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Implementing Lean Startup Methodology

- An Evaluation

Master of Science Thesis in the Master Degree Programme
Management and Economics of Innovation

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Abstract

The Startup Methodology (LSM) has recently gained a lot of attention among entrepreneurs for how to manage new ventures. LSM is a breed of literature that provides normative guidelines to entrepreneurs for how to systematically test and refine business model hypotheses. However, limited academic research has been conducted to assess the validity of LSM. The purpose of this master thesis was to identify and evaluate barriers to implement LSM for early-phase manufacturing ventures. The study was conducted by an action research methodology where LSM was firstly compiled into a number of principles. These principles were implemented for a case company in order to evaluate barriers to implementation. Data was collected through diary keeping and 69 semi-structured interviews.

Barriers connected to particularly four principles of LSM were identified. First, LSM calls for rapid iteration and quick feedback which was inhibited by physical distribution channels. Second, principle of pivot if necessary if scalable business model cannot be identified was associated with two barriers; lack of big customer problems and lack of scalable business models due to disparate customer processes. Third, the minimum viable product had three barriers connected to it; an inability to quickly create prototypes, which could be attributed to complex products and physical distribution channels, customers' importance of reliability, and finally creating a general minimum viable product due to customers' disparate processes. Fourth, LSM advocates for early customer interaction for which two barriers were identified; finding an opportunity, which are connected with high variation and complexity in customer processes, and accessing customers connected to few customers and challenges to contact them.

Finally, a number of suggested guidelines are provided for how new ventures can overcome the encountered challenges associated with the implementation of LSM in order to find a better fit between customer need and technology.

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Anders Gustafsson and Jonas Qvillberg

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1 Introduction

This section includes an introduction to the research problem along with the purpose and research question of this master thesis.

1.1 Background

Technological innovation and entrepreneurship are considered to be key factors to national economic growth (Crosby, 2000; Solow, 1956; Nadiri, 1993). Inability to exploit technological opportunities that occur and lack of innovative efforts can cause slow growth in countries (Fagerberg, Guerrieri & Verspagen, 2000). Unfortunately, a majority of new enterprises fail within the first years of existence. Statistics show that about a third of the Swedish firms started in 2005 had failed three years later (Hjalmarsson, 2010), and similar numbers can also be found for U.S. start-ups (Shane, 2008).

The remarkable high failure rate for new companies has received much attention during the last decades. A considerable amount of effort has been devoted to the identification of factors, conditions and characteristics which promotes new venture creation and contributes to their success (e.g. Watson, Scott & Wilson, 1998; Zimmerman & Zeitz, 2002; Barron & Hannan, 2002; Ensley, Peers & Hmiellski, 2006; Brinchmann, Grichnik & Kapsa 2010). Even though this literature provides a theoretical perspective of characteristics that promotes new ventures, actual protocols for implementation are not evident. However, some academic authors have also been starting to develop more normative guidelines for entrepreneurial decision-making following a Popperian approach (e.g. Harper, 1999; Sull, 2004; McGrath & MacMillan, 1995).

A new breed of literature emerged in the 2000s with Steven Blank in front, literature that provided a stronger focus on actual implementation and hands-on recommendations for entrepreneurs. In this thesis, this literature will be grouped together under the name Lean Startup Methodology (LSM), a name that became popularized by the Silicon Valley entrepreneur Erik Ries in his blog and his subsequent book “The Lean startup” from 2008. The theory emphasizes the importance of learning from the customers to produce a solution based on customer needs and wants. This is done through an iterative process where problem, product and customer hypotheses are developed and validated. The theory also puts emphasis on building prototypes of important features to minimize waste, thus resulting in less time and money spent, which further enables more iterations (Ries, 2011; Furr & Ahlstrom, 2011; Blank, 2006).

However, even though this customer-centric and hypothesis-driven business development methodology has gained a lot of attention, there is a dearth of academic research on the methodology. There have been some articles written about lean product development process

(e.g. Karlsson & Åhlström, 1996; Oppenheim, 2004) but not how these principles can be applied in a start-up context. Further, the methodology is also mainly focused on companies within the IT industry developing software. Research within this field would therefore help to increase the understanding of the methodology and evaluate whether it is applicable for the manufacturing sector. The main difference between software startups and manufacturing industries are that the manufacturing industry produce physical products while the software industry produce digital products. Further, this fact implicates the available distribution channels. A physical product demands a physical distribution channel, while a company can choose a digital distribution channel in the software industry. This would thus be valuable and interesting to investigate from the perspective of both practitioners as well as academia. In order to evaluate the appropriateness of the methodology in the manufacturing sector, an in-depth case study of the early-stage company InCorp (fabricated company name due to secrecy) was conducted.

1.1.1 Case company background

The master thesis was performed together with InCorp. The company (started in 2005) has developed a proprietary metal composition together with a unique manufacturing method, which allows lower energy consumption, possible efficiency and quality wins as well as less need for space. The company's system is today used in early applications primarily for induction heating systems (focus area), but also for electromagnetic components.

InCorp needed help to analyze the market and identify potential applications for the company's new technology. Furthermore InCorp wanted to know about common customer problems and how to solve them in the best way. The question was thus how the company both can create value for customers and how that value can be appropriated. Most of the early applications had been highly customized to meet customers' individual needs and demands in a wide range of businesses. The systematic and iterative learning- and discovery process of LSM was therefore pursued to identify common customer problems and how InCorp's technology could be used to solve these problems and hence create customer value. By targeting specific customer segment, common needs and wants could be identified, which could simplify the selling process for InCorp and thereby facilitate better opportunities for growth. Our experiences and findings from the case study were then used as a basis of an evaluation of the first phases of LSM for small manufacturing firms with physical products. The first phases include the Customer Discovery phase in the book by Blank (2006) or/and up until Nail the Solution/Nail the Go-to-Market Strategy of Furr and Ahlstrom (2011).

1.2 Purpose and research question

The purpose of this thesis is to explore challenges when implementing principles of LSM for early-phase manufacturers of physical products with a new technology facing high degree of uncertainty about customer need and potential applications. Furthermore we will suggest how these firms can overcome challenges with LSM to find a better fit between customer need and technology.

To be able to fulfill the overall purpose of the thesis, the following research question will be answered:

- *What are the barriers to implement LSM for InCorp and why is this the case?*

1.3 Disposition

This thesis is structured in five different chapters. First, a literature section is presented that begins with a presentation of literature related to the subject and then continues with an overview of LSM. Second, the research methodology is presented including the research approach and design, data collection, data analysis and a discussion about the reliability and validity of the thesis. Third, the empirical results contain the derived information from the case study. It is divided in three parts; create and validate the problem hypothesis, create and validate the solution, and then problems occurred during LSM implementation. Fourth, the discussion is presented that is divided after the principles that were hard to implement; iterate rapidly and pivot if necessary, minimum viable product and get out of the building. Lastly, the conclusion is presented including a discussion of this thesis's academic contribution and managerial implications.

2 Literature

This section consists of an overview over relevant literature and the framework used to perform the case study. . First, literature related to LSM will be presented, mainly academic literature concerning entrepreneurial decision-making. Second, the literature of LSM is synthesized into the framework used in the case study at InCorp.

2.1 Related literature

The discussion of how to successfully bring a new product to the market has been present for many decades. The traditional product development model applied by numerous companies and entrepreneurs starts with the identification of an opportunity, followed by creation of specifications, building the product and finally selling it to customers (Blank, 2006; Furr & Ahlstrom, 2011). Authors like Cooper (1986) and Schilling & Hill (1998) highlighted modifications of the traditional product development model, but the foundations remained the same. Furr & Ahlstrom (2011) argue that the most common process for entrepreneurs to start their businesses has the same characteristics as the traditional product development process. Like in the traditional product development it starts with identifying an opportunity, raising money, developing the product, refining the product for the broad appeal and then selling the product. Except from an initial market sizing and early customer interviews, customers are often not involved until the end of the process when a substantial amount of money has been invested. (Blank, 2006; Furr & Ahlstrom, 2011)

However, even though this process may make sense for ongoing business focused on execution on relatively known problems, it is less appropriate for new ventures (McGrath & MacMillan, 1995; Furr & Ahlstrom, 2011). New ventures are often characterized by a high degree of uncertainty with a lot of unknowns, meaning that new ventures are often based on assumptions. The critical task for entrepreneurs is thus to effectively manage the uncertainty associated with the creation of a new venture (Sull, 2004). A topic that has been increasingly discussed by researchers is the role of planning in new venture creation given the high degree of uncertainty.

2.1.1 Business planning

A common advice to entrepreneurs is to write a solid business plan before they launch their new ventures (Lange et al, 2007; Furr & Ahlstrom, 2011). Writing business plans has traditionally even been considered to be the most important feature of entrepreneurship courses by entrepreneurship educators (Hills, 1988). Even though business plans have become deeply rooted as a key component for new ventures, the importance of business planning for start-ups has been discussed and questioned during the last years (e.g. Blank, 2006; Ries, 2011).

The debate about business planning for new firms can be categorized into two broad groups. The proponents of business planning argue that a systematic, prediction-oriented and formal planning approach results in superior venture performance (Brinckmann, Grichnik & Kapsa, 2010). The other group of researchers argues that entrepreneurs instead should be focused on flexibility, learning and controlling resources (Brinckmann, Grichnik & Kapsa, 2010). Critics primarily consider formal business plans to be an important requirement when entrepreneurs seek formal venture capital for the new ventures (Lange et al., 2007; Zacharakis & Meyer, 2000; Gruber, 2007) meanwhile the business plan itself is not perceived to be a key determinant for success (Lange et al, 2007; Bhide, 1999). Too rigorous planning in early phases has even been considered to be "at worst, fundamentally misleading" (Alvarez & Barney, 2007, pp. 12) and "will almost always lead to failure" (Furr & Ahlstrom, 2011, pp. 10).

The traditional recommendation to entrepreneurs of writing business plans is not perfectly suitable for start-ups, which face a high degree of uncertainty. The absence of a business plan or research and planning can in these cases be economically reasonable due to economic constraints that limit the entrepreneur's opportunity to afford much prior research and analysis (Bhide, 1999). Business planning can result in cognitive rigidities where entrepreneurs are unable to change direction (Vesper, 1992). Further, McGrath and MacMillan (1995) argue that conventional planning approaches, commonly applied in more mature and ongoing businesses, that tend to focus on fulfilling the plan is counter-productive since insistence on meeting the plan prevents learning. The process of how entrepreneurs discover new opportunities and appropriate them is different from the context of established companies competing in industries with known conditions (McGrath & MacMillan, 1995). When discussing business planning it is important to understand the process of how entrepreneurs learn and discover and appropriate new opportunities. We will now continue by describing theories about entrepreneurial decision-making and how entrepreneurs learn by systematically test and modify hypothesis to evaluate their business in the marketplace.

2.1.2 Entrepreneurial decision-making

Increasing attention in recent years has been given to understand what entrepreneurs do and what characterizes successful entrepreneurs and the methods that they use. One central aspect within the field of entrepreneurial research is how opportunities are considered (Venkataraman, 1997).

David Harper (1999) describes the entrepreneurial discovery process by drawing upon the Popperian approach (by Karl Popper, e.g. 1999) about the growth of knowledge in order to describe entrepreneurship and market processes. Harper's development of the Popperian approach was initiated as an alternative to Kirzner's theory of entrepreneurship, which is based

on a set of highly restrictive assumptions. According to the Popperian approach as presented by Harper, learning is a consequence of how entrepreneurs choose to test particular hypotheses in the marketplace and how they interpret the results according to their learning methodologies. Entrepreneurship can thus be seen as a kind of scientific process of discovery and learning where entrepreneurs continuously select relevant conjectures to test and then make judgments about revising them based on the findings. (Harper, 1999)

The process of entrepreneurial learning and discovery of new problems can be described by Popper's scientific model:

Problem 1 → Hypotheses 1 → Test in Marketplace 1 → Problem 2 → Hypotheses 2 → … → Problem n+1

In the model, an initial problem is first encountered. This could for example be an attempt to appropriate the value of an invention. Harper (1999) argues that entrepreneurs develop new business ideas from three main types of empirical theories; theories of latent demand (unsolved problems), theories of production (new combinations) and theories of governance (economic transactions). Hypotheses are then generated about how to solve this problem. These hypotheses are then tested in the marketplace where assumptions, technological feasibility etc. are evaluated. Depending on the outcome of this market evaluation, hypotheses can be refuted or validated leading towards a revised version of the problem. The process will then continue with a new set of hypotheses that are tested in the marketplace. Even though the entrepreneur might succeed in solving a particular market problem, new problems are continuously discovered during the process, which implies that the entrepreneur's learning process does not have a definite end. This model shows how the entrepreneur's learning process is an ongoing evolutionary and endogenous process. How fast the entrepreneur can identify significant errors, respond and learn from them is determined by the entrepreneur's methodology. Since entrepreneurs can learn from their mistake it is desirable for them to discover these mistakes as soon as possible due to the exponential growth of product development costs. (Harper, 1999).

Another researcher that explicitly builds upon the Popperian approach in entrepreneurship is Professor Donald Sull. Based on in-depth case studies on how startups[1] and established companies manage uncertainty, Sull (2004) suggests that entrepreneurs should manage uncertainty by taking a disciplined approach similar to the model described by Harper (1999). The approach consists of three sequential steps. The first step is to formulate a working hypothesis or "a mental model that generally includes a definition of the opportunity, the

[1] "A startup is a human institution designed to create a new product or service under conditions of extreme uncertainty" (Ries, 2011, pp. 27)

resources required to pursue it, the value that would be created if it were to be successful and a plan to pursue it" (Sull, 2004, pp. 2). The mental model has the ability to shape the entrepreneur's behavior (Markides, 1999). The model comprises a set of implicit and explicit assumption about multiple variables (e.g. technology, demand and competition), which are all uncertain. Sull (2004) emphasizes the importance of flexibility and identification of potential deal killers that are likely to be fatal for the venture. The second step is to assemble resources that are necessary to conduct experiments to test the hypotheses. Cash provides a hedge against uncertainty (Sahlman, 1999), but it can also lead to additional costs (e.g. unnecessary spending) (Sull, 2004). Entrepreneurs should therefore only raise sufficient capital needed for the next round of experiments (Sull, 2004). The last step is to design and run experiments. Ultimately, entrepreneurs have to test their plans in the marketplace through iterative series of experiments such as customer research, prototypes or beta customers (Sull, 2004). Depending on the outcome of these experiments, the entrepreneur may either decide to cut their losses, revise their hypotheses or appropriate the created value (Sull, 2004).

The evolutionary process of entrepreneurial learning described by e.g. Harper (1999) and Sull (2004) have also been embraced by McGrath and MacMillan (1995) expressed in their discovery-driven planning approach, which they describe as "a systematic way to uncover dangerous implicit assumptions" (McGrath & MacMillan, 1995, pp. 46). Discovery-driven planning can be used to convert assumption into knowledge as the venture progress, where new data are discovered and incorporated into the evolving business plan. The process is captured in four documents; (1) a reverse income statement consisted of assumed economics needed for the venture to be successful, (2) pro forma operations specs that include the activities needed to run the venture, (3) a key assumptions checklist that entrepreneurs use to assure that important assumptions on which the venture's success depends on are checked during the process and (4) a milestone planning chart which specifies when specific assumptions should be checked. This process can thus help the entrepreneur to test underlying hypotheses and correct the business model in light of new information and thereby abandon poor concepts before major investments have been made. (McGrath & MacMillan, 1995)

Even though these authors provide frameworks of how entrepreneurs continuously develop and test their hypotheses in an uncertain environment, little is said about how the entrepreneur discover the initial opportunities that are later tested and adjusted depending on the outcome of the experiments. As finding an opportunity is the starting point of a startup it is central to have an understanding of it to be able to evaluate startup methodology.

2.1.3 Discover opportunities

There are different theories for finding new opportunities. The leading management schools in the world mainly teaches students casual reasoning (Sarasvathy, 2001). Casual reasoning means that you have a pre-determined goal and the challenge is to find the solution. It is suitable when for example facing a make-or-buy decision in production. Though, according to Ried *et al.* (2008) it is not used by entrepreneurs. They do not start with a goal, but must put in an effort to find the problem that should be solved. In casual reasoning you try to predict the future, and this is obviously hard in situations where there is a high degree of uncertainty, e.g. starting a new venture (Ried et al., 2008).

