
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<tr>
<td><strong>D 2</strong> - 2:14 Our planners procure a lot, even the materials that we don’t need for a long time. Idea of dock to stock is to order the packaging materials when needed, not put them in the warehouse, but directly to the production lines. So, if you order too much it stops when there is no space at the production line.</td>
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<tr>
<td><strong>D 3</strong> - 3:35 Analysis has been done last year to reduce the tail spend. Re-allocate these with as less as possible resources. Cost and time savings. Less reports if we have less suppliers.</td>
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<tr>
<td><strong>D 6</strong> - 6:3 We had to look into the subject like cost reduction. At the end we choose the path of the Lean and make drastic changes, because we knew if we don’t do that we would be next on the list for closure.</td>
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<tr>
<td><strong>D 9</strong> - 9:14 We have seen that in the previous decennia the pharmaceutical industry has (don’t get me wrong) earned enough of money and were not very focused on the costs or reducing the costs. They didn’t look into what they buy. Last years there is more focus on the cost price of their products.</td>
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<tr>
<td><strong>D 9</strong> - 9:15 A company can’t exist without profit. The price of the product needs to be conform markets and the cost of that product need to be as less as possible for a certain quality grade that you want to deliver. At this point lean manufacturing is where you need to look at.</td>
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<tr>
<td><strong>D 10</strong> - 10:5 The pressure from the market is the cost pressure. The pressure from our customers is from our partners is high and because they are partners you want to come to a better performance.</td>
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<tr>
<td><strong>D 10</strong> - 10:44 Also because a lower cost has already been agreed with the tender, that can also be a reason to start improvements at the suppliers. Or to decrease the lead times.</td>
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<tr>
<td><strong>D 10</strong> - 10:63 I think that that is the biggest change compared to the old times. The supplier portfolios are getting smaller. Every supplier that you can get rid of is a cost reduction.</td>
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<thead>
<tr>
<th>Drivers-Performance</th>
<th>17</th>
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</thead>
<tbody>
<tr>
<td><strong>D 3</strong> - 3:22 Resources for change is possible when there is a big issue with a supplier. Only if there is big trouble (manufacturing can’t go on) the changes can go faster. We can do this better.</td>
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<tr>
<td><strong>D 6</strong> - 6:1 The performance of the company was not very good.</td>
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<td><strong>D 6</strong> - 6:2 We had to change something to be able to keep existing as a site.</td>
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<tr>
<td><strong>D 10</strong> - 10:5 The pressure from our customers is from our partners is high and because they are partners you want to come to a better performance.</td>
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<tr>
<td>Drivers-Lead time</td>
<td>15</td>
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<tr>
<td>D 2 - 2:41 What I have done. We are looking into “what buttons” can be pushed. Where can we do something on this part? First one is the certification of our suppliers. The more suppliers get certified as “certified supplier” the sampling is less. This is an advantage. By certifying our biggest supplier we reduced our lead time of the packaging materials from 10 to 5 days.</td>
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<tr>
<td>D 5 - 5:22 To avoid that and to bring down these stock situations, to be in control and to be able to narrow down the lead time to our customer I think that is why they come up with lean six sigma</td>
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<tr>
<td>D 10 - 10:19 We were working on projects to accomplish shorter lead times, but we needed their commitment. Because if they were gone in two months we would have a problem. We came through this together and we started improvement project together to shorten the lead time. We went from 10 days to 9 days and at the end to 7 days.</td>
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<tr>
<td>D 10 - 10:43 There could be some costs topics in the discussion but this is not most important. Mostly we talk about the reliability of the delivery, the lead times, quality guarantee etc.</td>
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<tr>
<td>Drivers-Inventory</td>
<td>11</td>
</tr>
<tr>
<td>D 2 - 2:16 We have to change our processes to be able to get our stock levels down. You need a metric where it is visual that somebody has ordered something, we put it in our warehouse, and then the time that is needed to take that certain material into production. You would like to have this consumed within a week or 3 days.</td>
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<tr>
