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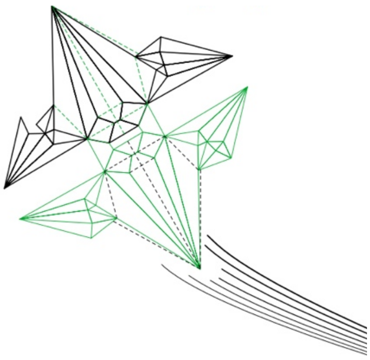
Lean Startup Orientation:

Empirical Evidence on Venture Success



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Berlin, 13.03.2018

Mario Patrick Schwery

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Abstract

The Lean Startup Method (LSM) has reached a high popularity and wide use in the startup world. However, it's unknown if LSM is positively related to the performance of a new venture. Existing research on the effectiveness of LSM is either scarce or indirect. Therefore, the popularity across entrepreneurs using LSM is in contrast with the lack of its empirical validation. First qualitative research and operationalisation to reveal the essence of LSM exists but an empirical validation is still missing. This thesis advances the academic discourse on LSM by providing direct evidence that supports the effectiveness claim of LSM. First, the degree to which startups use Lean Startup (Lean Startup Orientation, LSO) is presented. The quantitative analysis of data collected by 100 Berlin-based software startups revealed a strong, robust and highly significant relationship between LSO and performance. Therefore, LSO delivers on its promise for new venture performance. The relevance for research lay in the proposed operationalisation of LSO that future research can build on and refine. Moreover, evidence for the positive performance impact of experiential entrepreneurship is provided. The empirical validation of LSO activities contributes to existing management strategies by providing strong justification for lean startup capabilities leading to a higher likelihood of success.

Keywords

Lean startup, experiential entrepreneurship, experimental learning, digital products, software, technology entrepreneurship

Management Summary

Understanding the determinants of new venture success is a central objective for every economy as entrepreneurship and entrepreneurs are the backbones and driving force of a healthy economy (Schumpeter, 1934; Gartner, 1985). 9 out of 10 startups fail. Therefore, wasting time, creativity and a lot of potentials. “The only way to win is to learn faster than anyone else” (Ries, 2011, p.111). The Lean Startup Method (LSM) promises to bring a structured process into the chaotic nature of innovation and is hypothesized to be an important approach towards more successful digital product and service development. LSM has reached high popularity and wide use in the startup world. However, the approach lacks empirical testing, and the academic discourse has just started to analyze and understand the elements linked to the LSM. First qualitative and conceptual research, a scientific reflection on LSM and first steps towards an operationalisation for the leanness of a startup were found. Existing research on the effectiveness of LSM is either scarce or indirect. Therefore, the popularity across entrepreneurs using LSM is in contrast with the lack of its empirical validation. The core of this research is the operationalisation of the Lean Startup Orientation and investigation of its effectiveness in a quantitative manner conducting a survey research and the connected data collection. This survey research aimed to investigate empirically on the assumed link between the lean startup orientation and new venture project performance considering key contingencies. The quantitative data analysis of Berlin startups (n=100) developing digital products and services revealed a strong, robust and highly significant relationship between LSO and performance. LSO is found to be positively associated with new venture performance and delivers on its promise. Analyzing the contingencies, it underlined the effectiveness of LSO for incremental innovations. Unexpectedly, LSO was found to perform equally well in the B2C and B2B context as well as under different levels of market and technology uncertainty. The relevance for research lay in the proposed operationalisation of LSO to build on and refine. The academic discourse on LSM is extended by the evidence for the positive performance impact of experiential entrepreneurship. Further research is required to extend the conceptual model and to reveal the applicability of LSO across different industries and over time using a longitudinal design. The empirical validation of LSO activities contributes to existing management strategies by providing strong justification for lean startup capabilities leading to a higher likelihood of success. Moreover, the development of an online self-assessment tool including recommendations to improve the likelihood of new venture success was suggested.

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Abbreviations

AVE	Average Variance Extracted
B2B	Business-to-Business
B2C	Business-to-Consumer
BMC	Business Model Canvas
BML	Build-Measure-Learn
CTO	Chief Technology Officer
EVA	Exploratory Factor Analysis
Fintech	Financial Technologies
IPO	Initial Private Offering
KPI	Key Performance Indicator
MVP	Minimum Viable Product
LSM	Lean Startup Methodology
LSO	Lean Startup Orientation
OODA	Observe, Orient, Decide and Act
TDM	Total Design Method
VIF	Variance Inflation Factor
VPC	Value Proposition Canvas

Glossary

Beta Version

An early but uncomplete version of a program or application containing the major features (working definition).

Build-Measure-Learn (BML) loop

The BML loop is in the core of the Lean Startup Method and helps startups to turn ideas into products by accelerating the learning whether to pivot or persevere (Ries, 2011).

Business Model Canvas (BMC)

A template as alternative to a classic business plan which defines the business model of a startup with nine blocks and considered important to capture how the company is creating value for its customers (Osterwalder & Pigneur, 2005).

Customer Development

A parallel process to Product development which is customer and market centric to learn and discover the startup's initial customers (Blank, 2013a).

Incremental and radical Innovation

"Incremental innovations are minor improvements or simple adjustments in current technology" (Dewar & Dutton, 1986, p.1423).

"Radical innovations are fundamental changes that represent revolutionary changes in technology" (Dewar & Dutton, 1986, p.1422).

Iron Triangle

Concept from project management literature which defines the success of a project with the elements cost, quality and time (Atkinson, 1999).

Lean Startup Method

A methodology towards new venture creation using hypothesis-driven experimentation and iterative product releases for shorter and cheaper development processes. It aims to avoid costly mistakes early on and increase the chances of success (Ries, 2011).