In the case of a new venture, another sort of reasoning is more appropriate that is less common in management schools, but more common among entrepreneurs, effectual reasoning. Effectual reasoning is based on having a given set of means, but no pre-determined goal (Sarasvathy, 2001). The entrepreneur should use its means to find a problem and thus a goal to pursue. The means consist of three parts: who they are (e.g. taste and abilities), what they know (e.g. education and experience) and whom they know (social and professional network). Barney (1991) presents three categories of resources or means that can help companies to pursue value-creating strategies. These are called the physical capital resources, human capital resources and organizational capital resources (Barney, 1991). Sarasvathy (2001) argues that these are corresponding to the entrepreneurs' means in effectual reasoning.

Effectual reasoning has four main principles according to Sarasvathy (2001); affordable loss, strategic partnership, leveraging contingencies and controlling an unpredictable future. Affordable loss means that the entrepreneur should focus on minimizing its expenditures, in term of time, money and resources, to reach the market. The strategic partnership highlights the importance of finding partners to reach the market. The partners is both making it easier to find a market and thus an opportunity as well as committing to the project, which reduces the risk. The choice of partners is an important determinant for which markets the company will end up in. Leveraging contingencies concerns how to make use of unexpected events and turn them into profit. The last principle, controlling an unpredictable future, deals with how to control the future rather than predicting it. (Sarasvathy, 2001)

However, the question remains about where the opportunities occur. In academic research the focus has been on a variety of different aspects ranging from science development to changes in the socio-economic environment (demographics, institutions, etc.) (Shane, 2004). But opportunities can also occur during the actual entrepreneurial process (Sarasvathy & Venkataraman, 2011).

2.2 Lean Startup methodology framework

In this section the Lean Startup methodology (LSM) framework used to complete the case study at InCorp is presented. The framework is based on the four authors; Eric Ries, Steve Blank, Nathan Furr and Paul Ahlstrom. We studied the field online in for example blogs and forums and found that these authors best represent LSM, especially Ries and Blank.

Blank was the pioneer in the field and the one who introduced the concept customer development describing the process for how entrepreneurs should test and refine business hypotheses through customer conversations. His book, "The Four Steps to the Epiphany" from 2006, in which he describes the process of customer development has become a must read for Silicon Valley entrepreneurs and is highly mentioned in the community. Ries is a former student of Blank and has popularized the concept Lean Startup in his blog and subsequent book "The Lean Startup" from 2008. He has received a lot of attention with this book and it was therefore natural to include him in the framework. Further, Furr and Ahlstrom has gained a lot of attention in the field recently for their book "Nail It Then Scale It" from 2011. They provide prescriptive and hands-on tips to the entrepreneur. We believe they are a good complement to Blank and Ries, and they are also respected in the LSM community. In the study of the field three other authors that needs to be mentioned was found. Brant Cooper and Patrick Vlaskovits have received a lot of attention for their book "The Entrepreneur's Guide to Customer Development". However, it is based on the work of Ries and Blank so we believe it is better to include the sources. The last author is named Ash Maurya who has written the book "Running Lean". He is not perceived to bring anything new to LSM and is therefore not included in the framework.

LSM has become increasingly popular during the last years as an approach to create and managing startups, especially among IT-practitioners. The LSM approach advocates for early customer interaction where assumptions concerning the business model is tested in the marketplace through a series of iterations (Ries, 2011).

The term lean startup is derived from principles of lean manufacturing, a manufacturing philosophy mainly originated from the Toyota Production System (TPS) that is centered on the aim of identification and minimization of waste (Emiliani, 2006). Waste is defined as "any human activity which absorbs resources but creates no value" (Womack & Jones, 2003, pp.15). In the context of a startup, waste is described as anything that inhibits the team from learning about how to create value for customers (Ries, 2011). The term customers includes all the external actors (e.g. individuals, companies and organizations) for which the startup's solution potentially could be applicable. The approach does also draw upon principles of other

management theories such as Agile Development[2], design thinking[3] and Lean Product Development[4]. The approach is similar to other concepts such as Customer Development (Blank, 2006) and Nail-It-then-Scale-It (Furr & Ahlstrom, 2011). Blank's Customer Development model can be viewed below in Figure 1.

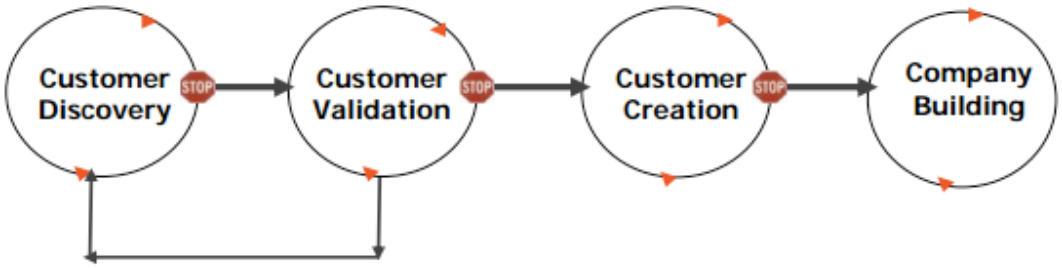

FIGURE 1. THE CUSTOMER DEVELOPMENT MODEL BY BLANK (2006)

It consists of four iterative phases. First, the customer discovery phase concentrates on understanding customer problems and needs. Secondly, in the customer validation phase a replicable sales model is developed. Third, customer creation deals with end user demand, and how to create and drive it. Finally, in company building the company's focus is changed from learning to growth. Furr & Ahlstrom (2011) has a similar approach but with five steps where Blank's first phase is divided into two. First, nail the pain that represents the validation of the problem. Then the product/service is validated in the nail the solution phase.

However, the term Lean Startup has become the commonly used label for the new movement among practitioners. The movement will also hereafter be denoted as Lean Startup Methodology (LSM). A central part of Ries's description of LSM is the Build-Measure-Learn feedback-loop, which is influenced by the Observe, Orient, Decide and Act (OODA) loop developed by the military strategist John Boyd as a tool for how to win battles (Richard, 2004). The two loops are illustrated in Figure 2.

[2] A group of software development methods based on iterative and incremental development, where requirements and solutions evolve through collaboration between self-organizing, cross-functional teams

[3] Design Thinking refers to the methods and processes for investigating ill-defined problems, acquiring information, analyzing knowledge, and positing solutions in the design and planning fields.

[4] Lean product development is the application of lean principles to product development, a cross-functional activity that seeks to uncover product knowledge hidden within the end-to-end production flow, typically in the hand-over points between functional units.

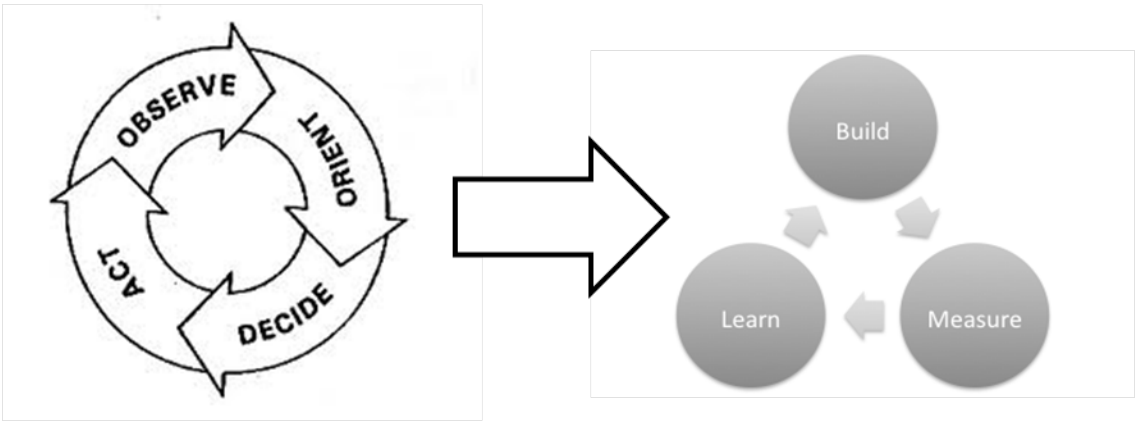

FIGURE 2. THE OODA-CYCLE AND THE BUILD-MEASURE-LEARN FEEDBACK LOOP

The idea of the feedback loop is that the entrepreneur should get the products in the hands of customer as fast as possible in order to receive feedback that can be used to reject or validate assumptions. The goal of LSM is to minimize the time through the feedback loop, implying that the startups need to build faster, measure faster and learn faster. (Ries, 2011)

The Product/Market fit is another important element in the LSM literature, a term that is often attributed to Marc Andreessen. Andreessen (2007) describes product/market fit as: "being in a good market with a product that can satisfy that market", in other words, whether the startup has built something people want. Blank (2006) defines Product/Market fit as whether the startup has found a repeatable and scalable sales model. Not until the startup has achieved Product/Market fit with repeatable customers with a repeatable sales process should the startup move on to the next phase and scale up the business (Blank, 2006; Furr & Ahlstrom, 2011). Next, we will continue with a synthesis of the principles of LSM.

2.2.1 LSM principles

The authors of the LSM literature (Blank, 2006; Ries, 2011; Furr & Ahlstrom, 2011) do all provide a number of principles (or "fundamentals") capturing the essence of their view of LSM. These principles have been summarized and are presented below as "LSM principles":

Get out of the building: A business model of a new venture is filled with assumptions and hypotheses since little is known at start. In order to ascertain vital hypotheses in the business model, entrepreneurs should interact with customers as early as possible. Blank (2006, pp. 20) argues that the entrepreneur should "leave guesswork behind and get outside the building" in order to understand "their reality" and learn about important customer problems, what matters to them and whether the startup's product solves that problem.

Pivot if necessary: If the entrepreneur's assumptions of the startup's business model turn out to be incorrect after interaction with customers should the entrepreneur consider a major change –

a pivot. Ries (2011, pp. 149) describes the pivot as "a structured course correction designed to test a new fundamental hypothesis about the product, strategy, and engine of growth". The pivot is a decision to change some or several parts of the hypotheses concerning the startup's business model based on learning from customers.

Validated learning: The purpose of the startup is to learn how to build a sustainable business model. The learning necessary to fulfill this purpose can be validated scientifically through experiments designed to test hypotheses. Validated learning should be backed up with empirical data gathered from real customers. (Ries, 2011) Further, the entrepreneur should develop an attitude to learning that enables the entrepreneur to discover a real opportunity by recognize common learning traps, reframing the purpose of the venture to be learning what the market want and becoming a person that "maintains a seed of doubt that they may be wrong" (Furr & Ahlstrom, 2011, pp. 52).

Minimum Viable Product: An effective way to test and learn from customers is build a Minimum Viable Product (MVP), defined by Ries (2011, pp. 77) as "the version of the product that enables a full turn of the Build-Measure-Learn loop with a minimum amount of effort and the least amount of development time". A MVP has just those features that allow the product to be deployed and is typically showed for a subset of possible customers that can provide feedback. A MVP may be a landing page with a click-through to examine interest or a demo that shows the customer how the problem is being solved. A similar term is the minimum feature set, which Furr and Ahlstrom (2011, pp. 95) define as "the smallest, most focused set of features that will drive a customer purchase". The minimum feature set represents the features that customers must have in order to buy.

Iterate rapidly: LSM is an iterative process similar to the OODA-loop developed by John Boyd and refined in Ries' (2011) Build-Measure-Learn feedback loop. The aim is to iterate through the feedback loop as fast as possible, not to reduce the quality of each iteration (Ries, 2011).

Avoid premature scaling: One of the major causes to startup failure is premature scaling. Premature scaling means that the startup starts to spend money on growth (e.g. hiring sales persons, leasing offices, expensive marketing etc.) before finding the Product/Market fit. (Furr & Ahlstrom, 2011) Startups should avoid scaling before finding a valid business model with a repeatable sales process (Blank, 2006).

2.3 The Lean Startup methodology process

The authors chosen to represent the LSM in this master thesis to a large extent share their views of LSM and their associated recommendations to entrepreneurs; working in small groups, having an iterative process, going for small markets first and develop the products with early customer interaction. Nevertheless, there are also some differences in their views of LSM. A synthesized version of the LSM process used in the case study at InCorp will therefore be presented in this section. The LSM process is represented in Figure 3.

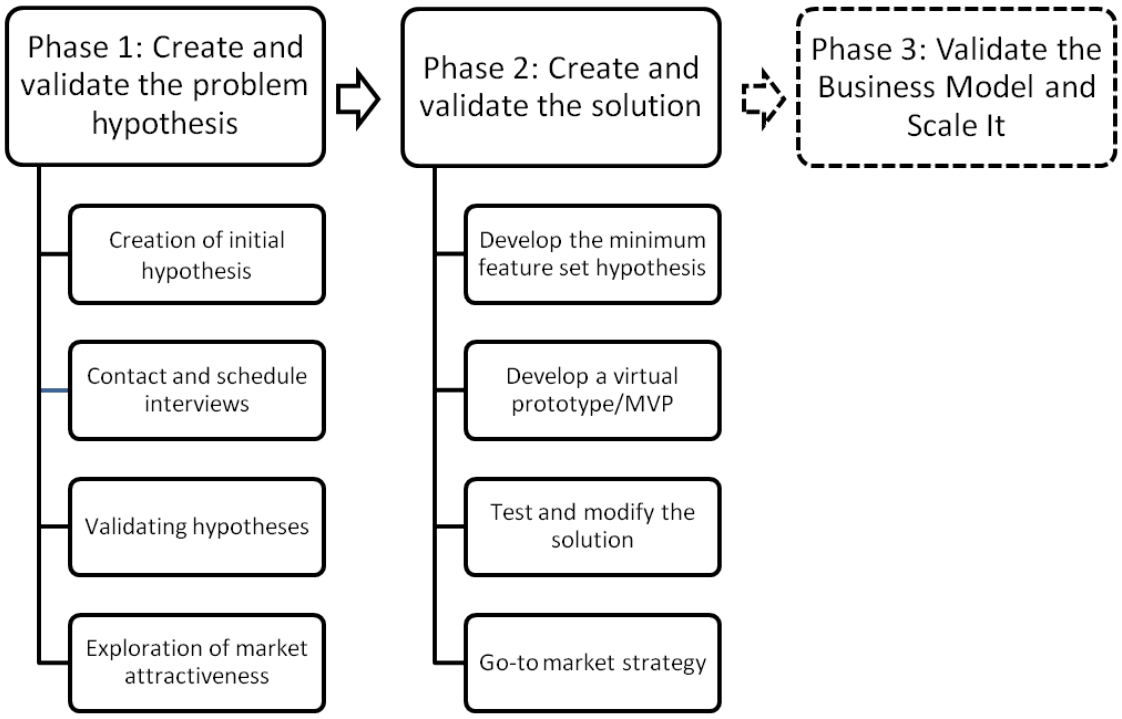

FIGURE 3. THE LSM PROCESS

Figure 3 shows a three-phase-process starting with the creation of hypotheses and ends with validation of business model and business scaling. The scope of this thesis includes an evaluation of the first two phases of the LSM process, phases that will be presented more in detail below. The last phase, including the validation of business and scaling of the business, is not described here[5].

2.3.1 Phase 1: Create and validate the problem hypothesis

The LSM process begins with the formulation of working hypotheses that later will be tested through conversations with customers. The first phase of the LSM process includes the creation of initial hypotheses, contact and schedule interviews, validating hypotheses and an exploration of the market attractiveness.

[5] The curious reader can find more information about this phase in "Nail it then Scale it" (Furr & Ahlstrom, 2011) or "Four steps to the Epiphany" (Blank, 2006).

Creation of initial hypotheses

In order for a startup to be successful, the entrepreneur must find a problem for a specific customer group (Furr & Ahlstrom, 2011; Blank, 2006; Ries 2011). The entrepreneur should always search for the big problems as customers usually can live with the small problems without finding a solution (Furr & Ahlstrom, 2011).

The identification of the first hypothesis should be based on a company's basic mission and its core values according to Blank (2006). This is similar to argument given by Ries (2011), who writes about basing the initial hypothesis on the company's vision. The core values are rather vague, e.g. maximizing the profit in a sustainable way, meanwhile a company's basic mission is more specific and is based on the first thoughts about the market and the product (Blank, 2006). The basic mission statement is likely to be changed over time, while the core values most likely remain the same. It is important to base the changes on a sufficient amount of data to be certain that the changes are correct (Blank, 2006). Furr & Ahlstrom (2011) do not mention how the first hypothesis is found.