<td>D 2 - 2:17 Within the stock to dock project we focus on the packaging materials because that is our biggest stream of materials. It is easy to implement these because for example with the raw materials you get the discussions like what about the strategic stock build. Some raw materials are rare and we have to build strategic stock on them. This can’t be delivered Just in time.</td>
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<tr>
<td>D 5 - 5:84 Rapid response will give us insight in our end to end inventory levels. From scratch to customer , so that is really helping in making the improvement and taking all those in between stocks that you don’t want to have. So, that is really driving that.</td>
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<tr>
<td>D 6 - 6:19 Benefit of ordering per lot is that there are no depreciation because there is no inventory.</td>
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<tr>
<td>Drivers-Customer focus</td>
<td>11</td>
</tr>
<tr>
<td>D 1 - 1:33 the company had a lot of focus to the emerging (new) markets where the costs price is very important.</td>
<td></td>
</tr>
<tr>
<td>D 5 - 5:18 That means that the customer already had to wait a long time for their products, because we do have already long lead times in our industry. And if that lead time is not secure than it really annoys the customers.</td>
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<tr>
<td>D 10 - 10:32 think that the most important trigger was the pressure of the markets. We knew that we needed to do something there.</td>
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<tr>
<td>D 10 - 10:57 The biggest change is that we have a much better vision. That we want to be the best in the class. We became a much more reliable partner to our customer and much more of a professional partner. And for those customers that demand a better performance, we are the partner that they want to work with. If we don’t do this for those demanding clients they just say goodbye to you. You have to be in that adoption phase of lean to be able to collaborate in the projects together with those customers. For some customers we needed to change and we came along with them, but some customers were behind in this and we helped them to get to the higher level and take steps.</td>
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<td>Column</td>
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</tbody>
</table>
| Drivers-Cutting resources | D 2 - 2:6 Not “implement” lean, because we are implementing lean to reduce in headcount. That is a side that I don’t like but I want to create a finer working place for everyone.  
D 55:63 People that don’t really see the future in there, they don’t cooperate, and that is what you saw. And you saw that more in the middle management then along the operators. That was a strange thing, but at the end everyone knew from the Org design phase that the middle management would be the one that would be gone.  
D 7 - 7:31 In 2012 it became all about survival. A big reorganization took place were a whole layer of management and departments was gone. The fear of not surviving as a department was bigger than the fear to learn and improve, so you learn and improve.  
D 10 - 10:56 Everybody has to stand in front of the car and pull it together. And it is OK if you go and sit on the car for a while and are not pulling but resting. But walking behind the car with you heals in the ground is not acceptable. In past, we kept those people but now we have to say goodbye. Feel the pain and go on. |
| Drivers-Stability | D 2 - 2:21 To be able to manage it in this way we need to get stable internally. Our forecast and our production.  
D 2 - 2:22 Yes, we have project team of 4 people. At this moment we are working on the stability of the logistics department first. So, work on the project itself is very limited now.  
D 5 - 5:17 The reason for that is that the manufacturing was very unstable. You couldn't really tell the customer when is something coming off the line, because the planning was very inaccurate |
| Management | D 1 - 1:60 We were an organization that was managed by make to order principal and now we are implementing now the “make to stock” principal.  
D 2 - 2:37 In the matrix management you don’t only look into the matric itself. Is t “green” or not. You have to look into it in a way that you know that you are doing the right things to get somewhere within a year. Achieve your goals. Management needs to work together on this part. We need to manage processes and not matrices.  
D 2 - 2:39 What you see is that we have a lot of matrices. For me the SIPOC is the most important to manage. It should always be in the lead. That is your process. Management need to look into to their processes (input and outputs) and manage that. We must not become the matrix managers.  
D 3 - 3:32 Lean is so integrated and is a part of our company DNA. Not all actions can be linked to lean in particular. Lean is a part of the strategy that we have on site.  
D 6 - 6:62 All the steps that are taken to accomplish something need to be well thought. This is what you do in your site portfolio.  
D 6 - 6:63 Think about every step .You have to know where you want to be in about 5 years. |
This program has changed from direction a few times because of the several causes along the way. Sometimes we took another turn than first thought, in some cases as a pilot. You see a lot of changes and you have to be careful with changing a lot at the same time. You have to recover from some changes.