The hypothesis takes on different shapes depending on the author. Blank (2006) has a more extensive one that includes assumptions about the customers' problem, the proposed product, competition, pricing, demand and market. Ries (2011) does instead emphasize two important assumptions, denoted as the leap of faith assumptions, on which the whole business model resides upon. These are the value and growth hypothesis. The value hypothesis is an assumption of how the entrepreneur will create value in the long term, while the growth hypothesis is the assumption for a sustainable growth of the business. It is important that both of these hypotheses can be validated in order to succeed (Ries, 2011). Furr & Ahlstrom (2011) create two different hypotheses. The first only considers the problem and is denoted the monetizable pain hypothesis. The second hypothesis is called the big idea hypothesis that includes targeted customer group, problem, key benefits of the potential solution, competitors and how the potential solution is better than the competitive alternative. The big idea hypothesis can either be a breakthrough idea or a "better, faster, cheaper" idea (Furr & Ahlstrom, 2011).

To validate the problem hypothesis, the entrepreneur has to find potential customers for evaluation. Blank (2006) argues for the importance of the type of companies the entrepreneur approach. The entrepreneur should create an innovators list that contains the customers that are smart, respected and first in line for new things (Blank, 2006). It should consist of 50 potential customers and they can be retrieved from contacts, magazines, and whatever sources the entrepreneur can find. This list can be used to find the visionaries who could give new ideas and also be a contact list for the advisory board and influencers (Blank, 2006). Another name used

by Blank (pp. 34, 2006) for the visionaries is earlyvangelists, which he describe as ”The most important customers you’ll ever know”. Earlyvangelists are identified by the following characteristics presented in Figure 4. The earlyvangelists are aware of having a problem and are actively seeking for a solution with a budget at their hands (Blank, 2006).

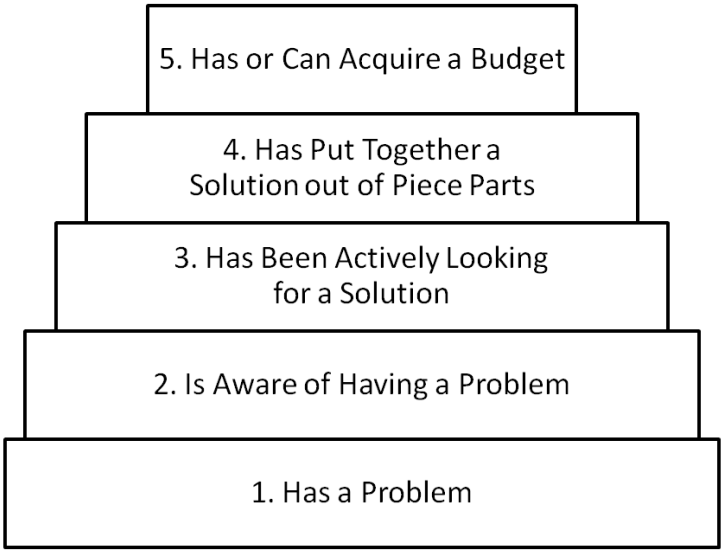

FIGURE 4. CHARACTERISTICS OF EARLYVANGELISTS

Furr & Ahlstrom (2011) does not mention earlyvangelists, but instead argue that mainly low-end customers in the target group should be approached first as they are more receptive to new technology.

As the hypothesis has been created and a sample of customers found it is time to validate the problem. All three authors write about the importance of having validated learning, which mean that every claim should be tested on the targeted customer group. Following from this claim they also emphasize the importance of moving outside the company and actually talking to the customers.

Contact and schedule interviews

There are generally two different techniques for the initial contact with the identified customer, either by email or by telephone (Blank, 2006; Furr & Ahlstrom, 2011). Once the entrepreneur starts contacting the potential customers, it is important to keep statistics regarding the hit rate (Furr & Ahlstrom, 2011; Blank, 2006). Furr & Ahlstrom (2011) argue that the entrepreneur should move on or revise the hypotheses based on the hit rate. The hit rate denotes the percentage of the customers contacted that agrees to a meeting or phone interview. Their rule of thumb is that if 50 percent or more previously unknown customers returns the cold calls the entrepreneur has found a substantial problem for the customers. If there are less the entrepreneur

should revise the hypothesis to find a more stressing problem. Blank (2006) use the hit rate to determine appropriate ways to get a first meeting, for example regarding which person that is best to approach and how to best conduct the conversation.

Validating hypotheses

Once the entrepreneur has set up an interview with potential customers, different approaches is best depending on the complexity of the hypotheses (Blank, 2006). Complex hypotheses demand several interviews, where the first one is focused on the most important questions, while the latter more about understand the customer's ordinary day and also investigate the market. For less complex hypotheses less formal meetings are required and telephone interviews could be used instead of actual meetings (Furr & Ahlstrom, 2011). The entrepreneur should avoid selling in conversations, but instead try to find the willingness-to-pay for a solution to the problem (Furr & Ahlstrom, 2011; Blank, 2006). Furthermore, it is important to avoid drawing conclusions from single customers and consider the type of customer who answers (Furr & Ahlstrom, 2011). The entrepreneur should try to accurately capture the data in the interviews (e.g. taking extensive notes or record conversation) to decrease the probability of drawing wrong conclusions (Furr & Ahlstrom, 2011).

There may be differences between the opinions of the managers and the users of a product (Furr & Ahlstrom, 2011). The entrepreneur should therefore consider the buying panel, which have three types of customers; the end-user (the user of the product), the technical customer (the person who install and maintain the product) and finally the economic customer (who makes the final purchase decision) (Furr & Ahlstrom, 2011). In contrast, Blank (2006) argues that the title of the customer is not of importance at this stage. After the hypotheses have been modified iteratively the entrepreneur should evaluate the response from the customers (Furr & Ahlstrom, 2011).

Furr & Ahlstrom (2011) and Blank (2006) argue that the entrepreneur should gather information about what kind of solution the potential customers need simultaneously to testing the hypotheses. Even if Blank's hypotheses include product features, is this not the purpose of the initial meetings. "For the first product in a startup, your initial purpose in meeting customers is not to gather feature requests so that you can change the product. Instead, your purpose in talking to customers is to find customers for the product you are already building." (pp. 36, Blank, 2006) Furr & Ahlstrom (2011) also puts emphasis on their monetizable hypothesis that deals with solely the problem, while the big idea hypothesis works as a way to collect data for the feature set of the solution in the next phase. Ries (2011) tests the problem hypothesis with the help of a prototype in the next phase of the process. Though he does propose creating a

customer archetype, where the mass market is approached with the problem, but this is performed to assess the market rather than validate the problem (Ries, 2011).

If customers have not showed interest during conversations, a pivot should be considered to find a new problem. In the case that the hypothesis has been validated as a big problem, the entrepreneur should move on to evaluate the attractiveness of the segment (Furr & Ahlstrom, 2011).

Exploration of market attractiveness

When the entrepreneur has validated the problem in a customer group it is important to evaluate the segment's attractiveness before moving on with the process (Furr & Ahlstrom, 2011). Furr & Ahlstrom (2011) presents three main aspects to consider; market size & growth, competition and matching the capabilities of the company with the market. When determining the market size it is important to investigate how many customers that have the problem out of the total market. The targeted market must be large enough to justify the investments needed. The competition must also be reviewed to find out if someone already has solved the problem and to find out whom the main competitors are. Finally the entrepreneur must find out if the company holds the necessary capabilities to create the solution (Furr & Ahlstrom, 2011). Also Blank (2006) argues for the importance of retrieving market knowledge, which include qualitative aspects like industry trends, unresolved needs, key players and what kind of important information that needs to be attained (Blank, 2006). This information can be retrieved through interaction with customers and key influencers in the market or secondary data such as industry analyses (Blank, 2006). Ries (2011) does not mention how to evaluate if a market should be pursued, apart from the already mentioned customer archetype. Instead he points out the risk of analysis paralysis, doing too much research about the market and the customers.

2.3.2 Phase 2: Create and validate the solution

After a validated problem has been found and the target segment is found attractive it is time to develop the solution (Furr & Ahlstrom, 2011). All authors describe the phase as an iterative process with the goal to create a product that meets the customers' needs with the least amount of effort needed to build it. This section is divided in three steps; develop the minimum feature set hypothesis, develop a virtual prototype/MVP, and test and modify the solution.

Develop the minimum feature set hypothesis

To develop a product that meets the customers' needs with the least amount of effort the features offered must be limited (Furr & Ahlstrom, 2011; Ries, 2011). Therefore the entrepreneur has to create a minimum feature set prior to building the solution. Furr & Ahlstrom (2011) proposes the creation of a minimum feature set hypothesis based on the big idea

hypothesis in earlier customer interaction. The feature set is then validated by further contact with customers. Blank (2006) includes the feature set in his initial hypothesis and the feature set is continuously developing. It is important to find a feature set that is common for the customers in the target segment (Ries, 2011; Furr & Ahlstorm, 2011; Blank, 2006).

After the minimum feature set hypothesis has been created it is important to develop a profile of your customers (Furr & Ahlstrom, 2011). The different kind of persons at the targeted customers that the entrepreneur needs to meet with should be identified. The entrepreneur could manufacture a matrix over the target customers where all the companies are covered, including the roles of the buying panel with the responsible persons at the positions (Furr & Ahlstrom, 2011). The buying panel presented in the earlier phase consists of the economic buyer, the technical buyer and the end-user. It is vital for the entrepreneur to present a solution that adds value to the different members of the buying panal. The information could be gathered from social-media tools, leveraging your network or through telephone calls to customers (Furr & Ahlstrom, 2011). The matrix can then be used to find the right persons to talk to.

The feature set is developed into the MVP and it is essential to have a MVP to be able to scale up the production (Ries, 2011). If it is not possible to find a single product that can be used by the customers in the target segment the entrepreneur should abandon the segment or find a new problem to solve (Furr & Ahlstrom, 2011).

Develop a virtual prototype/MVP

The developed minimum feature set is then used to develop the prototype. Ries (2011) claims that the process of learning about the customers starts when the customers has a prototype in their hands. The most effective way to create a prototype and start learning is to build a minimum viable product (MVP) (Ries, 2011). The MVP, based on the minimum feature set, is created to answer the leap of faith assumptions stated in the earlier step (Ries, 2011). It is the simplest possible solution to the problem that is being tested. Simpler products lead to faster iterations with minimum effort, which in the end results in the possibility to conduct more tests and thus generates a higher likelihood of success (Ries, 2011; Furr & Ahlstrom, 2011). The MVP should be used as a way to start learning from the customers and additional time spent on polishing it is only seen as waste (Ries, 2011).

The first MVP is not always a ready-to-use product, but can also be a virtual prototype (Furr & Ahlstrom, 2011; Ries, 2011; Blank, 2006). While Ries (2011) and Blank (2006) view the virtual prototype as an alternative way to start Furr & Ahlstrom (2011) use it as a step in their process. The first part in the creation of a virtual prototype is to find a suitable technology to produce it. The virtual prototype can take on different forms like e.g. a PowerPoint presentation or a video.

It can give the entrepreneurs insight if their proposed solutions are close to fulfilling the actual customer need or not (Furr & Ahlstrom, 2011). It is important for the entrepreneurs to clarify that the company is in the developing phase and not selling any products (Blank, 2006).

The physical prototype is either developed from the validation of the virtual prototype or the minimum feature set. The process of building a MVP should not be mixed up with traditional product development, where quality is an important measure of success (Ries, 2011). High-perceived quality by the entrepreneurs might not be equal to high-perceived quality by the potential customers and if there is a problem with low quality it is a perfect time to learn more about which features the customers wants developed. The first prototype should be as inexpensive and easy to make as possible (Furr & Ahlstrom, 2011). The goal is to try to transform the features that were retrieved with the virtual prototype into an actual product that can be tested in front of the customers (Furr & Ahlstrom, 2011). The entrepreneur should try to find suppliers or partners that could bare part of the cost and try to find the simplest way to manufacture a prototype (Furr & Ahlstrom, 2011). The actual purpose of the prototype is to test the minimum feature set (Ries, 2011). The use of a prototype to learn from customers helps the entrepreneur to get better information than in the case they ask hypothetical questions (Ries, 2011). The customers' interaction with real products can also raise questions that the entrepreneur would not have asked without the observed interaction. Many customers do not acknowledge the problem until a solution is in their hands (Ries, 2011).

However there are also some potential risks with releasing a product early (Ries, 2011). If the entrepreneur relies on a patent to protect its technology the release could trigger the time window to file for a patent. Another argument for not releasing a MVP is the risk of a powerful competitor stealing the idea. Though according to Ries (2011) the risk is rather small as the big companies rarely have time to evaluate all ideas out there and if the competitor would outperform the entrepreneur once the idea is known the startup could never succeed anyhow. The startups need to learn faster than their competitors to win the race (Ries, 2011). There is also the risk of damaging the brand name if the MVP is of low quality and the customers are not satisfied with it (Ries, 2011). The solution to the risk could be to release it under another name (Ries, 2011). Furthermore, releasing products in early startups rarely draw much attention and thus the risk of damaging the long-term brand is higher in a bigger release with PR and hype building activities (Ries, 2011).

Test and modify the solution

All authors use iterative processes to test their MVPs. However there are differences as Ries (2011) views the process as one phase, which is in contrast to Furr & Ahlstrom (2011) who

instead use three separate iterative processes in their evaluation of the MVP; the virtual prototype, the prototype and the solution. Ries (2011) illustrates the validation process with his Build-Measure-Learn loop (Figure 5) with the most important goal being minimizing the time through the loop. The basic principles in the loop; build, measure and then learn, are representative for all three authors' view of the validation process.

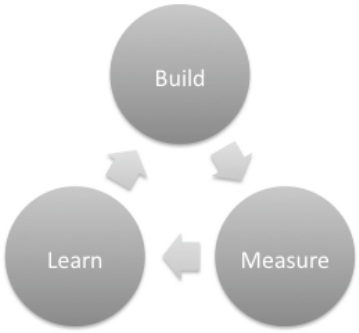

FIGURE 5. THE BUILD-MEASURE-LEARN FEEDBACK LOOP

The first phase, building, revolves around building the MVP based on the original hypotheses. The next phase is measure, where the entrepreneur is trying to find out if the product development is leading to a better product or not. The data from the measure-phase is then analyzed in the learning-phase and used in the build-phase to move closer to the product the customers need. In this phase Ries (2011) proposes a standardized approach, innovation accounting. The approach includes three steps, where the first one is establishing a baseline that is being investigated, preferably the most critical and riskiest assumptions that the business model resides upon. Based on this the MVP is built to collect data, which lead us to the next step; tuning the engine. This step focuses on the analyzed data and then tries to change the MVP to improve the areas that were lacking. The final steps in the approach are pivot or persevere. As the product or service has been modified it should move closer to the ideal one that was established in the business model and if not the entrepreneur should pivot (Ries, 2011).

Furr & Ahlstrom (2011) use the virtual prototype to further validate their minimum feature set before building a physical prototype. The virtual prototype can be tested either through a visit or if possible over the telephone (Furr & Ahlstrom, 2011). An interview guide should be created with the goal to learn about the pain, how the customer solves the pain today and their opinions about the entrepreneur's solution. The questions should not be too complex, making the customer innovate for you, and not too simple, as they get answered with a yes or no then (Furr & Ahlstrom, 2011). As in earlier steps it is important to not draw any conclusions from single opinions, remain unbiased and focus on optimizing through learning (Ries, 2011; Furr & Ahlstrom, 2011).

There are two important aspects that the entrepreneur should keep in mind during the testing of solutions, except the minimum feature set, according to Furr and Ahlstrom (2011); price points and breakthrough questions. These aspects increase in importance as the process goes on. Once a prototype is demonstrated the entrepreneur should try to understand if the customers are willing to pay for the product and how much (Furr & Ahlstrom, 2011). The breakthrough questions represents the tough questions like if the customer would pay money for the solution. In the solution test the validation of the product is customers buying a pilot study (Furr & Ahlstrom, 2011). It is important that the whole buying panel is present at the meetings (Furr & Ahlstrom, 2011). Blank (2006) also use actual purchases as the validation of the solution.

To evaluate the responses from the customers the entrepreneur should, if possible, use metrics (Ries, 2011). The choice of metrics should not be taken lightly as the quality of them is important (Ries, 2011). A bad metrics can make the team optimize the wrong thing. The entrepreneur should choose metrics with three characteristics; actionable, thus have clear cause and effect, accessible, creating reports that are simple to understand and to access, and lastly the metrics should be auditable, the data being credible to other employees (Ries, 2011). The gathered data should then carefully be analyzed to make decisions. It is important to segment the data gathered into different customer groups to find patterns and trends in the data (Ries, 2011).

Furr & Ahlstrom (2011) and Blank (2006) discuss the analysis of the data but do not talk about quantitative tools. They provide more general guidelines for interpreting the data. Blank (pp. 115, 2006) provides the following statement as the most important exit criteria for the product: *"whether the sales closer believes that other salespeople can sell the product as spec'd in a repeatable manner"*. Furr & Ahlstrom (2011) argue that the test might have to be repeated until it perfectly matches the customer need. Furthermore the entrepreneur should not base decisions on single opinions from a customer, but instead use multiple customers to verify it before changing features (Furr & Ahlstrom, 2011). The first interviews with customers often do not yield any insights, but after four to six interviews patterns often start to emerge. These patterns can then be used to revise the minimum viable product (Furr & Ahlstrom, 2011).

If the data has been analyzed and the customers have not embraced the product the entrepreneur can either persevere or pivot (Ries, 2011). Ries (2011) identifies a problem in a lack of pivoting in startups. He presents three main reasons for the excessive persevering; vanity metrics are used which makes it hard to motivate change, an unclear hypothesis that makes it hard to see results and finally the fear of failure (Ries, 2011). If the entrepreneur decides to pivot it is important for the entrepreneur to use the experience received in previous steps when finding a

new approach to the problem (Ries, 2011). The startup should strive to reuse the validated learning from the customers and try to change. Pivot is a special type of change where a new fundamental hypothesis is created and tested (Ries, 2011).

Go-to market strategy

During the validation of the product solution information is also gathered about the customers and the surrounding industry. This is an important part in order to grow a successful business (Furr & Ahlstrom, 2011; Blank, 2006). The entrepreneur should list all the data needed and create an interview guide to be able to retrieve the data at the meetings. The customers' workflows should be visualized with and without the product (Blank, 2006). The buying panel should be identified and then verified by the customer. The next step is to listen to the customer and get as much input as possible about e.g. the problem, features, influencers and positioning of the product.

The information gathered in the early versions can be used to understand the customers' buying process and also discover an appropriate sales model (Furr & Ahlstrom, 2011). The buying process includes everything from the customers being aware of the product to evaluation of it, purchase and finally the usage. The retrieved data can also be used to understand the market infrastructure that can be seen in Figure 6 (Furr & Ahlstrom, 2011).

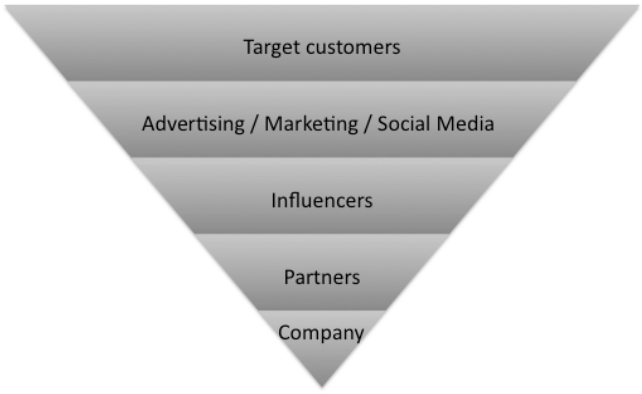

FIGURE 6. THE MARKET INFRASTRUCTURE

The entrepreneur should create an understanding of the players between the company and its customers, as seen in Figure 6 (Furr & Ahlstrom, 2011). The players closest to the company are the partners, which could be defined as the players that want to sell products or services to the same customers as the company. They could for example be resellers, content providers or early-reference customers. Early-reference customers want others to follow their groundbreaking efforts. The players that influence the whole industry constitute the influencers, the next level. The influencers include the press, industry analysts, user groups and so on. To

leverage them the entrepreneur needs to understand what matters to them and communicate that (Furr & Ahlstrom, 2011). The last players before the customers are within advertising, marketing and social media. The entrepreneur should collect information about the customers' preferences regarding this, where they find information about new products, and use this to put the efforts in the right place (Furr & Ahlstrom, 2011).

Blank (2006) gathers information regarding how to use the other players in the industry and how to best approach the customers. Ries (2011) does not deal with the other players, but instead concentrate on the engine of growth for the companies. He identifies three different ways that companies grow and how they can leverage these. The first one is sticky growth, where the growth is the new customers subtracted with the old customers leaving. The key to growth here is to keep the old customers and maintain a stream of new ones. Secondly it is viral growth, in which the growth is determined by the number of persons every customer recommend the solution too. So the key to growth is to get the customers to recommend the solution more commonly. Finally it is the paid engine of growth and the important metrics are how much each customer costs to acquire and the revenue from it (Ries, 2011).

A summary of the presented authors' view of LSM is presented in Table 1.

TABLE 1. SUMMARY OF LSM AUTHORS

	Furr & Ahlstrom	Blank	Ries
Create the hypotheses	Develop a hypothesis about the problem. Then develop a big idea hypothesis including features of the solution and whom to sell it to. Be careful with specific features in the solution. The problem should be a big one to the customers.	Include detailed information about the product, but also about the market, competition and distribution.	Create two kinds of hypotheses; the value and growth hypothesis. They establish whether the solution delivers value to the customers and how the customers get information about the product/service.
Validate the problem	Focus mainly on low-end customers. Use the response rate on emails or cold calls to measure the magnitude of the problem (at least 50 % to move on). It is important to be aware of the type of customer the person contacted is.	Start with a long list of potential customers. The initial purpose is to find customers that share your vision. The title of the customer is not the important thing. You should focus on understanding the customer's needs.	Validate it together with the solution.
Exploration of the market attractiveness	Perform a quick exploration of market dynamics and competition after validating the problem. Check the size, growth and competition, but also if the technological cycle of the market is ready for adapting the new technology.	Should gather a vast amount of knowledge about the market. Ranging from quantitative data like market size and growth to qualitative like trends and needs.	Could interact with mainstream customers[6] to understand if there is a problem to solve and thus an attractive market.
Build the solution	Develop a minimum feature set based on data from previous stages and by contacting customers. Use a rapid prototyping technology to build and test respectively a virtual prototype, prototype and solution. Focus on few features that will drive the purchase and simplify.	Start with a hypothesis of the product features and then validate them before finally a prototype is built.	Create a MVP to test the hypotheses. It is the simplest way to start with validated learning. Try to simplify with few features. The prototype should build upon the riskiest assumptions that need to be verified.
Validate the solution	Use an iterative process to validate the three consecutive steps. Should use interview guides to learn about the problem, how it is solved today and opinions about the proposed solution. In the solution test the whole buying panel should be involved.	Validate the features of the product and the business model with the customers. Then build the product based on these features and the validation is the sales to the earlyvangelists.	Test the MVP on early adopters in an iterative process, where it is continuously developed to better fit their needs. The data should be quantified and evaluated to track the progress.
Go-to market strategy	Collect information about the different types of customers in the buying panel and their needs. Also try to understand the players between your company and the customers and exploit them to succeed.	Use a hypothesis about the business model that is to be verified. Should also investigate e.g. distribution channels, sales materials and sales road maps.	Ries does not focus on the players between the company and the customers.

[6] Mainstream customers includes the vast majority of customers. These customers are not first to buy new technology and are usually less forgiving of an early product (Ries, 2011).

3 Research methodology

This section includes a description of the research methodology used during the study. First, the chosen research design is described and motivated by literature. Then, a description of the data collection and data analysis is given.

3.1 Research approach and design

The purpose of this thesis is to identify challenges when implementing LSM for early-phase manufacturing firms with physical products. Due to the nature and purpose of this research, a single case study was an appropriate research design since case studies allow the investigator to retain the holistic and meaningful characteristics of real-life events (Yin, 2009), in this case the LSM process.

According to Yin (2009), the classification of research questions being asked is the first and most important condition for differentiating among various research methods. "What" questions can be broadly categorized into exploratory- or prevalence nature (Yin, 2009). The two research questions in this study are of exploratory nature where the goal is to develop an initial analysis and pertinent hypothesis of problems using LSM outside the IT-industry. An exploratory type of research question is a justifiable rationale for conducting a case study (Yin, 2009). Further, case studies are particularly suitable for research questions that are of a how/why-character (Bryman & Bell, 2007) and do not require control of behavioral events and focuses on contemporary events (Yin, 2009). A case study is therefore an appropriate research design where large amounts of data were collected to provide a deep understanding of challenges associated with LSM. As in a case study, the focus in this report is on elucidating the specific details of the process at InCorp. InCorp was perceived to be suitable research object because of its characteristics of an early-phase manufacturer of physical products that currently is searching for a scalable business model. Further, the company's technology could potentially be used in multiple different applications potentially making InCorp suitable for the LSM process which is used to test and refine business model hypotheses. Conclusions generated from the single case study at InCorp were used to evaluate the theories regarding the LSM.

Even though the case study is an appropriate research design to capture in-depth contextual dynamics, many researchers nevertheless disdain the design. One of the main concerns about the strategy have been the lack of rigor case study research where systematic procedures have not been followed or biased views have influenced the findings and conclusions (Yin, 2009). A systematic procedure has therefore been pursued to assure that data and evidences are reported consistently throughout the study. Another common concern for case studies is the rather

limited basis for scientific generalization. Case studies could result in too complex theories stemming from large amount of data and theories that are too narrow, thus not generalizable. (Eisenhardt, 1989) The goal of the thesis is, however, to expand and asses LSM and its associated problems and not to provide a statistical generalization of the frequencies of problems. We believe that the findings from the case study can be applicable to companies with similar characteristics as InCorp, due to the deep contextual understanding retrieved, and thereby provide a valuable initial effort to assess LSM. The case study provides a holistic and in-depth view of why some aspects of the LSM might be difficult to implement. However, the generalizability problem should indeed be accentuated.

The research strategy pursued in this research can be categorized as action research, a term popularized by Professor Kurt Lewin (1948). A distinct feature of action research is an active and interactive self-involvement of the researcher in a problem solving context (McKay & Marshall, 2001). Action researchers are thus not only observing something happing, instead researchers take an active role in making something happen. Action research was an appropriate approach in this particular case since it allowed us to systematically test LSM in a real-life situation. We had the ability to control and ensure that the principles of LSM were properly followed throughout the process. This is a vital aspect in order to make an accurate assessment of the LSM and associated challenges.

The goal of action research is two-folded: solve a problem and contribute to science. (Gummesson, 2000) The process should thus be beneficial for both researcher and organization (Baskerville & Wood-Harper, 1996). We took therefore an active part in and drove the LSM process for InCorp and at the same time stood back from the action and analyzed the process in order to be able to contribute to the body of knowledge of entrepreneurial decision-making. This gave us a holistic understanding of the process and opportunity to recognize its complexity. The process followed during the case study can be represented by two cycles illustrated by Figure 7 and Figure 8 (see McKay & Marshall, 2001). Our problem solving interest is represented in Figure 7.

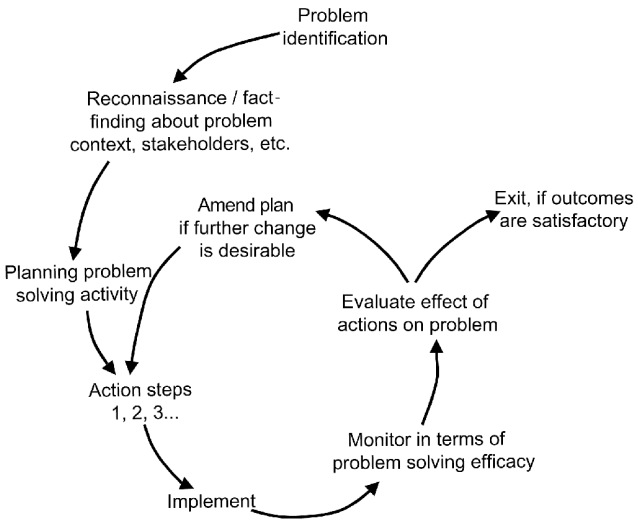

FIGURE 7. THE PROBLEM SOLVING INTEREST IN ACTION RESEARCH

The research started with the identification of a real-world problem; finding a scalable business model for InCorp. This was then followed by fact finding about the problem where we found out more about the context of the problem and stakeholders in the process. A problem solving strategy was then planned which then proceeded with the implementation of a number of action steps (principles of LSM) that were monitored and evaluated in terms of the effect on the initial problem. Depending on whether we considered the outcome to be satisfactory and that the problem was solved, a decision was made whether to exit from the situation or to continue and make additional changes to the problem context. A similar cycle was used for the academic research, see Figure 8.

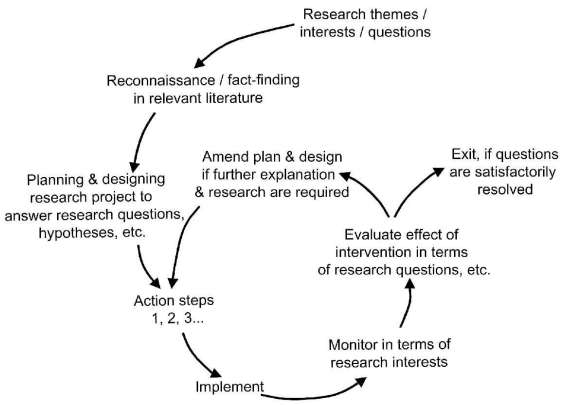

FIGURE 8. THE RESEARCH INTEREST IN ACTION RESEARCH

The research interest cycle followed a similar structure where the research theme was first selected followed by fact-finding in relevant literature. The principles of LSM were then implemented and evaluated in terms of problems and challenges during the implementation. When the research questions had been satisfactorily resolved could the process be ended.

Despite a growing interest in action research, a number of potential problems with the research strategy have also been raised by researchers. Action research has been accused of lack of impartiality and methodological rigor (Baskerville & Wood-Harper, 1996). Further, the results produced by action research are claimed to be non-generizable (McNiff & Whitehead, 2009). The potential problem of low methodological rigor was managed in the study by a rigorously and carefully planned data collection method (described in the data collection section).

The issue of our self-involvement in the process and potential impartiality are something that needs to be reflected upon. We entered the process as both participants and researchers due to our dual interest in the process. It is thus necessary to reflect about our dual role which potentially could have biased the data gathering and analysis. It is possible that the fact we were students and not the actual management of the case company could have affected the results such as lower barriers to get access to customers and opportunity to fully dedicate ourselves to the project. For example, the management for the case company InCorp had other commitments that they had to honor. However, in consistence with arguments provided by action researchers (e.g. Coughlan & Coughlan, 2002; McNiff & Whitehead, 2009), self-involvement as practitioners was considered necessary since it would have been difficult to get access otherwise. Further, by conducting the study by ourselves, we could ensure that the principles of LSM were implemented and properly followed throughout the process, a vital aspect in order to make a proper evaluation of LSM. Conducting action research did also provide us with the ability to change the process if considered necessary. The advantages of action research such as ability to control, get access and change the process were thus considered to outweigh potential drawbacks such as potential personal biases resulting in a decision to pursue an action research approach.

Another aspect worth mentioning is, according to the authors of LSM, the importance that the founders of the startup or/and the CEO are involved in customer conversations and do not leave this task to junior employees. Furr and Ahlstrom (2011) argue that the founders are the ones that actually believe that they understand the reality and that information gathered by a junior employee could easily get neglected (Blank, 2006). However, we do not believe that this has affected the findings since we could take on the role as founders and implement the principles of LSM and did not have to suffer from information being neglected. Pre-study and problem formulation

The purpose of the pre-study was to establish an understanding of area of research and determine the specific scope of the thesis. The scope of the thesis has been developed through interviews with key persons in both InCorp and the company's main owner. The nature of these

interviews was open due to the explorative character of this phase. A workshop has also been conducted with the business area manager and the sales manager to specify the scope of the thesis.

Since the purpose of the case study was to test theories concerning LSM, a literature study of relevant concepts was necessary before starting the actual LSM process for the case object. McKay and Marshall (2001, pp. 51) describe this work as a process where the researchers "engage the relevant literature, clarifying issues and identifying existing theoretical frameworks of relevance". An initial step of the study was to study existing literature concerning LSM. An initial exploratory literature study of relevant material concerning LSM was done in order to understand the principles and concepts later applied. These principles were applied for the InCorp and it was thus crucial to gain a solid understanding of the theories in order to critically assess them properly. The literature provided knowledge about LSM, knowledge that later was used to structure the research process at InCorp and to formulate interview guides. Research studies were also pursued to gather related relevant literature that was used to critically assess the LSM. There is today a dearth of academic literature concerning the concept Lean Startup even though research has been conducted on related concepts such as entrepreneurial learning and hypothesis-driven business development (e.g. Sarasvathy, 2001; Harper, 1999 and McGrath & MacMillan, 1995). In order to limit the risks of unnecessary literature search beyond theoretical saturation, concepts and theories were grouped and categorized to determine whether theories are new or just modifications of others. Search for relevant literature was mainly done through the search engine Google Scholar. Searches for e-books were performed on Chalmers library's database. Other sources of information included books, Internet (such as blogs and forums) and journals. Keywords used during the search included e.g. "Lean Startup", "Customer discovery", "Entrepreneurial learning", "Entrepreneurial decision making", "Entrepreneurial action" and "Business plan".