Alignment | 12  |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>D 1 - 1:50 The work sessions with the vendors were mostly about the costs. Variable versus fixed costs.</td>
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<tr>
<td>D 1 - 1:94 There is intention to look into the possibility of providing the suppliers with our planning and they plan and supply the packaging materials. So also from that perspective order to stock</td>
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<tr>
<td>D 6 - 6:32 What you also see is that we often think to know how processes work at the supplier without looking into it more deeply and find out that it can be done differently</td>
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<tr>
<td>D 6 - 6:97 It is important for them to understand. We often fill in the needs of a customer or marketing ourselves and think to know what they want and need and this is often not the case. We need to talk to them and understand each other needs to be able to standardize.</td>
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<tr>
<td>D 8 - 8:22 Al lot of information is company critical. The suppliers don’t want to share company information.</td>
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</tbody>
</table>

Alignment-Performance | 14  |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>D 1:97 Do we share some information with our suppliers (matrix, KPI’s)? Yes, with the top suppliers we share the “on time in full” and “first pass quality”. Matrixes were the strategic conversations are about.</td>
<td></td>
</tr>
<tr>
<td>D 8 - 8: This is being sent for different reasons. If a supplier shows a very bad performance and we don’t want to get rid of this supplier. We than look into how can we get the supplier to improve.</td>
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<tr>
<td>D 8 - 8:69 We have already KPI’s for our suppliers in place.</td>
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<tr>
<td>D 8 - 8:90 Well, we did this performance management already but differently. When you look into SDPM now there are 3 categories of “clients”.</td>
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<tr>
<td>D 10 - 10:51 For everybody it is clear what the status is of the company when they see the visualized Measurements. We have several goals set on these measurements.</td>
<td></td>
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</tbody>
</table>

Commitment | 14  |
<table>
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<tbody>
<tr>
<td>D 1 - 1:52 At the start there was a dedicated team of 18 people, and after a while this was more because of the integration in the organization.</td>
<td></td>
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<tr>
<td>Commitment-Management</td>
<td>21</td>
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<tr>
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<tr>
<td><strong>D 6B - 6:61</strong></td>
<td>think about where you want to go with your company and stick to the plan.</td>
</tr>
<tr>
<td><strong>D 6 - 6:106</strong></td>
<td>What we need to make sure is that we don’t stop to change and keep going.</td>
</tr>
<tr>
<td><strong>D 10 - 10:31</strong></td>
<td>We also made mistakes in our set up of the groups and need to change this. Also here you need to create a broth group with a full commitment.</td>
</tr>
<tr>
<td><strong>D 10 - 10:56</strong></td>
<td>Everybody has to stand in front of the car and pull it together. And it is OK if you go and sit on the car for a while and are not pulling but resting. But walking behind the car with your heals in the ground is not acceptable. In past, we kept those people but now we have to say goodbye. Feel the pain and go on.</td>
</tr>
<tr>
<td><strong>D 6 - 6:81</strong></td>
<td>When we implemented the Kata, I and another leads took the training ourselves and have been on the shop floor for a few weeks to see and learn all the processes that we were about to change.</td>
</tr>
<tr>
<td><strong>D 6 - 6:82</strong></td>
<td>This way we as sponsor knew exactly what the processes were and were it is about. You see often that the sponsorship is often available, but from behind the desk but in fact real sponsorship is something else. It is understanding and being part of the process.</td>
</tr>
<tr>
<td><strong>D 7 - 7:12</strong></td>
<td>For the management there was a “lean leadership training”.</td>
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<tr>
<td><strong>D 8 - 8:54</strong></td>
<td>In this case there are three answers: management, management and management.</td>
</tr>
<tr>
<td><strong>D 8 - 8:55</strong></td>
<td>If you want to implement something like mentioned earlier than this needs to be done top-down. You have to have your buy-in from your manager. I call it rather buy-in than sponsorship but in fact it is the same.</td>
</tr>
<tr>
<td><strong>D 8 - 8:76</strong></td>
<td>But also here the top management needs to see the importance of that. You need your buy-in. Even if you a big customer and the top management don’t see the importance you have a problem.</td>
</tr>
<tr>
<td><strong>D 10 - 10:7</strong></td>
<td>We always worked on some projects, there was always something to improve. But, it was always very small scale. Than we decided to do something else. With our MT we went to a course. It was something like a green belt, it was an introduction course on the green level. This was to make the MT aware Our Quality manager wen further in this, for his black belt.</td>
</tr>
<tr>
<td><strong>D 10 - 10:9</strong></td>
<td>Whole our MT and leads had the course and we began with lean after this.</td>
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</tbody>
</table>
## Appendix III: Coding results on Supply Chain