3.1.1 The LSM process

Four authors have been chosen as representation of LSM; Blank (2006), Furr and Ahlstrom (2011) and Ries (2011). As described earlier in the literature section, there are many similarities between the authors but also some differences in their views of LSM. Table 2 below summarizes the steps that have been conducted and tested during the study, steps that are based on the LSM literature written by the four authors.

TABLE 2. OVERVIEW OF THE TESTED LSM PROCESS

Generic phase of LSM process	Characteristics
Phase 1: Create and validate the problem hypothesis	Identify suitable segments Formulate hypotheses about product, customer problems and big idea hypothesis Find potential customers Get out of the building and test hypotheses through customer conversations 3 steps: 1. Contact and schedule interviews 2. Test and modify hypotheses 3. Explore market attractiveness Pivot if necessary
Phase 2: Create and validate the solution	Review of conversations during phase 1 Pre-test: Develop a minimum feature set hypothesis Develop a customer profile Develop a virtual prototype/MVP (the product/solution presentation) Make visits to understand how the solution solves the problem Pivot if necessary

The LSM process were conducted in an iterative manner where hypotheses concerning one particular segment were formulated and tested consisted with the LSM process presented in Table 2. Put differently, hypotheses were first formulated for one specific segment and then tested through customer conversations. Depending on customer responses in phase 1, a decision was made whether to pivot or to continue to the next phase. Table 2 present the general steps that have been implemented in order to find a scalable business model for the case company InCorp. A more detailed description of the implemented LSM process is described in section 4 Empirical results together with the encountered challenges of the implementation. Including detailed descriptions about events in the LSM process provides context to the encountered challenges.

3.1.2 The role of the InCorp employees

Since we had limited knowledge of InCorp and their technology, several members of their management team has been part of the case study. InCorp's sales manager for the particular business area involved in this study participated in several meetings with potential customers and did also provide valuable information from his experience. The information was used both to find appropriate segments with a significant problem and for evaluation of LSM.

Workshops were also conducted with additional key persons in InCorp's management team to discuss hypotheses about the company's business model. These workshops did also include discussions about subjects such as different methods for prototyping and how to present

InCorp's solution to potential customers. Finally, a person that had performed a customer discovery project for one of InCorp's other business areas was interviewed about his experience when conducting this project.

3.2 Data collection

The nature of the study and its research objectives determines which kinds of data that is needed (Hair *et al*, 2003). Further the type of data needed will then determine which data collection methods that are appropriate to use (Bryman & Bell, 2007). The data collection process for this study can be seen as two cycles that is superimposed on each other (see McKay & Marshall, 2001). The first cycle included the data collection method applied to evaluate the LSM and thereby fulfilling the purpose of the thesis. Apart from the data collection for assessing LSM, there was a separate method running in parallel for which data was collected for the actual LSM process that was used in order to find suitable applications for InCorp's technology by following the principles of LSM. The two separate data collection cycles will be presented in more detail under the headings LSM evaluation and LSM process.

3.2.1 Evaluation of LSM

To evaluate LSM and thus answer the purpose of this thesis only qualitative data was used. The data consisted solely of primary data, which is based on information and facts that are collected directly for the purpose of the study (Churchill, 1983). The primary data was mainly collected through direct observations from the work in the process and interviews, which is an important source of case study information (Yin, 2009).

Journal keeping

To capture experiences and observations, a research journal was kept to follow the process and understand the reasoning behind the decisions. The journal was an important part of the study since it helped us to reflect on experiences and observations in an effective way, but also to seehow think about and anticipate future experiences, consisted with argument provided by Coughlan and Coughlan (2002). Events, dates, people and reflections were noted in the journal on a regular basis in the end of every work day during the LSM process. By keeping journal on a regular basis could experiences of key events be captured close to the event when they occurred and thereby reducing the risk of changed perception of the events due to the time that had passed by.

The journal was divided into two main parts. The first part consisted of an unreflective description of what had been done that specific day (e.g. people talked to, segment worked with, formulation of hypothesis etc.). The second part was of a more open character, structured around questions such as: "What did not work out as planned with LSM?", "Which principle of

LSM was difficult to implement in this phase?", "Was there something that was contrary to the principles of LSM, but turned out successful anyway?" and "How can experienced problems be managed?".

The reflections were documented in one shared journal after discussions about the day's events and experiences including both the two authors. The person responsible for documentation were shifted between the authors where the person that did not write read through the notes in order to ensure that important information was not neglected.

Interviews

Interviews were also pursued with people within the organization to discuss important principles of LSM and potential associated problems when implementing the principles of the methodology. Semi-structured interviews were used in this research to generate primary data that was used to answer the research questions. The interviews were conducted with employees at InCorp that were participating in the LSM process.

The topics of these interviews were similar to those topics reflected upon in the research journal, i.e. "Which principles of LSM are difficult to implement for InCorp?", "Which principles of LSM are possible to implement?" etc. Questions were also asked about the development process of new products within the company and how InCorp currently use prototypes in the development process and if the company involves customer considerations in their development process.

3.2.2 LSM process

The data for completing the LSM method were mainly of highly qualitative nature collected from interviews with potential customers and with management at InCorp. These interviews together with direct observations of potential customers' processes constituted the primary data collected for the completion of LSM. In order to find companies and to analyze the markets secondary data were collected from internal documents at InCorp, financial reports, market analysis, and business directories (e.g. 121.nu).

Direct observation

Direct observations of processes related to heating process were pursued at production site of potential customers. These observations were done in order to generate a better understanding of potential problems encountered by companies. This provided a good opportunity to understand a normal workday and company processes that might had been difficult to understand just through interviews.

Interviews

The main source of data for pursuing the LSM process was interviews with potential customers and other relevant actors. The primarily purpose with these interviews was to generate a solid understanding of customer wants and needs related to heating of metals and whether InCorp could provide a solution to these needs. The companies to be interviewed were chosen after consulting InCorp and searches in business directories. They consist of both current and potential customers to InCorp within the business segments that were analyzed. Snowball sampling was pursued to identify important actors within these companies that function as important key influencers in investment decisions. Snowball sampling means that the respondents are asked for future knowledgeable interview objects (Goodman, 1961). The interviews were conducted with different members of the buying panel in the chosen companies. The buying panel is made up by stakeholders influencing the purchase of the specific application and is comprised of end users, technical users and economic buyers (Furr & Ahlstrom, 2011). Interviewing several persons within each company did also increase the opportunity to triangulate the information and not relying on solely one person's statements.

The initial topics in the interviews were generated from the LSM literature and were the basis for the first interview templates. The templates were refined during the interview process. There are two important jobs to think about throughout the interviews; pursue your line of inquiry and remain unbiased (Yin, 2009). By consistently keeping notes of the results it became easier to keep the needed information in focus during the interviews. Respondents were also given the opportunity to review information gathered from interviews to decrease the likelihood for misinterpretations of given information. The number of people interviewed during the LSM process is represented in Table 3. More information regarding the responses from interviews are presented in the result section (4 Empirical Results).

TABLE 3. SUMMARY OF INTERVIEWS CONDUCTED DURING THE LSM PROCESS

Segment	Phase	Number of actors called	Number of answers	Number of interviews	Number of face-to-face interviews
Industrial frying	1	20	20	9	7
Industrial frying	2	6	5	5	5
Paper & Pulp	1	21	15	10	0
Printing	1	10	6	4	2
Coating	1	37	33	23	5
Drying sheet metal	1	42	35	8	0
Other interviews	1	20	15	10	2
Total		156	129	69	21

3.3 Data analysis

The analysis of the collected data is a vital part of a case study. According to Eisenhardt (1989, pp. 539), data analysis is "the heart of building theory from case studies, but is both the most difficult and least codified part of the process". The data analysis was a continuous process throughout the research period where data analysis was performed concurrently with data collection rather than subsequent to it.

Collected data, mainly consisted of our experiences documented in the research journal, was analyzed by grouping experiences under different themes. The analysis constituted of identification of problems associated with the implementation of LSM. Problems were grouped into themes that were structured according to the main principles of LSM. The research journal was read thoroughly in order to ensure that no important observation was neglected. The analysis has also been conducted by comparing LSM literature and own experiences to related academic research.

3.4 Reliability and validity

The reliability and validity must be ensured in a study to be able to draw synthesized conclusions from the research (Bryman & Bell, 2007). There are several different forms of validity that are relevant for this research study. First, the ecological validity refers to whether the methods, material and setting of the study approximate to the real-life situation studied (Brewer, 2000), i.e. to what extent the testing environment influences the behavior of the

involved actors in the study. The ecological validity for this master thesis is considered as high since the study has been conducted in a real-life setting where the purpose of the master thesis has not been revealed to involved actors outside of the case company.

Further, Yin (2009) argues that there are three main tests to ensure validity; construct validity, internal validity and external validity. Construct validity try to assure that the study measures the correct concept that is being studied (Yin, 2009), that is, the extent to which what was to be measured was actually measured. To ensure the construct validity of a case study, the authors should follow three procedures; multiple sources of evidence, chain of evidence and interviewees reviewing the interview (Yin, 2009). First, multiple sources of data were used during the case study, including semi-structured interviews with management of InCorp, semi-structured interviews with investors and literature review in addition to our own observations and experiences. Second, a chain of evidence where preserved as each analytic step were conducted. A journal was kept throughout the case study to capture particular pieces of evidence that also imposed a discipline and a structure during the research process. The action research approach did also increase the possibility to ensure that the principles of LSM presented in Table 3 where actually followed by having control over the process. Third, practitioners interviewed about LSM principles had the opportunity to review transcripts from interviews before findings were reported.

Internal validity relates to the establishment of a causal-relationship between variables (Yin, 2009), in this case, whether the implementation LSM principles, X, for InCorp cause problem Y. The internal validity is considered to be relatively high in this case study given the fact that we could control the process and closely observe problems occurring.

The external validity concerns to what domains a study's result can be generalized (Bryman & Bell, 2007). This thesis has concentrated on a specific company and a single technology, even though several different industries have been involved in the process. Case studies normally have a hard time to generalize its finding to other cases or industries (Bryman & Bell, 2007). It is probable that some of the problems discovered during the implementation of LSM are applicable to other similar companies but this can of course not be stated with high confidence. The external validity is therefore perceived to be low.

Reliability concerns whether the results of a study are repeatable or not (Bryman & Bell, 2007). A measurement has high reliability if the study would generate the same result if repeated with the same object. The reliability is regularly lower with a qualitative analysis due to the nature of the data collection which holds for this study as well. Although, the steps followed during the study and data collection have been outlined which would imply a higher replicability but since

the case company and the potential customers are anonymous, it is probably impossible for other researchers to replicate the results of the study. The fact that the data collection has taken place within a specific time period at an organization with a high degree of change further decreases the replicability of the study.

4 Empirical results

The empirical results from the case study at InCorp are presented in the following section. The findings constitute of a summary of our experiences from conducting the case study, including more detailed description of our LSM process and the barriers encountered. The section is divided into two separate phases; create and validate the problem hypothesis, and create and validate the solution.

4.1 Phase 1: Create and validate the problem hypothesis

The purpose of phase one was to create and then validate the problem hypothesis by interacting with potential customers. The phase, completed iteratively, consists of four steps. It began with problem identification and formulation of hypotheses, Secondly, suitable potential customers were searched for and contacted. The third step involved validating the hypotheses through customer conversation. Finally, the market attractiveness of the identified segments of potential customers was explored. If the customers did not validate the hypothesis or the market was deemed unattractive the hypothesis was either modified or the segment was abandoned.

4.1.1 Find problems and creation of the hypotheses

Before the creation of initial hypotheses the segments to approach had to be chosen. InCorp's technology for heating can be used in many different segments and in different applications, which provided many alternatives. However, the identification of suitable segments with a potential problem for InCorp to solve was difficult even though the technology had a high degree of flexibility in terms of application. The difficulty of finding suitable segments could be addressed to two main reasons. Firstly, it was difficult to fully understand company specific processes from the outside without having specific experience from them. Secondly, the companies in all of the targeted segments were too disparate, which made it difficult to find specific problems that were in common for all companies in a segment. This challenge was perceived to be one of the main challenges during the study and was prominent even though the problem identification process was done in collaboration with the management at InCorp in order to leverage their expertise. In addition, several meetings with customers that had purchased InCorp's solution took place together with InCorp's sales manager. Customers were interviewed about their problems and advantages with the new solution as well as about their buying process.

To overcome this challenge, additional interviews with experts within both academia and established contacts with manufacturing companies were also performed. The following potential segments were identified after all information had been interpreted; industrial frying

(frying machine), printing (heating of cylinders), drying sheet metal (drying with heaters), coating (hardening) and paper & pulp (heating of cylinders).After the segments had been identified, further discussions regarding potential problems and InCorp's advantages were held to create the initial hypotheses. The most significant advantages could be divided in the follow categories:

- Energy savings
- Faster heating time
- Less factory space needed

And the biggest obstacles for implementing the technology were considered to be:

- Products had to be of a magnetic material
- Heater needs to be close to the material

Hypotheses included problem hypotheses, product proposition hypotheses and hypotheses about distribution and pricing. These hypotheses were written down to ensure a coherent understanding about their meaning. They were then merged into the big idea hypothesis. The formulation of hypotheses was an iterative process that was conducted for one segment at a time. The hypotheses were iteratively reformulated depending on the outcome of the customer conversations in subsequent phases, described further below.

The creation of the hypotheses was found to be challenging given that the processes in the different segments were complex with a high degree of company specific characteristics. For instance, companies that perform drying processes of sheet metal usually have different process stages, production volumes, product dimensions and interdependent processes. Differences in product dimensions were particularly troublesome since the heater needed to be close to the metal in order to be efficient. Further, the volumes had to be sufficiently large to motivate an investment in the technology given the relatively high investment cost. The only segment that had a rather standardized process was the food segment, in which industrial frying was considered. Though even in this segment, there were differences in both products and the processes in connection to the frying machine. The former customers of InCorp have, almost without any exceptions, got a customized solution to fit their particular need. Consequently, earlier applications had been very disparate in a wide range of different industries. The challenge was thus to formulate a problem hypothesis that could be applicable to a sufficiently large market without with a low degree of customization.

In order to find more information about the segments various interest groups were contacted through e-mails. They were asked about common problems that occurred in their industry and

what they thought would be the advantages of InCorp's solution. The creation of the hypotheses was an iterative process, where the collected information could be put together into a preliminary hypothesis. The hypothesis was then discussed with InCorp's management to get more input from their experience in the segments, but also whether InCorp's solution was suitable for these problems. When a segment and an initial hypothesis had been chosen, the search for potential customers to contact started.

4.1.2 Finding and contacting potential customers

Finding and contacting relevant customers was found to be more difficult than anticipated in advance. In accordance with LSM, a search for earlyvangelists were pursued, but the only customer with characteristics resembling an earlyvangelist, in the segments approached, was already in contact with InCorp prior to the study. The company, which was active in the food industry, was aware of their problems and had acquired a budget that was used to find a partner who put them in contact with InCorp. There was also a big difference in how open the different potential customers were to new technology. On one side there was a company that was active in the coating segment that did not recognize any problems at all, even though obvious problem was present. In the other end of the spectra there were more open-minded potential customers that recognized problems and looked actively for a solution to them. One of the potential customers worked towards a goal to reduce the lead-time by more than forty percent and talked about continuous improvements.

When potential customers had been identified in the segments, an initial contact was established. The contact was initiated through a telephone call or by e-mail. Though no responses were retrieved from the e-mails sent so the telephone was used exclusively after that. In the initial call, if the name of a person had not been given, the operator was consulted about the correct person to talk to. The correct person was described as the employee responsible for the specific process that was investigated. In most of the cases the person provided was incorrect, but they were almost always able to give the name of a new person. Though in some cases there were challenging to reach the correct person, demanding hours and tens of tries to finally reach them. Generally the higher up in the hierarchy the employees were, the harder it was to get hold of them.

Of the hundreds of contacts taken only a few of those who met the requirements were not willing to talk. The requirements were that the heater had to be close to the products and therefore the geometry had to be rather flat with low variations. As induction is used the products also had to be made up of a magnetic material. A majority of the companies, that fit the requirements, were interested in a face-to-face meeting at their facilities. The interest can be

summarized with the following quote of a potential customer: "*It is always interesting to take a closer look at a new technology*". However there were also persons who were negative. The reasons could be divided into three main categories of rejection:

- Too big of a change
- Do not want to reveal information
- Wants companies to contact their suppliers instead

Another challenge during the identification of customers to contact was the absence of a large potential customer base to target. The investigated segments in which the technology potentially could be applicable were characterized by relatively few companies active in Sweden. Around 10-20 was found in the industrial frying, pulp & paper and printing industry. The drying of sheet metal and especially coating had more companies, but there were still a limited number of less than a hundred companies found. This created a challenge for the face-to-face meetings as long distances had to be covered by car, which took time and cost money. To be more effective the meetings were scheduled so that the multiple visits could be covered during the same trip. This fact made the meetings take place a bit further in time as the companies calendars had to be synchronized. Some customers needed up to three weeks until the interview could take place. It forced some of the interviews to be performed over the telephone instead of physical meetings. However, despite the efforts on synchronizing meetings into clusters, some meetings were nevertheless cancelled with short noticed causing multiple trips to the same region with associated higher costs and efforts.

4.1.3 Validating the hypotheses

After the hypotheses had been created, it was time to validate them with the customers. The iterative process of testing and validating hypotheses was conducted in the segments identified earlier during the study. One of the main challenges encountered during this part of the process was the decision to pivot and preserve. Many of the interviewed customers did not perceived our assumed customer problem to be particularly troublesome but were nevertheless interested in continuous improvements, such as lower energy consumption and opportunity to reduce the manufacturing throughput time.

Once out in the field new discoveries caused the hypotheses to change. The first segment to be pursued was the industrial frying segment. In the segment none of the advantages that InCorp proposed, such as quick changes in temperature or low energy consumption, were part of the biggest problems seen by the potential customers. The most pressing problem was instead the carrier belt on which the food is heated. These carrier belts tend to break during regular intervals and needs to be replaced multiple times each year which results in additional costs for new

carrier belts and also costly down-time. Furthermore, all the interviewed companies in the segment talked about the importance of retaining the moisture throughout the cooking process in order to reduce the weight loss in the food. A couple of companies experienced an uneven temperature from the heating plates, which consequently resulted in an uneven internal temperature in the food. Since the general guidelines applied by the food industry demand an internal temperature above +72° C (in order to exterminate pathogens) a relatively large proportion of the food will have an unnecessary high internal temperature in order to assure that all food is at least above the given threshold. This unnecessary high temperature will therefore result in a higher moisture reduction and associated weight loss. These problems were turned into hypotheses that were validated by potential customers.

In the printing segment, the hypotheses created were not validated by the potential customers. The printing segment lacked any big problems and the potential customers were negative towards new technology. As in the other segments the most crucial feature in the machines was the reliability of them. Therefore they were not interested in switching any machines and the majority of the machines were from the 1980s. Apart from that there were also only a few potential customers in Sweden.

After the printing segment had been pivoted the hypotheses in the drying of sheet metal were created. However, also this segment had to be pivoted. The reasons were attributable to in particular too big differences between the different potential customers, as well as a lack of big problems that could be solved with InCorp's solution. After several interviews it was clear that it would not be possible to find a single solution for the segment. The processes were too different with a range of different geometries and characteristics of the material that was to be treated.

The next segment, for which hypotheses were created, was the coating segment. The initial hypotheses centered on problems with high-energy consumption, but the problems in coating were actually more related to the quality and a slow heating sequence. Though energy consumption was also a pressing problem that the customers mentioned. The quality problem was attributable to powder that was erupted as pollution when the paint was heated. Their current heaters consisted of convection ovens that use fans to blow the heated air, which creates turbulence in the oven making the problem more severe. However, there were too few potential customers found with the problems to validate the modified hypotheses and no other problems related to InCorp's solution could be found and the segment was therefore pivoted.

The next segment pursued, the paper & pulp segment, was the only segment where the companies actually had energy consumption as one of their biggest problems. As mentioned

InCorp's management perceived the energy consumption as the biggest advantage with InCorp's solution, but also the biggest problem for potential customers. Though the hypotheses still had to be modified as another important problem was discovered. The current solution with steam heating caused problems with condensation in the cylinders that lowered the temperature of them and thus forced the production speed to be lowered. The potential customers validated the modified hypotheses.

In the cases where an initial telephone interview had been done it was common that new problems were mentioned in the face-to-face interviews that were not expressed before. Another important aspect that was important to take into consideration was the position of the employee in the company. During the interviews it was clear that depending on the role there were different metrics that were used to evaluate them. For example one customer in the industrial frying segment said that he acknowledged the high energy consumption, but did not have responsibility over it.

During the validation of the hypotheses in the different segments, it was challenging to decide whether a problem was big enough to pursue or not. In all the segments the solution offered was of the "better, faster" type, thus an incremental solution. The potential customers were not so excited about the new solution due to its non-revolutionizing characteristics. Summarizing the segments two of them had enough potential to create a potential solution. However, in accordance with LSM the market attractiveness also has to be analyzed before moving on to the next phase and therefore an analysis of the size and structure of the market segments were undertaken after the validation of the problem.

4.1.4 Exploration of market attractiveness

The size of the market was estimated by investigating the revenues of the competitors and through looking at the potential customers' investment needs. Through discussions with InCorp and the potential customers together with searches on Google the competitors to InCorp were mapped. The revenues of competitors were found at business directories while the investment needs for potential customers were found in interviews. The paper & pulp segment was big enough for InCorp to pursue solely, while industrial frying would constitute of a substantial part of InCorp's forecasted growth, but was not large enough for to focus on solely. A decision to pursue the industrial frying segment of limited size was taken after discussions with the management at InCorp. The segment was seen as large enough to be of value to InCorp. The competition was rather limited in all of the segments and was not seen as a problem. As the technology is patented and the technology is a relative advantage InCorp has a competitive advantage in it. Due to mainly time limitations only the industrial frying segment was pursued.

Except the lack of time, the paper & pulp segment was even more focused on reliability and the potential customers emphasized that they would only like to buy from established suppliers. The recommendation to InCorp was therefore to pursue the segment by approaching the established suppliers. The industrial frying segment was pursued to the next phase.

4.2 Phase 2: Create and validate the solution

The purpose of the second phase was to develop and validate InCorp's hypothesis about a potential solution to the customers' needs and common problems identified during the previous phase for the industrial frying segment. The phase was divided into two main sub-phases. First, the problem hypothesis was turned into a hypothesis about a potential solution that corresponded to the minimum viable product (or minimum feature-set solution). Secondly, the solution hypothesis was validated by asking potential customers about whether the proposed solution met their needs and solved their problems.

4.2.1 Pre-test: Develop a Minimum Feature Set (MFS) hypothesis

The previous phase consisted of conducting interviews with potential customers to learn more about their common workdays and the problems that the industry is struggling with. This phase begun with a search for key themes in the conversations that had been conducted so far in order to identify commonly mentioned problems and needs. This was done by reviewing the notes from the interviews and summaries of responses during the previous phase. The summaries were particularly useful for this purpose since it gave us a good overview of the frequency of responses and a simple quantification of the importance of a particular problem. It was clear that our perception of the frequency and importance of a specific problem differed from the actual situation in some cases showed by the summaries. The following problems were identified as the biggest:

- Carrier belts breaking
- Weight loss of the product

It was thus of interest to suggest a solution that included more durable carrier belts in order to reduce the frequency of belts breaking down. The problem with the weight loss was caused by having an uneven temperature on the carrier belt, which could then be solved by a solution that has an even temperature across the belt. Besides previously mentioned problems, no significant problems were perceived to be particularly prominent within the industry associated with the process of continuous food cooking. However, several respondents said that they were always open for new investments if the initial investment could be justified by cost reductions in a given corporate-specific payback period. This would therefore indicate that companies could be interested in a new solution even in the absence of a recognizable significant problem. Given

that one of the major customer advantages with the new solution was assumed to be cost reductions derived from major reductions in electricity utilizations it was also an important part of the solution.

Based on these problems, as well as about the earlier conversations about the customers' everyday, a hypothesis about the minimum feature set could be developed. A great deal of thought was given to address and focus the solution around the supposed features in the solution which eventually would drive the customer purchase. These drivers were assumed to be connected to the biggest problems, but also the financial savings that the potential customers highlighted.

During the interviews in phase one it was clear that many actors within the industry were reluctant to invest in a new technology that has not been proven reliable in a similar context during an extensive time period. This is mainly because of the nature of the process, which is characterized by a continuous flow and fragile products where unexpected interruptions could be devastating for the company. The fear of a technological breakdown was eloquently described by a customer, when talking about testing a new technology, in the following expression; "If it breaks down my head will get chopped off".

All but one potential customer that were approached said they would feel more safe if the new technology had been installed in another facility prior to their purchase. They believe it is better to be number two or number three that installs the new technology. The majority of the customers had experience from being first to install new technology and had mostly got bad experiences. The potential customers also said that they preferred to buy from known suppliers, especially if the technology was not installed in any other facilities. The one exception mentioned that if a new technology can create a competitive advantage for them they would be willing to be first with the technology in their segment. However they wanted exclusive rights to the technology in their segment and said that it would be an advantage if the technology had been implemented in another segment or industry prior.

In order to reduce the size of the investment and thereby hopefully make the solution more attractive, a minimum feature set hypothesis based on an upgrading package of existing machinery was developed. This hypothesis included features that potentially would solve the companies' problem with broken carrier belts and an uneven temperature distribution throughout the heating plates. Another feature that was perceived to be important to test in this phase was the reduced energy utilization to determine whether the actors within the industry where willing to invest in a new technology that could reduce energy costs. Some actors had also earlier mentioned ease of cleaning the machine and possibility to increase/decrease the

temperature as important features of a new machine, features that were naturally included in the solution due to the specific properties of the InCorp's technology.

An important reflection during this work was the fact that the actors asked for relatively few features described above. Even though the perceived importance of a particular problem differed among respondents, it was clear that they asked for and valued similar features. Many of the requested features, such as an even temperature distribution and possibility to change temperature, were also met given the inherent characteristics of the technology on which the solution was based on. Much of the development work had therefore been done already and left was some rather non-advanced mechanical optimization needed to fit the particular context in terms of geometries etc.

During all the phases we tried to collect information regarding the different types of customers in the companies. The goal was to create a customer profile matrix that could be used in efforts to include the whole buying panel in the solution test. Though it turned out to be more challenging than anticipated due to difficulties of finding information online and that the operators could not provide it either. Even in the interviews with the responsible persons it was challenging to get the information. In the majority of the cases a project group was put together to evaluate the offer, but the final decision was completed further up in the hierarchy and generally no specific name could be given.

4.2.2 The virtual prototype test/Creation of the Minimum Viable Product

As the feature set had been established the next step in the third phase was to develop a virtual prototype in order to test whether our minimum feature-set hypothesis could reduce the customer pain and fulfill their needs.

This step was primarily associated with two main challenges inhibiting InCorp's opportunity to pursuing a prototyping strategy of create a minimum viable product that could be used in order to maximize learning. Firstly, it was realized early that it would not be possible to build a physical prototype due to the associated high costs and long lead-time of building the prototype. A sufficiently good prototype needed would require a considerable amount of engineering hours before actually being able to build it. Further, necessary material and components would have to be procured before the construction of the prototype could begin. This costly and time consuming process of building a prototype would thus require a genuine interest from the customer to pursue the development of the prototype. The customer should be so interested in the projected that they would be willing to bear the costs of a prototype. The second challenge associated with the creation of a minimum viable product was the difficulty of finding a common minimum feature set to create the prototype. Even though the frying segment was

characterized by similar processes and needs to a high degree compared to other segments investigate, conditions and wants did nevertheless differ in terms of needed size, energy utilization and prerequisites for cooling.

Therefore, only the virtual prototype step was conducted to measure if the solution hypothesis was near to solve an important customer pain. The virtual prototype comprised of two parts; one Power-Point presentation about the technology and associated customer value (read: problem solution) and a ROI-calculation based on the suggested solution.

The Power-Point presentation was used to build up trust and show that we had understood their common workday and associated problems and needs. It was also used to further validate our hypothesis about customer problems from previous phases. There were also discussions with InCorp whether a model of the solution should be included in the presentation. The physical appearance and interface was more or less similar to the current machine even though the internal technology was radically different. Thus the proposed solution could be characterized as an incremental improvement seen from the perspective of the customer, and therefore a model was not considered necessary. Instead a slide about how the everyday of the customers would look like with and without the solution was used to illustrate the new machine. As most of the customers did not have the technical knowledge to understand how the technology worked we believe this was a more effective way to illustrate the machine.

Since the solution could be characterized as an incremental solution or a "better, faster"-solution, it was important to be able to show that the investment would make sense from an economic perspective, which in the end usually determine whether to invest in new technology or not. A ROI-calculation was therefore used to visualize and clarify the financial consequences of the solution. The main components in this calculation were cost reduction derived from solving the problems of broken carrier belts, an uneven temperature distribution and high energy consumption. These calculations were obviously associated with a number of assumptions since no other machine had been built before in this particular context. Necessary assumptions and calculations were therefore done together with employees from InCorp to increase the reliability of the numbers. The calculations were then adjusted with respect to the companies' specific circumstances.

Response from Interviews

The interviews in the second round were conducted with representatives of five different companies, representatives that were also interviewed during the first round in our search for the common problems in the industrial frying industry. The same people were interviewed since the number of relevant actors in the industry is relatively limited and it would therefore not be

possible to conduct the second round otherwise. The difference in these interviews compared to earlier conducted interviews was primarily the focus on a discussion about the suggested solution. The purpose was to determine whether the induction-solution was perceived as interesting by asking the interviewees if this was something that they were looking for. The purpose of the interview were clearly outlined for each of the respondent in order to assure them that we were not selling anything to them but instead listen and would like honest feedback about the proposed solution.

The main lesson from the interviews in this phase was the importance of the ROI-calculation when talking about the solution with customer. Even if customers had been hesitant in the beginning when talking about the solution, they became more enthusiastic when showing the ROI-calculation. This made it possible for them to actually see how much they potentially could reduce costs by investing in the technology. We did also feel that customers had more confidence in us when being able to show that we understood their specific circumstances as well as common problems and processes within the industry. It was also beneficial to actively involve the customer into a conversation instead where the customer took an active part in the ROI-calculations instead of turning the meeting into a presentation. However, it was difficult to determine the level of interest even though a customer might have been enthusiastic about the solution. Most of the customers were reluctant to the idea of buying directly from a new and less proven startup compared to well-known manufactures.

4.3 Barriers encountered during LSM implementation

Several barriers were encountered during the case study at InCorp. These barriers were mainly related to four of the principles of LSM. Therefore the information in the diary was categorized under the different principles. They were combined in three different groups; getting out of the building, iterate rapidly & pivot if necessary, and rapid prototyping & minimum viable product.

4.3.1 Iterate rapidly and pivot if necessary

Iterate rapidly and pivot if necessary were combined into one group as they are closely related. There were two main barriers associated to the two principles. The first was the challenge to move rapidly through the iterations, which was caused by difficulties to quickly get feedback on the hypotheses and solution. The customers were not that talkative over the telephone and therefore face-to-face meetings were preferred, especially regarding the validation of the solution. The other barrier was related to the decision process of whether we should pivot or not in the segments. In none of the two segments, where the hypotheses were validated, the customers experienced a big problem. We struggled with finding out if it was time to pivot or if the problem actually was big enough to continue.

4.3.2 Iterative development of minimum viable product

Rapid iteration is connected to rapid prototyping, which together with MVP turned out to be challenging. The barriers can be derived to mainly two separate issues. First, a physical prototype of InCorp's solution would take too much time and resources to complete. The potential customers emphasized reliability, which made it even more difficult to develop a MVP rapidly. Secondly, it was challenging to find a common minimum feature set to create the prototype. Even in the industrial frying segment with the least differences between the processes it was not possible to create a MVP. The low amount of potential customers and the complex processes made it extremely hard to find a MVP.

4.3.3 Get out of the building

The importance of interacting with customers early was evident as the first hypotheses were modified or pivoted in all cases. However, a significant barrier was to actually find a problem to start the process. Many conversations with the management at InCorp were undertaken to find problems, but the complex processes of the potential customers made it hard. Furthermore, it was more difficult than anticipated to access the potential customers. There were relatively few customers in the segments, which made it hard to visit them, as it was both long physical distances and a challenge to schedule them. Another barrier encountered when "getting out of the building" was InCorp's partnerships that created a new challenge with the validation of the solution, as some secrets could not be revealed. Lastly, there was a problem with too much resources being put in before a market sizing was undertaken. The industrial frying segment, for example, was barely big enough and a lot of resources would have been wasted if it had been too small.

5 Discussion – lessons learned

The discussion section addresses the barriers identified when implementing a Lean Startup methodology for the case company InCorp. The section is structured based on fundamental principles from the methodology earlier described in the literature section.