### Supply Chain

<table>
<thead>
<tr>
<th>Customer</th>
<th>Number of Quotations</th>
<th>Quotations examples (not all)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>50 (total)</td>
<td>D 1 - 1:61 We have integrated lean management far towards the customers, but there is almost none lean implementation upstream towards the suppliers.</td>
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<td>D 5 - 5:65 What you saw there is that where we already had shipping calendars for trucking we speeded those up for the larger countries in Europe.</td>
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<td>D 5 - 5:67 And what you see now because of the Darwin program we completely reorganized the way that we are working into the customers. The demand has been split off in 5 regions. That is different from before.</td>
</tr>
<tr>
<td>Inventory</td>
<td>4</td>
<td>D 7 - 7:21 At the customers end there were changes in structure. Introduction of local sales organization.</td>
</tr>
<tr>
<td>Lead time</td>
<td>7</td>
<td>D 5 - 5:73 If you look into the way in how the relationship has been built in the last couple of years we saw that first we had this department in Luzern that dealt with all the customers interregional and were kind of mailman doing all this communication and now we are dealing with this more directly and we have this communication matrix so people really understand who to talk too directly if they need to.</td>
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<tr>
<td>MTO/MTS</td>
<td>5</td>
<td>D 6 - 6:96 We also call them about our standardization activities and explain to them so they understand what benefits are there for them.</td>
</tr>
<tr>
<td>Order management</td>
<td>14</td>
<td>D 6 - 6:99 Take an active role and understand, for example what triggers their reimbursement. Discussion with the governments: what triggers their notifications? If you don’t understand this you can’t make changes.</td>
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<td>D 1 - 1:59 We are getting a pull signal from the planning system of the market to produce to be able to manage their stock between a minimum and a maximum.</td>
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<td>D 1 - 1:74 Previously mentioned “make to stock”. The relationship between manufacturer (us) and customer (distribution center) has been changed tremendously. The distance between manufacturing site and customer was bigger in the past. The manufacturer is now responsible for the first 3 months of planning of supply and managing the minimum and the maximum stock at the customer.</td>
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<td>D 7 - 7:22 2011: Inventory control at customers</td>
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</table>
D 3 - 3:31 90-day project: Total Time from the start formulation of the bulk until the product is at the customer. Max 90 days.

D 5 - 5:83 The global operating model is really changing the way that we work both in our organization and in how we do the business. That is happening NOW. We started two years ago and we are now finalizing what we need to do and the next step is to incorporate the DNL processes in those. But, this didn’t really come from lean perspective that it was done. It was more in the sense of in how can we go faster to our customers or how can we improve inventory levels and how can we narrow down our inventory because they are too high. Our working capital spend is too high and that is a driver to have to improve that.

D 1 - 1:60 We were an organization that was managed by make to order principal and now we are implementing now the “make to stock” principal.

D 5 - 5:72 For make to order orders the customer is the one that own the batch and the process so they need to create the delivery and for the MTS orders that are being pushed by the supplying site they do the delivery creation because they are pushing out they deal with the credit blocks. And we added a communication matrix so people know who to contact when something is wrong and to who to escalate in every country.

D 5 - 5:69 What you saw is to be able to create a delivery your order need to be clean. So you can’t have any block in the systems, no credit blocks, not GTS block. These need to be done by the receiving region because they can tell if there is a credit block or not. Supply sites don’t know this.

D 5 - 5:70 Order management was done very poorly by the regions we saw a lot of times that supplying sites tried to make the delivery but the order wasn’t clean. And then you had a large e-mail correspondence. So, we change the way we did that.

D 5 - 5:75 They build the forecast and put it into the system. So that really has also changed a quite a bit because now we are driving that more by looking into the statistical forecasting instead of the historical forecasting.

D 5 - 5:76 What I would like to see is that we also look into the slow movers and expedites. Because if you could control those and know why they happen that will also help you to stabilize your supply chain.

D 6 - 6:9 The clients were able to order when needed. We didn’t focus on forecast any longer. The orders were made 3 days before the start of the production.

D 6 - 6:66 We had to make the internal changes first to be more responsive towards the customers. We didn’t do this by telling the customer to be better at forecast or change anything. We decided to not be sensitive to this and let go of the forecast.

D 7 - 7:27 If the customer puts his order to late in the system, than there is urgency to produce but also more pressure on the vendors to deliver the materials faster.