5.1 Iterate rapidly and Pivot if necessary

Two of the fundamental principles of LSM literature are the principles of rapid iterations and pivot if necessary. The goal of LSM is, according to Ries (2011), to decrease the time needed for each iteration, consistent with the idea of how to rapidly move through the OODA-cycle described by John Boyd to gain a competitive advantage. If the solution targeting a particular segment cannot be turned into a scalable business model, the entrepreneur should pivot and initiate a new iteration. Three main challenges when trying to follow these two principles have occurred during the case study.

Firstly, the speed, by which InCorp could move through each iteration, was dramatically lower compared to startups developing software, as described by the LSM authors. The purpose of the early phases of LSM is to gather customer feedback concerning the entrepreneur's hypotheses about customer problems, suggested solution, pricing- and distribution strategy etc. The challenge of rapid iterations can be attributed to the nature of InCorp's product and distribution channels. InCorp sell physical products through physical distribution channels and simply do not have access to the channels of immediate feedback that Internet provides. Applications through Internet make it possible to effectively modify and test the product and use real-time data in order to optimize and fine-tune the features of the product. Software companies can thus collect and act on information much faster compared to InCorp. This should also hold for other manufacturing companies selling physical products through physical distribution channels.

The second challenge was to decide whether to pivot or to continue to subsequent phases. Blank (2006) argues that the product should solve a real customer problem, which preferably should be so painful that the customer has cobbled together an interim solution and/or has acquired a budget to solve the problem. These kinds of solutions are generally of radical nature as it is such a big problem that an incremental solution in most cases cannot solve, but what can the entrepreneur with an solution that does not solve a big problem but nevertheless provides an increased performance do in such a case? The entrepreneur will most likely not have customers to actively search for a solution, meanwhile Furr and Ahlstrom (2011) argue that these types of solutions can be used in LSM. The tough decision to pivot or not was indeed evident during the case study. Customers were not experiencing a big problem that the authors of LSM request. A

big problem that was detected by the majority of the customers could not be found in any of the five segments pursued in the case study. However, customers in three of the segments were explicitly telling us that they were continuously looking for new ways to decrease costs and increase productivity. These attributes were not mentioned as problems, but would qualify as needs of the customers. A potential challenge is thus that entrepreneurs abandon possible opportunities in favor for endless pivoting instead of capturing discovered opportunities. It might therefore also be important to look beyond the big pain points and also look for customer needs that can be of the incremental character.

However, worth to mention is that even if this challenge was present for InCorp it might not be the case for manufacturing company in early phases per se. New ventures developing software could as well be selling products that provide higher performance than what is currently offered. The challenge of pivoting or preserve due to absence of a big perceived customer problem can thus be attributed to the character of the product rather than any specific characteristics of the manufacturing industry. This discussion can be related to different types of markets described by Blank (2006) who argues that the entrepreneur initially should identify which kind of market (e.g. new product in existing market or new product in new market) in which the startup competes within.

Another challenge associated with the decision of pivoting or not is related to the underlying premise of the LSM about finding a scalable business model for the company. The most important exit criteria for the startup is, according to Blank (2006, pp. 115), "whether the sales closer believes that other salespeople can sell the product as spec'd in a repeatable manner". However, our case study indicates that the overarching goal of LSM about developing a solution that can be sold to multiple customers without any major modifications in a repeatable manner might be less suitable for InCorp. Furr and Ahlstrom (2011) argue that it might be necessary to repeat tests until the entrepreneur have developed a product that perfectly matches customer's need. When the product has been launched the goal is to develop a repeatable business model where the product is evolving to fit customers' need.

But what if customer specific circumstances require customized solutions and sales processes that cannot be duplicated to multiple customers without significant modifications? Experiences from the case study tell us that it was more difficult to develop a solution that could be sold to multiple customers with the same specification that perfectly matched their needs. It can depend on a difference in the processes of the customers or that the market is limited. In none of the segments pursued in the case study a single solution could be found that would fulfill the criteria of a repeatable business model described in the LSM literature. For example, the

processes of the frying segment in which the technology could be used where similar to high degree and the solutions for the customers were similar, but there were nevertheless a relatively big difference in size and utility need. The management at InCorp said that it was as standardized as their solutions could get.

We could thus identify an intrinsic dilemma during the case study between developing a product that matches customers' need perfectly, and the ability to sell a solution with similar specification and sales process in large scale. This trade-off between customization and scalability is not explicitly discussed in the LSM literature and it is probable that the problem is less prominent for software, especially those developed for the consumer market, where customer processes are more similar and the customer base is much larger counting the number of actors. Though, disparate customer processes are not unique for manufacturing companies. For example, IT companies that produce enterprise systems will probably face similar challenges as in the case study since no company and associated processes are identical. These types of software- companies together with manufacturing startups like InCorp who do not have the privilege of a tremendous customer base with similar processes might need a higher level of customization of their solution from case to case. In the same way, manufacturing ventures selling physical products through physical distribution channels could indeed find a product that matches customers' need in a large scale. The trade-off between customization and scalability is thus not something that is necessarily related to particular industry in which the startup competes. This could instead be attributed to the process complexity related to the investment. Given the challenge of finding a solution that could be sold to multiple customers without major modifications, the product needed to be more flexible for InCorp. We will therefore turn to another important principle of LSM; the Minimum Viable Product.

5.2 Minimum Viable Product

An essential part of the Lean Startup methodology is the principle of an iterative development of a minimum viable product in order to test the validity of a product and increase the rate of learning for entrepreneurs. Speed is emphasized as a crucial factor when developing the minimum viable product since shorter time needed for each prototype increase the number of potential iterations and consequently also the probability of success. This principle is consistent with established research of entrepreneurial learning (Sull, 2004; Harper, 1999) and the idea that entrepreneurs learn through iterative series of experiments used to test assumptions and hypothesis. The presented authors of Lean Startup argue that the methodology could help entrepreneurs to reduce time to market and spending by pursuing a rapid prototyping approach. This is well in line with the affordable loss principle for effectual reasoning and how entrepreneurs find ways to go to the market with minimum expenditures in form of money, time

and effort (Sarasvathy, 2001). Further, Sull (2004) describes how successful entrepreneurs effectively design and run experiments to reduce sources of uncertainty through e.g. prototypes and customer research. However, even though the idea of an iterative development of a minimum viable product has a bearing within the academic area, a number of barriers that hindered us from effectively pursuing a minimum viable product strategy have been identified during the case study.

First of all, a significant barrier that hindered the implementation of the principle of a minimum viable product was the inability to quickly create prototypes that could be used for instantaneous customer feedback. Ries (2011) describes how the team at his Lean Startup-company IMVU was able to create and ship new prototypes (or updated versions of the minimum viable products) in weeks and then measure and analyze the customer data. This was not possible for the complex physical products that InCorp is developing. First of all, the cost for developing a prototype is much higher. It is thus not reasonable to build a prototype unless there is a serious interest from the customer. Secondly, the time needed for developing a prototype for this type of applications and showing them in front of customers is longer than a few weeks. IT-based solutions can leverage efficient online distribution channels and associated network effects to effectively test new solutions, which are not possible for physical products. Ries (2011) describes how a company could spend five dollars a day to get 100 customer interactions with the product. Startups building physical products face different challenges since raw materials and components needs to get procured, prototype needs to get designed and built and finally, the physical products needs to get in front of customer in order to obtain feedback and assess the test results. The speed through the build-measure-learn cycle developed by Ries is thus much lower compared to software-companies, which usually have a less complex product and access to these virtual distribution channels. There should also exist software-companies that, like InCorp, spend large amount of time and money to create a prototype. These companies should face the same challenge with LSM. In some cases it is not even possible to get into the cycle early since the company cannot build anything. Further, the importance of reliability was identified as barrier to the creation of a minimum viable product during the case study. The LSM literature emphasizes the importance of getting the company's product in the hands of customers as early as possible. Ries (2011) argues that early versions of the product (even if the product is poor) will establish a baseline against the startup, which can try and improve the baseline. Based on the customer conversations during the case study, it is clear that InCorp often cannot take the risk of sending out poor products in the hands of customers. A failed "experiment" could result in a negative and devastating reputation for the company that is hard to regain. This barrier cannot be derived from manufacturing ventures per se, but is simply

connected to the focus on reliability of the product by customers. The markets approached with InCorp's technology were characterized by few and large actors. Customers interviewed during the case study testified that information about new technology and suppliers was diffused rapidly between actors within the industry. Furr and Ahlstrom (2011) recognize this issue of negative word of mouth but argue that this is not a great concern for the first customers. Further, Ries (2011) argues that startups have the advantage of being obscure which allows for experimentation. However, these arguments (which might be valid for ventures with larger customer bases) appear to have lower bearing for markets characterized with few actors where information is quickly diffused among actors. One could argue that the issue of negative word of mouth is more prominent for startups selling a physical product based on a specific technology such as induction heating in the case of InCorp. The potential negative perception could then be tied to the technology. Something that was exemplified during the case study where some customers told us that induction heating had been tried out before and did not work even though the induction heating provided by InCorp was a new type of technology. This might not be the case for software startups which are not tied to a particular technology. These startups could then potentially avoid the negative word of mouth by launching the minimum viable product under different brand names, a strategy proposed by Ries (2011).

Given the challenges of creating a minimum viable product, the concept of virtual prototype is becoming more relevant for physical products because of the difficulties of developing and test physical prototypes in front of customers. A PowerPoint presentation focused on the problem-solution is a valuable tool for validation of hypothesis concerning customer problems and whether the solution fulfills customer needs. But more importantly is the ability to effectively show how the new solution makes economic sense from an economic point of view. This was effectively done by a Return On Investment-calculation (ROI) showing how the new solution could help customers save money. We believe the ROI-calculation is most important in cases when the solution is incremental and do not solve a big perceived customer problem. In the case study it was easier to visualize the benefits of the incremental solution with a ROI-calculation. In the end, the economic sense of a solution was perceived to be the major decision point for almost all interviewed companies when deciding about incremental investments such as our suggested solution.

Another learning from the case study was the challenge with identifying a general minimum viable product that could be addressed to many actors without any major modifications. Conditions and circumstances in the case study were often different between different customers even though the customers' manufacturing processes are similar in many aspects. It was thus difficult to develop a solution that would fit to these different circumstances such as needed

size, electricity supply etc. without making customer specific adaptations. Since LSM advocates for a solution sold to many customers without major modifications, the principle of a minimum viable product could be challenging for a company like InCorp given the high level of customization needed. This challenge could not necessarily be attributed to the manufacturing industry, it is rather the differences in customers' processes that causes this challenge, something that also can be found in other industries. A solution to this barrier for implementing a minimum viable product approach could be to pursue a module-based solution strategy to maintain the necessary flexibility needed but at the same time increase the possibility to create a scalable business model.

The absence of a large potential customer base to which InCorp's product could be targeted is thus also related to the LSM principle of validated learning. The principle state that learning should be backed up with empirical data gathered from real customers. A barrier to implement this principle was thus the relatively limited amount of customers whose behavior could not be tracked in real-time using sophisticated software tools. This could be partly attributed to few customers per se, which could be the case for manufacturer – as well as software startups, but also the absence of virtual distribution channels which is more typical for manufacturers.

5.3 Get out of the building

One of the main principles of the Lean Startup methodology is to involve customers early in the creation of a new company or as Blank (2006, pp. 20) put it: *"you need to leave guesswork behind and get outside the building"*. However, the principle of early customer involvement was also seen to be associated with a couple of challenges even though the idea itself is perceived to be a powerful advice to entrepreneurs. Especially the problem identification and possibility to interact with customers were perceived as troublesome and will be discussed more in detail in the following sections.

The importance of involving the customers early was indeed evident during the case study. Many of the initial hypotheses about customer problems did not survive the first round of interaction with customers and had to be modified to better fit the findings derived from customer conversations. To manage such uncertainties is one of the critical tasks for the entrepreneur, according to Sull (2004). The importance of involving the customers early can thus not be underestimated. It is seemingly hard to handle uncertainties by more planning, that Lange et al. (2007) claim is a common advice to entrepreneurs. Also Bhide (1999) argues that startups facing a high degree of uncertainty should avoid spending resources on too much planning. This is consistent with the idea in LSM that entrepreneurs should get out of the building and start learning from their potential customers as early as possible and avoid writing

detailed business plans. The case study indicates that there is no major difference between software startups and manufacturing firms concerning the importance of involving customers in early phases when facing a high degree of uncertainty. However, the vital process of identifying a segment with a similar significant problem to solve has been challenging and will be discussed further below.

5.3.1 Opportunity discovery

Excessive planning is nothing to strive for, but the entrepreneurs need to put in effort in the beginning to find a specific segment with an associated problem to which the entrepreneurs can focus their efforts towards. This was one of the major challenges encountered during the case study. This barrier does not seem to stem from the characteristics associated with manufacturing ventures. Instead the barrier appears to be connected to the high variation and complexity in customer processes that need to be understood. One could argue that this challenge potentially could be due to the fact that we had limited knowledge about the processes within manufacturing firms and that this absence of in-depth knowledge and experience could inhibit our ability to envision potential segments for the technology. However, the management at InCorp was involved throughout the LSM process and their knowledge from their prior interactions with customers and earlier experiences from manufacturing firms were leveraged in order to overcome this challenge. Though, the challenge remained as management had concentrated mostly on single customers in different segments. Conversations with a couple of key persons within manufacturing companies as well as academia were also carried out to discuss suitable segments of interests. Symptomatic for the majority of the companies to which InCorp had sold early applications to was that they had already decided to invest in new equipment, often as a consequence of a need for capacity expansion or a problem that needed to be solved. However, these companies often came to InCorp instead of the reverse situation where InCorp found these companies.

The challenge of finding initial hypotheses to be tested through iterative conversations with potential customers is to a large extent neglected by the LSM literature. The process of finding an initial problem appear to be trivial and the authors focuses on the later phases instead and omit the creative process of formulating the first assumptions. As an example Ries (2011) describes the decision to target a specific segment like this; “We decided to enter the instant messaging market.” (Ries, 2011, pp. 39). Further, Furr and Ahlstrom (2011, p. 66) argue that “The foundation of the path to success is to first identify a real, monetizable pain to solve”, where the first phase of their Nail-It-then-Scale-It process is to determine whether this pain represents an opportunity. However, nothing is said about how entrepreneurs come up with these new ideas. In this respect the LSM literature is similar to the Popperian tradition of

hypothesis-testing embraced by Harper (1999) and Sull (2004). These authors spend less effort describing how entrepreneurs actually discover these initial problems or creatively formulate new hypothesis.

Another barrier that could inhibit the opportunity discovery is that InCorp's technology has a set of conditions, which the customer processes must fulfill (e.g. uniform shape and magnetic material). The technology could be seen as a part of the entrepreneur's available means that is the starting point in effectual reasoning described by Sarasvathy (2001). In effectual reasoning, the entrepreneur should base its search for a problem on who they are, what they know and whom they know. This is in contrast to regular planning where the focus is on the current position of the company and how to reach pre-defined goals. A similarity between the LSM literature and effectual reasoning is thus the continuous evolving process of entrepreneurial learning even though Sarasvathy focuses more on the actual discovery of opportunities.

Little is explicitly mentioned in the LSM literature about entrepreneurs' initial set of means (Sarasvathy, 2001) such as skills and resources (e.g. networks and contacts) that can be used to exploit opportunities that have been discovered. The actual ability to listen to customer and embrace constant changes is instead emphasized as key traits for a successful entrepreneur. Furr and Ahlstrom (2011) argue that the entrepreneur initially should identify key assumptions of the business (preferably based on the business model canvas created by Alex Osterwalder. But the entrepreneur is not recommended to tackle all assumptions at once; first should the customer segments be validated, then the value proposition, customer relationship and distribution channels. Assumptions concerning key resources and key activities are managed in later phases of the process.

However, the available means (primarily the new technology) was crucial for InCorp's ability to discover and exploit new opportunities. A significant majority of examples presented in the LSM literature comprise of software-related start-ups that possess a relative broad and general software-competence that often can be applied in a myriad of applications. This is an important difference compared to InCorp with a new technology. InCorp are thus linked to and constrained by the new technology in the search for new opportunities. Potential application areas for InCorp's technology needed to be related to heating of metal in processes characterized by sufficiently high production volumes and low variation in the geometry of the component that should be heated. There was of course a wide range of industries that fulfilled these requirements but the number of interesting sectors where to search for a significant problem were nevertheless limited compared to software-related companies making it more difficult to actually start the LSM process.