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<tr>
<th>Supplier</th>
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<tr>
<td></td>
<td>D 1 1:49 The focus of lean management implementations was very internally focused and these services were offered by</td>
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<tr>
<td>Collaboration</td>
<td>Performance measurement</td>
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<td>the vendors and we only had to accept it. We did not initiate these services at vendors. They came to us.</td>
<td>D 1 - 1:61 We have integrated lean management far towards the customers, but there is almost none lean implementation upstream towards the suppliers.</td>
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<tr>
<td>D 10 - 10:61 So the pressure on the amount of the supplier has been building up. You also see this in the tender market. There is a cost pressure, but you also see that they make choices base on how many suppliers they get to deal with. They keep this to a minimum.</td>
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<td>D 10 - 10:63 I think that that is the biggest change compared to the old times. The supplier portfolios are getting smaller. Every supplier that you can get rid of is a cost reduction.</td>
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<td>D 3 - 3:11 Organization: Supplier Development and Performance Management (SDPM) are connected to the procurement department. I see this organization as an extension of lean</td>
<td>D 3 - 3:11 At first they were working on supplier interruptions and supplier issues. They visited the suppliers to solve the issues and help develop the suppliers.</td>
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<td>D 6 - 6:15 Together with the suppliers we came up to the idea to receive goods from supplier per order (customer).</td>
<td>D 6 - 6:15 Yes, what you see at our biggest supplier that they are also moving along with us.</td>
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<td>D 6 - 6:24 For example how to get the cost price lower together. We chose together for a rhythm wheal of a week. We order on a fix day and they start production also on affix date. The schemes of ordering and reducing have been aligned with each other. In this way they could be more efficient and site Beta could also be more efficient.</td>
<td>D 6 - 6:34 They experiment together with site Beat, what works for you and what works for us? You have to help each other.</td>
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<td>6 - 6:32 What you also see is that we often think to know how processes work at the supplier without looking into it more deeply and find out that it can be done differently.</td>
<td>D 6 - 6:58 We are looking for manners to get cheaper together with suppliers without negative impact on one or the other.</td>
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<td>D 6 - 6:35 Improvements and innovations are looked into together. Digital printing is expensive to implement, but the benefit is that there is no setup time, like in classic printing and a specific amount (also small) can be bought per each. Classic printing is interesting when you have a lot of orders (about 5000) and digital printing is more interesting for smaller order amounts.</td>
<td>D 6 - 6:57 After the research suppliers makes a report and CAPA’s. If a complaint is simple it is done with a report and CAPA. If it is more complex, with very low interval than we need to look into the problem more deeply. In that case I can visit the supplier and we look together into the problem and how to solve it. How to improve?</td>
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<tr>
<td>D 7 - 7:30 There is more involvement in the design so the materials that the vendors deliver are being improved.</td>
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The first question is to the supplier is How far do you think you are with implementing lean/six sigma in your company? After they gave me an impression about what they did and what they think I visit them to see for myself how far they are.

But also here it depends on if the supplier wants to change. If they are not open to it, than forget it.

Total cost of ownership. Cost at the end of the production need to be acceptable and sometimes more expensive base material can be better to come to an acceptable total price. In this case we look into design and involvement of the supplier in the design, and in the end a better product has been designed. (supplier perspective)

From my function I look into these improvement and design and not to lower the cost price. The focus is on better products with fewer issues. (supplier perspective)

It is customer and product dependent if we are involved in the design. We are delivering only to the pharma industry at this point. There are lot of procedures (according GMP – practices) and checks in this industry and those high quality level of work is too much and too expensive for the other branch. That is the reason that we now only deliver to pharma.

We are looking into the reduced incoming inspection as improvement. Also specification release at the supplier. We are testing the goods but you are testing also. The specifications are not exactly the same, but this is possible to implement. Our outgoing inspection is for 85% the same as your incoming inspection. You production can be faster if the release is at the source (vendor). Waiting time is less if the product can be released based on the release of the vendor.

We went to other companies to see how they are doing this. Not only in the same branch but we also heard from the customers. You get these signals from a very broad public. (supplier perspective)

It was not the customer who was helping us but a company specialized in this. We have informed our customers that we are starting with Lean adoption but they were not a part of this start up or did help us. We did this later, when we were further in this. At some point you have to do projects together with the customers. So, we had a base in place to be able to start projects together. (supplier perspective)

We demand this from our suppliers. If a suppliers doesn’t want to cooperate in this project that we want to start with the, while we are also want to help them (we didn’t choose them by mistake, we see a good partner in them), than we have not made a right choice. So, all the suppliers are cooperating. This is not an option but we make agreements on paper and also measure that. We talk about this with each other, to be able to get a higher performance together. Supplier perspective about their suppliers)

For a tender you have to give your lowest price. Than Ixion can come along and they try to get the price even lower. Sometimes they go so far that you price is lower than your cost price and then you have to choose because if you lose those packages it is also dangerous. So, you go on otherwise you can lose your business but you are delivering under your cost price so you are losing money. In this case you have to reach out to improve your business and reach out to your network to make the improvements together, so you don’t lose your money to this tender. (supplier perspective)
The biggest change is that we have a much better vision. That we want to be the best in the class. We became a much more reliable partner to our customer and much more of a professional partner. And for those customers that demand a better performance, we are the partner that they want to work with. If we don’t do this for those demanding clients they just say goodbye to you. You have to be in that adoption phase of lean to be able to collaborate in the projects together with those customers. For some customers we needed to change and we came along with them, but some customers were behind in this and we helped them to get to the higher level and take steps. (suppliers perspective)

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<th>Supplier-Involvement</th>
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<td>Agreement</td>
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<tr>
<td>Information</td>
<td>12</td>
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<tr>
<td>Inventory</td>
<td>33</td>
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<tr>
<td>Resources</td>
<td>6</td>
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<td>10</td>
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The work sessions with the vendors were mostly about the costs. Variable versus fixed costs.

Well, there are a couple of suppliers, external manufacturing sites mostly, that do play a role. What you see is that it is still almost separate completely.

Well, there are quite some suppliers that have already lean principles or handle these principles. But, this is not because MSD is asking them to do so.

Later on we made the steps towards our suppliers. This came much later.

None.

JIT deliveries is a future state what we would like to implement.

No, no role played. The link between our production and your production could be possible.

Other site (Belgium) is further in this. They have an EDI system with this supplier. Alpha site is looking into this opportunity.

This has been initiated from the supplier’s side but not asked by site Alpha.

For the rest, everything is in place to set up the integration. You are not our first customer that has been looking into the supply chain integration. Several customers have been integrated.

What I have done. We are looking into “what buttons” can be pushed. Where can we do something on this part? First one is the certification of our suppliers. The more suppliers get certified as “certified supplier” the sampling is less. This is an advantage. By certifying our biggest supplier we reduced our lead time of the packaging materials from 10 to 5 days.

Also, there were initiatives to set the TQA (Technical Quality Agreement) up differently. The tests that are being performed for the release of, for example, packaging materials are the same at release by the vendor as at release by MSD.

Revision of the service level agreements. Reducing the amount of materials, standardize. Specifications improvement. Less testing in-house.

Yes, because our business is stable now we also demand more from our suppliers. They have to do now with business reviews and agreements where the Audits are based on. There are suppliers that are not used to that and these suppliers we need to educate them. In fact, they are not a good supplier if they don’t want to cooperate with us on this. The
also see that we are very far in this and they use this knowledge. (Suppliers’ perspective about their supplier).

D 1 - 1:44 There were only a few work sessions. Their role was very limited because the lean implementation was focused on internal company processes.

D 3 - 3:9 In some cases the supplier does a root cause analysis of a for example product deviation. Also CAPA’s are being raised. Corrective and preventive actions towards the supplier. KPI's (OTIF = On time in full and First Pass Quality) are being shared with some of the suppliers.

D 3 - 3:15 Also they have EDI (Electronic Data Interchange) possibility to get the orders from customers. At this moment the order is being sent as a PDF per e-mail, so no EDI has been used yet. This possibility is being looked in to again at this moment because the Oss site has implemented a new IT landscape (ERP-system) last year, so it should be easier to connect the IT systems. This functionality is being implemented at another site (Belgium) this year.

D 5 - 5:26 So what you could in the way Toyota did or ASML does, this is really not happening. We still have to take a major step there. We ask our suppliers to deliver fast but give no insight at all.

D 5 - 5:38 What you see is that the way we source is pretty classic. We want to have the cheapest product, lowest price and long pay term. That is what we do and we could do a lot better if we would integrate that more and give people insight in our planning and really make sure that they are part of our process and we don’t do that.

D 6 - 6:38 We share information. If there are issues there is direct contact and we solve these together by discussing them.

D 8 - 8:13 In the scope is complaints management. Input is a complaint from MSD to supplier and the suppliers starts a research.

D 8 - 8:24 TCA is some kind of questionnaire that is being sent to the supplier to do a self-assessment.

D 1 - 1:46 Partnership with our supplier of Safety gear is vendor managed inventory.

D 6 - 6:13 The driver was that we wanted to get rid of the inventory in our ware house. Together with the suppliers we came up to the idea to receive goods from supplier per order (customer). For a few components we have introduced VMI.

D 7 - 7:5 There we some small initiatives in the past regarding to vendor managed stock, but nothing implemented.