Even though less attention is given to the initial idea discovery in the LSM literature, all the presented LSM authors express how new opportunities can emerge during meetings with potential customers. LSM can thus be seen as a process that can generate new opportunities and not only a process to determine whether the initial hypotheses could be turned into a profitable and scalable business for the company. This can be contrasted to academic research that has been trying to find out where new opportunities come from and have focused on many different aspects such as technology – and science development to changes in the socio-economic environment (demographics, institutions etc) (Shane, 2004). However, Sarasvathy and Venkataraman (2011) noted that these answers are not sufficient partly since entrepreneurial opportunities also can be co-created through the entrepreneurial process itself, consistent with the LSM literature of how new opportunities also can emerge through customer interactions. This was indeed showed during the case study as new ideas and hypotheses were revealed when talking to customers about problems in their industries even though we did not have the time needed to further evaluate these ideas.

5.3.2 Access to customers

The finding of a segment with a potential problem to solve for the startup leads to the next phase: contacting potential customers. Two main barriers to implementation of LSM were encountered during this step; few customers to contact and difficulties related to actually contact and interact with customers.

Firstly, the number of actors for which the application might be of interest was low. The segments approached during the case study comprised of much fewer customers than most of the examples provided by the authors of LSM. The limited number of costumers could be attributed to the business-to-business market in which InCorp competes since business-to-business markets generally constitutes of significantly fewer customers compared to the business-to-consumer markets (Kotler, 2006). However, the limited number of customers could also be attributed to the specific conditions needed for InCorp's technology to be applicable such as relatively constant product geometry and magnetic material.

The second barrier related to the access of customers was the difficulties related to actually contact and interact with customers. Finding the right people to talk to was a barrier for the principle of getting out of the building in the case study at InCorp. Blank (2006, pp. 59) writes that the entrepreneur should start by making a list of fifty customers to talk to. But it is not just the identification of customers that is difficult, when finally succeeding in finding the right person to talk to the next challenge is to actually meet this person and talk. People may not be around or not accessible and scheduled meetings can be moved or canceled with short notice. The scheduling of the meetings with the customers created new challenges in the case study.

Since there were so few customers, it took several thousand kilometers of transportation to complete the case study. Both the cost and time associated with the lengthy transportation forced us to schedule the meetings in the same geographical area at the same day to be more effective. This both prolonged the time of each iteration and cost more money. It is of course possible to conduct some part of the conversations by telephone (especially in early phases) but to really understand customers' processes and everyday work life, it is often necessary to meet the customer face-to-face. This second barrier can be attributed to the absence of virtual distribution channels for InCorp. Software startups have access to virtual distribution channels through Internet in which they effectively can interact with customers. Manufacturing startups, on the other hand, do usually not have access to these virtual distribution channels which increase the cost and time needed for customer interaction.

Further, both Blank (2006) and Furr and Ahlstrom (2011) suggest that the initial contact could be performed by an introductory e-mail or a cold call. The frequency of customers returning these calls or e-mails should then be a good indication whether the entrepreneur had found a significant problem. E-mails were sent out to customers during the case study but none of the respondents answered. The absence of answers could of course be due to a problem hypothesis that did not correspond to customer perception. However, it could also be due to lower usage of IT by the companies in the case study or difficulties to find the right person to send the e-mail to. One might think that companies working with IT have a higher usage of IT which could increase their willingness to respond to e-mails.

To overcome the challenge, only telephone was used in the case study for the initial contact after e-mail had been tried but had not worked. Although it was a more effective way it was also very time consuming at times. There were two main reasons for this: Firstly, the entrepreneur has to go through an operator, which then can direct them to the right person. In the case study it took usually at least a couple of persons before reaching the right one. The second reason was that some people avoid answering the telephone. In some cases it took tens of tries and a few potential customers had to be scrapped. The snow balling method used in the case study helped to facilitate the first reason. The entrepreneur should therefore try to leverage its contacts to find new ways in to companies.

The time- and resource consuming process of interacting with customers due to the issues mentioned above makes partnerships an interesting option. Building strategic partnerships with key partners can ease the road to the market but also reduce the risk as partners commit to the project according to Sarasvathy (2001). Partnerships with established machine manufacturers were a particularly interesting option for InCorp. Building strategic partnerships with machine

manufacturers were perceived to have two main benefits for InCorp; access to customers and opportunity to complement InCorp's internal capabilities and resources needed to solve the customer problem.

Established machine manufacturers have established relationships with customers for which InCorp's technology could be applicable. Being able to leverage the machine manufacturers' current customer network would definitely improve InCorp's opportunity to get access to customers since the process of identification of new customers and establishment of new relationships would be more efficient. Being able to use the machine manufacturer's brand name would probable ease the way into corporations. The fact that the customers preferred to buy from a known supplier in the case study, made it tougher to convince the customers, as InCorp is an unknown name for the customers. In the segments of the case study, a majority of the companies pursued some kind of continuous process, which increased the demand of reliability. Continuous processes where reliability is a crucial factor are, however, nothing that is necessarily characteristic of manufacturing ventures. Reliability could indeed be as important for software-startups. For example, the software managing the money transactions for an investment bank is a vital part of the company that cannot fail. In the case study, we recommended InCorp to search for a partner in the paper & pulp segment as the customers only were willing to purchase from established suppliers. But also in the industrial frying segment the majority of the customers preferred to buy from an established supplier, and it would probably be more beneficial for InCorp to pursue a partnership there as well. Partnership has its biggest advantages when customers demand an established supplier. It is therefore of interest for startups targeting continuous processes where customers try to avoid stoppages by all means necessary.

Partnerships are also important in order to complement the startup's own resources and capabilities necessary to solve the customer problem or/and fulfill customer needs. Partnerships with established manufactures of machinery could extend InCorp's ability deliver a solution demanded by customers, for example, by providing complementary machinery components.

5.3.3 Risk of reveling secret material

A challenge associated with early interaction with customers is the risk of giving away classified information during conversations. This challenge appeared during the case study when planning discussions about our solution hypothesis with customers. Some information about one of the vital features of this suggested solution could not be disclosed due to a pending patent application. The management at InCorp had decided that certain information could not be told due to their current project with a machine builder that did not want to reveal information about the solution. The company was afraid that the information could fall into the hands of

competitors who eventually would steal the idea. The potential solution for one of the segments could therefore not be presented fully. However, this challenge could be sufficiently managed by talking about whether the benefits that the feature would provide to the customer were considered as important without talking about the actual technological attributes of the feature.

The risk of revealing secret material has been touched upon by Ries (2011) but is not discussed by the other LSM authors. Ries (2011) argues that companies should balance the risk of releasing an early product if they compete in industries in which a new scientific breakthrough is the crucial component of a company's competitive advantage. Though, Ries (2011) also claim that if a competitor can copy your idea and beat you it is better to leave the opportunity, as they would beat you once it was released anyway. The startup must be faster and better than the competitors to succeed, according to Ries (2011). The risk of revealing secret material is certainly something that needs to be stressed for startups for which their competitive advantage relies upon a particular technology or unique features. This could potentially inhibit their ability to demonstrate and talk about a potential solution. It is therefore necessary that companies planning to involve customers in early phases are aware of this risk and ensure that they fully understand the risks of early interaction with customers. It is also important to evaluate and communicate within the team about what kind of information that can be revealed to customers and what needs to be kept secret. Further, the market should be evaluated before the startup can move on in the LSM process, this will be discussed in the following section.

5.3.4 Importance of early market sizing

After finding a segment to target LSM proposes the entrepreneurs to go straight to the potential customers. The attractiveness of the market has rather low focus and is dealt with in later stages of the process. During the case study at InCorp a large amount of time and money was spent before the market segment was evaluated regarding its potential. McGrath and MacMillan (1995) argue that the use of a reverse income statement can help entrepreneurs to, early in the process, decide if the opportunity is worth pursuing. The reverse income statement starts with determining the required profit and then working its way up in the income statement to decide how much revenue that is needed for the particular profit. If the revenue in the segment pursued is not big enough for the risk associated with it you should leave the segment. The earlier a segment that is not attractive is dismissed the less resources is spent and thus more resources is available for new tries and the likelihood for success increases. Apart from that it can also help to get a hold on what we are dealing with early. Ries (2011) proposes the creation of a customer archetype, where the mainstream customers are contacted about the problem to understand them better before the early customers are approached. It will help to get the entrepreneur focused on

who the potential customers they should target are and on the assumptions that need to be validated instead of having too much focus on the product features.

Early market sizing is something that could be used in LSM for all kinds of industries. The initial process of contacting customers works the same way no matter what segment you target. Though, the access to data in order to complete the market sizing could of course vary and could therefore take up too much resource in some cases.

6 Conclusion

This master thesis was set out with the purpose to explore challenges when implementing principles of LSM for early-phase manufacturers of physical products with a new technology facing high degree of uncertainty about customer need and potential applications. More specifically, the following research question was formulated: What are the barriers to implement LSM for InCorp and why is this the case?

During the case study, we encountered a number of barriers to successfully implement LSM for InCorp. These barriers were mainly related to four of the LSM principles. First, the principle of rapid iterations was challenging because there was a barrier to get the quick feedback for physical products that can be retrieved for software ventures. The barrier can be attributed to the physical distribution channels as software ventures can have access to the Internet and thus quick feedback. The quick feedback is not available in physical distribution channels, as the entrepreneur has to put in effort to contact the customers. As manufacturing firms only have access to physical distribution channels it should be a general barrier to rapid iteration for these types of firms.

Second, the principle pivot if necessary was difficult to implement due to two barriers; lack of big problems and lack of scalable business models. LSM demands big customer problems, but in the case study the customer problems were minor and the solution simply offered increased performance. Though, the customers were interested and strived to cut costs and be more productive. Therefore it was hard to decide if to pivot or not. The other barrier was connected to the underlying premise of LSM to find a scalable business model. We could not find a solution that would fulfill the criteria of a repeatable business model described in the LSM literature in any of the segments approached. It seems to depend on the disparate customer processes. Neither of these two barriers can be generalized for manufacturing ventures, but is could also be present in other industries.

Third, the iterative development of a minimum viable product turned out to be difficult to implement, as there existed three main barriers. The first barrier was the inability to quickly create prototypes that could be used for instantaneous customer feedback. The barrier can be derived from the complex physical product of InCorp. It increases both the cost and time to build the prototype and show it to the customers. Generally this challenge is more prominent for manufacturing ventures as software-startups do not have physical products and have access to virtual distribution channels. Though, there exist software ventures with the complex products that face the same barrier. The next barrier to create a minimum viable product was the

importance of reliability in the targeted segments. The importance of reliability cannot be tied to characteristics of manufacturing ventures. In the segments targeted in the case study the majority of them had very few actors and quick diffusion of information between actors within the segment. Since we believe the product is more connected to the technology, it can be devastating to release a bad product. Software ventures do not seem to be connected with a specific technology in the same way. Therefore it should be easier for them to release the first prototypes under different brand names without suffering from it later on. The last barrier was associated to the creation of a general minimum viable product, which was hard to accomplish as InCorp's customers had disparate customer processes. The difference in customer processes is not something that is connected to the characteristics of manufacturing ventures.

Fourth, the principle of get out of the building was difficult due to barriers in finding opportunities to pursue and with accessing the customers. First, the difficulty of finding an opportunity appears to be connected with high variation and complexity in customer processes that need to be understood. These are not characteristics that are general for manufacturing ventures, but can exist in any kind of industry. Another possible barrier inhibiting opportunity discovering is that InCorp's technology has a set of conditions, which the customer processes must fulfill (e.g. uniform shape and magnetic material). Though, this barrier was deemed to be specific for the case study. Second, the barriers with accessing customers were few customers to contact and difficulties related to actually contact and interact with the customers. Few customers could be attributed to the business-to-business focus or the specific conditions the customer processes need to fulfill for InCorp's technology to be applicable. The difficulty to contact and interact with customers can be connected to that manufacturing ventures do not have access to the virtual distribution channels, which software ventures have. Contacting and interacting with customers through the physical distribution channel is associated with higher cost and longer time needed.

6.1 Academic contribution

The increasingly popular approach for systematic startup management, Lean Startup Methodology, has until today been largely practitioner driven. There is a dearth of academic research on the methodology even though some researchers have begun to pay attention to the new movement (e.g. Eisenmann. Ries & Dillard, 2012; Taipale, 2010). The thesis's academic contribution is thus an initial effort to assess challenges with the increasingly popular Lean Startup methodology in the context of an industrial startup. Further, different literature about the approach have been synthesized and compared in order to increase the understanding of the relatively disparate Lean Startup literature.

Even though statistical generalizations cannot be drawn from the study, it is nevertheless probable that some of the challenges discovered during the implementation of the principles of Lean Startup are applicable to other startups selling physical goods. The claim is based on that InCorp's problems are not tied to company specific characteristics, but more general characteristics such as selling physical products with high level of customizations through physical distribution channels. It would therefore be of interest to conduct further studies in this area to examine the prevalence of these challenges for other industrial startups developing physical goods.

6.2 Managerial implications

The implementation of LSM principles for InCorp has been associated with a number of barriers making the implementation more difficult. One part of the purpose of this study was to suggest how startups with similar characteristics as InCorp can overcome challenges with LSM in order to find a better fit between customer need and technology. Due to the inherent characteristics of these startups, the following guidelines are suggested:

Early customer interaction. First and foremost, entrepreneurs should engage in early customer interaction in order to test vital assumptions concerning the business model in accordance with recommendations given by the LSM authors. It was evident during the case study that many of the hypotheses created within the company walls had to be rejected after conducting customer conversations. The managers should maximize the learning from customers by having an open-mind and not concentrating on selling in the early stages, but learning. However, risks of reveling secret material need to be taken into consideration and the team should evaluate and communicate within the team about what kind of information that can be revealed to customers. Further, startups that have developed a new technology could benefit by looking for applications in adjacent markets outside of the entrepreneur's domain of expertise in order to discover a fruitful opportunity.

Identify Concept/market fit. Early-phase manufacturers of physical goods might not be able to pursue a minimum viable product strategy effectively that LSM advocates for due to high cost and long lead times associated with the creation of physical prototypes. Nevertheless, it is important to evaluate the market fit for the proposed concept in early stages in order to reduce the risk of misdirected investments or insufficient resource allocation. The proposed application should be visualized and socialized involving early interaction with important stakeholders. This evaluation of concept/market fit could be achieved by a virtual prototype (see Furr & Ahlstrom, 2011) describing the proposed application in terms of customer value, how it works, how it might affect the customer work-life etc. This can be done by, for example, a PowerPoint or/and

a ROI-calculation. This evaluation will visualize important challenges for the startup as well as give an indication on whether the development process for a particular concept is worth pursuing. It is also important to emphasize the importance of early market sizing in order to avoid that the entrepreneur spend years in a startup before realizing that the startup cannot grow beyond a few million dollars in revenue.

Build strategic partnerships. A key learning from the study is that entrepreneurs should start building strategic partnerships right from the start. Involving the customers into strategic partnerships could reduce the risk as partners commit to the project and bear some of the development costs. Further, the startup may not have the capabilities and resources necessary to solve the customer problem and provide the customer with the needed solution. Building strategic partnerships with other actors could thus complement the startup's internal capabilities necessary to solve the customer problem. For example, strategic partnerships with established machine manufacturers could improve the startup's access to customers by leveraging the established customer network. The startup could also benefit from a well-known brand which is particularly important in vital customer processes characterized by a continuous flow. Building strategic partnerships is actually well related to LSM since partnerships allows the entrepreneur to bring the idea to the market with lower levels of capital outlay.

Look beyond big customer problems. A central advice provided in the LSM literature is that the entrepreneur should focus on significant customer problems, preferably so big that the customer has cobbled together an interim solution and has a budget to find a more temporary solution. This is advice is indeed reasonable since big customer problems often include a big opportunity. However, entrepreneurs that develop a product that provides increased performance in existing performance parameters (i.e. a "better, faster, cheaper" solution) might be successful without finding a big customer problem. For example, it was evident during the case study that customers wanted to improve their processes and were willing to invest in new technology even though they did not experience a big problem. This advice can thus be seen as a reinforcement of Blank's (2006) discussion about market type; entrepreneurs should consider which type of market type that they compete within and what kind of product that they provide before starting sales and marketing activities.

More flexible view of the repeatable and scalable business model. The last advice to early-phase manufacturers of physical products relates to the overarching goal with LSM; to find a repeatable and scalable business model. An intrinsic dilemma was identified during the case study between developing a product that matches customers' need perfectly and the ability to sell a solution with similar specification and sales process in large scale. Manufacturers selling

more complex products may not have a large customer base with similar customer processes which means that it can be difficult to identify an application suitable for many without modifications. These companies might thus need a more flexible view of the goal of a repeatable and scalable business model and allow for a higher degree of customization. An advice to these entrepreneurs is to pursue a module-based solution strategy to maintain the necessary flexibility but still improve the chances of creating a repeatable and scalable business model.

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