D 1 - 1:39 No, suppliers did not allocate any resources.
D 1 - 1:44 There were only a few work sessions. Their role was very limited because the lean implementation was focused on internal company processes.
D 5 - 5:23 I think …Hardly any resources.
D 6 - 6:5 Supply network partners did not play a role at first. The main focus was first internally.
D 9 - 9:10 None resources
| Partnerships | 8 | D 1 - 1:81 Partnership with our supplier of Safety gear is vendor managed inventory.  
D 3 - 3:38 Long term relationship and trust is most important in the strategic partnership with this supplier. They deliver to the 16 MSD sites. Biggest strategic partner.  
D 3 - 3:39 The MSD is working with other suppliers to become strategic partners.  
D 6 - 6:33 So you can accomplish a lot but you have to take your partners serious.  
D 10 - 10:17 We like to share our knowledge with our customers to come up with mutual projects to get a better performance. If we work together we are being a better partner and for us that is a better guarantee than a contract. (suppliers perspective)  
D 10 - 10:58 In both situations, your guarantee of staying a partner is improving your performance, professionality and your flexibility. If we didn't come along with lean adoption and improved than we wouldn't exist anymore or be so successful. (suppliers perspective)  
D 10 - 10:59 When you build a partnership you “click in”. I call that “clicking in” because you have to click in on several levels. You click in with procurement, you click in with quality. You make agreements with logistics and manufacturing. You have to make agreements on every level and you are being audited. |
| Relationships | 37 (total) | Customer:  
D 1 - 1:77 The relationship between manufacturer (us) and customer (distribution center) has been changed tremendously.  
D 1 - 1:83 Global operating model has changed the relationship between manufacturer and customers.  
D 5 - 5:71 We gave training to everybody who was involved in that process. We trained them in how to do proper order management, so that improved a lot. That made the interaction easier with the supplying sites.  
D 9 - 9:27 There are enough points of contacts. When you look into supply, customers, quality, manufacturing. There is contact between different departments. It is not only one point of contact. The technical knowhow needs to be found at both (supplier and customer). They need to communicate to make the best products. This is very important. This is only possible if you have a long term relationship with the supplier. You have to be open to each other if you want to grow together. (suppliers perspective)  
D 9 - 9:28 Frequent communication and information sharing Design and engineering activities Attitude towards quality Problem solving. (suppliers perspective) |
Customer (manufacturing site)→Supplier

D 1 - 1:84 Merck focus is on top-40 critical suppliers. There is structure to manage the strategical relationship.

D 1 - 1:89 Long term relationships and strategic long term.

D 3 - 3:36 A relationship explained with one of our strategic suppliers. There is a certain product that can only be delivered by one supplier. The supplier had a power position in this case. When they have seen that they have this kind of power, they insisted to have a part of the profits of our company because they knew they were our only supplier. At this moment another supplier has been found that is capable of producing this product and the changes to the new supplier have been started. This takes a few years.

D 6 - 6:30 We look for a Win-win situations in our relationship with vendors.

D 6 - 6:37 You have to build a good relationship and have to trust each other. There a lot of vendors that we have built this. We share information. If there are issues there is direct contact and we solve these together by discussing them.

D 8 - 8:75 When you look into the supplier and importance of the supplier to your company. Is there some kind of power factor playing a role? There are some suppliers that you are dependent on but there are also suppliers that are very dependent of our company. If there is some power aspect paying a role you can force the supplier to do something that you want? As a company you know how important you are to a supplier, so is this power used to get supplier to do something for you?

Yes, of course!

D 8 - 8:89 Also setting up the SD&PM department is an important one, because there is much more focus on the suppliers. The department has being set up in 2012.

D 9 - 9:23 Now we are being invited to see the production and issues, so we can look for a solution or a design together. Sometimes we need to make small changes in our production to make your production better. (suppliers perspective)

D 10 - 10:3 For a listed company that is not so easy. The management changes often, if they not perform well. So every time a new management you have to start over again with building that relationship.

Training

D 6 - 6:36 We have sent our LSS engineers to them to introduce Lean and think together.

D 5 - 5:71 We gave training to everybody who was involved in that process. We trained them in how to do proper order management, so that improved a lot. That made the interaction easier with the supplying sites.

D 8 - 8:34 If they want, than we are on a whole another level. They can get a custom made training program. We do this a lot. For example 5S courses.

D 8 - 8:86 So, can I say that there is some kind of knowledge transfer needed from our side to be able to accomplish that? Knowledge that you have needs to be shared and you have to help them on their way.
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<td>D 8 - 8:87 As an example I give black belt membership training at one of our suppliers. These members then can train others in their company.</td>
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Appendix IV: Coding network and interactions
Appendix V: Final semi-structured in-depth interview script

This script is a guide only as the interviews will be semi-structured and in-depth. There are a number of questions directly related to the research goals. However, the interviewee will be allowed to answer the issues as fully as s/he wishes and stress will be put on any interesting aspects that arise at any given moment in order to find out about both the aspects targeted by the questions and any other determining factors connected with supply chain integration through lean management and its adoption across the supply network. Instructions and/or tips for interviewers are given in italics in the script, while the questions to be put to the interviewee/s are numbered and in bold.

Interviewers introduce themselves and present the research project; give thanks for interviewee’s cooperation. Brief explanation of what will happen in the interview, and ask for permission to record same. Then series of questions asked relating to research objectives.

1. **Why did you decide to adopt LM at your production plant? In other words, what were the reasons behind the decision? When was the decision taken?**


2. **What role did supply network partner’s play in the adoption of internal LM? And in the subsequent phases? What role are they playing at the current time?**

*Trigger factor, development of cooperation partnerships, and conviction on Lean. Emphasize in its role over time.*

3. **Did they allocate resources to LSCM? What? What type of LSCM practices have they adopted over time? Please tell us about this in a little more detail.**

*LSCM department, multifunctional teams, VSM, LM training, shared-risk associations, pull system, JIT.*

4. **What role did your organization play in the adoption of internal LM in your supply network partners? And in the subsequent phases? What role are you playing now?**

*Trigger factor, development of cooperation partnerships, and conviction on Lean. Emphasize in its role over time.*

5. **Did you allocate resources to LSCM? What? What type of LSCM practices have you adopted over time? Please tell us about this in a little more detail.**

*LSCM department, multifunctional teams, VSM, LM training, shared-risk associations, pull system, JIT.*

6. **What internal LM practices and/or tools did adoption begin with? Why these? And what about now?**

*Worker training, 5S, visual management, VSM. Role of people. Role of supply network partners. Emphasize in its evolution over time.*
7. What factors do you think favoured the adoption of LM at your plant? Please tell us how these factors have favoured the subsequent phases? And what about now?

People, training, management staff, selection of pilot areas, role of supply partners, supply relationships, state of supply network structure. Emphasize in its evolution over time.

8. What obstacles or difficulties did you encounter during both the prior phase to the adoption of internal LM and the adoption phase itself? How did you solve them? And what about now?

People, management staff, type of product, variability, low repeatability, role of supply partners, supply relationships, state of supply network structure. Emphasize in its evolution over time.

9. What changes have there been in the customer relationships in recent years? Would you mind giving us a few examples?

Supplier-customer relationship pattern: cooperative, trust, contact; time horizon: long-term or short term; frequent communication and information-sharing; involvement in design and engineering activities; attitude towards quality: certification, problem solving; JIT deliveries; role of Lean.

10. What changes have there been in the supplier relationships in recent years? Would you mind giving us a few examples? How did these affect the adoption of LSCM?

Selection and evaluation of suppliers: multidimensional criteria; supplier-customer relationship pattern: cooperative, trust, contact; time horizon: long-term or short term; frequent communication and information-sharing; involvement in design and engineering activities; attitude towards quality: certification, problem solving; JIT deliveries; role of Lean.

11. What changes have there been in the supply network structure in recent years? Is it a direct consequence of LSCM strategy? Please tell us about this in a little more detail.

Small supply base, low vertical integration, supply of complex products (systems and subsystems), number of suppliers by part/assembly/sub-assembly: single or dual supply.

12. What role has the supply network structure played in the adoption of LSCM? What role is it playing now?

Is it an inhibitor or a facilitating factor? Evolution.

13. What factors do you think favoured the adoption of LSCM? And what about now?

Type of supplier-customer relationships, level of internal Lean implementation, role of customers, supply network structure, ITs, communication and information-sharing, type of product, variability.
14. What obstacles or difficulties did you encounter during both the prior phase to the adoption of LSCM and the adoption phase itself? How did you and your partners solve them? And what about now?

Type of supplier-customer relationships, level of internal Lean implementation, role of customers, supply network structure, ITs, communication and information-sharing, type of product, variability, characteristics of aeronautics industry.