MVP

A minimum viable product (MVP) is a product with the minimum set of features which can be produced cheap and fast, ready to test it with early customers (Ries, 2011).

Pivot

A course correction **“**designed to test a new fundamental hypothesis about the product, business model, and engine of growth” (Ries 2001, p.178).

Prototype

“A prototype is any representation of a (design) idea, regardless of the medium“ and serves the dimensions of role (usefulness in user’s life), look and feel (experience using it) and implementation (how it works) in the design of this interactive artefact (Houde & Hill, 1997, p.369).

Startup

An emerging venture is a “temporary organization designed to search for a repeatable and scalable business model” (Blank, 2013, p.5). A startup is a new venture which is already operating on the market (working definition) and “designed to create new products and services under conditions of extreme uncertainty” (Ries, 2011, p.8).

Unicorn

A unicorn is a term used predominately in the technology industry for a startup backed by venture capital with a valuation of more than $1 billion (Kerai, 2017).

Validated Learning

By running experiments each element of the founders' vision is tested and validated by customer feedback in iterative cycles (Ries, 2011).

1 Introduction

1.1 Situation and Complication

“Starting a new business is essentially an experiment. Implicit in the experiment are a number of hypotheses (commonly called assumptions) that can be tested only by experience.” (Block & Macmillan, 1985, p.184)

Entrepreneurs are highly important for the economy due to their role in creating new ventures, products and markets. Entrepreneurship has emerged as a potent economic force contributing to technological change and productivity growth (Kuratko, 2005). Entrepreneurs identify, evaluate and exploit opportunities (Shane & Venkataraman, 2000). Those activities foster innovation, creativity and result in the creation of new markets, new ventures, new distribution channels and new products and services (Schumpeter, 1934; Gartner, 1985). Change and progress is initiated by innovation and the disruption of the status quo. Therefore, entrepreneurs are considered the backbone and driving force of a healthy economy (Schumpeter, 1934) and their success is a topic of high interest.

The myth and popularity of the successful entrepreneur conflicts with the reality of a high startup failure rate. The German media often reports entrepreneurial success stories, for example interviews with successful entrepreneurs with huge venture funding. The scaling of so-called unicorns such as Zalando, HelloFresh and Delivery Hero is widely reported, as are speculations about the next unicorn to come (Spain, 2017; WIRED, 2017). However, examination of the data shows that this view of the entrepreneurial life is biased. Firstly, statistics show that the chance to become a unicorn is less than 1% (CB Insights, 2017c) or approximately one-in-fifty-thousand reaches an IPO (Aldrich & Ruef, 2017). In general the failure rate of startups is high: According to Fortune Magazine and Forbes Magazine 90% of startups fail (Griffith, 2014; Patel, 2015), the failure rate is high around the world and more than 80% of startups fail in their first year of existence (Hyder & Lussier, 2015). Upstart tech companies have a 70% failure rate of around 20 months after first fund raising, whilst the rate for seed or crowdfunded consumer hardware startups is 97% (CB Insights, 2017a). These numbers underline the difficulty of creating a successful venture.

But why do startups have such a high failure rate? It is important to understand the biggest challenges startups face to reveal potential sources of failure. The European Startup Monitor 2016 survey found the most significant challenges for startups were in sales and/or customer acquisition, growth, and product development. This finding was emphasized by statistics showing that 46% of the startups judge the product development strategies as very challenging, followed by strategies for rapid growth (35.1%) and profitability (30.4%)(Kollmann et al., 2016). Similarly, the German Startup Monitor 2017 survey reported that the 4 biggest challenges for German startups were the distribution/acquisition of customers (19.7%), product development (17.1%), growth (14.7%) and collecting funding (12.3%) (Kollmann et al., 2017). Additionally, each unsuccessful startup reveals different reasons for failure. There are various reasons why, *e.g.* software startup companies fail (Crowne, 2002; Mullins & Komisar, 2009; Giardino et al., 2014). It is important therefore to look at startup failure from an aggregated level. A study collecting the reasons for startup failure revealed the top 20 reasons (CB Insights, 2017b). The findings showed that running out of money, a poor team and fierce competition were indicated as common reasons for startup failure. However, the most mentioned reason for startup failure was the development of a solution which is not solving a market problem nor a user pain point. Whilst startup failure can occur due to many factors, new product development is considered highly challenging and of top strategic relevance in startups across Europe.

The development successful of new products / services is a challenging activity crucial to the survival of a new venture. Creating new products and services and finding a suitable business model is becoming increasingly challenging due to increased market volatility, uncertainty, complexity and ambiguity (Rodriguez & Rodriguez, 2015). On the one hand, startup face uncertainty in the current fast-moving, global business world characterized by saturated market, empowered customers and fierce competition with established players (Jaworski & Kohli, 1993; Chen et al., 2005, Mullins & Komisar, 2009; Andries et al., 2013). The success rate of new products was found in general below 25% (Evanschitzky et al., 2012). This high failure rate clearly puts pressure on companies, but startups with limited resources are at most risk. It is important therefore to identify the factors of success to increase the success rate.

The identification of factors for successful entrepreneurship and product development has already received much attention. Over the last decades, both politics and academia have shown interest in the factors necessary for successful entrepreneurship. Political institutions started to measure various indicators for successful entrepreneurship on the macro-level with the opportunity to compare across different countries and economies (Baron & Hannan, 2002; Kakati, 2003; Neck & Greene, 2011; OECD, 2017; Herrington & Kew, 2017). Considering the high importance of entrepreneurship, it is not surprising that academic researchers started investigating the micro-level on elements necessary for successful ventures and product development (Henard & Szymanski, 2001; Ernst, 2002; Chen et al., 2005; York & Danes, 2014). All those activities aim to foster the identification of elements leading to successful entrepreneurship.

Well-established processes for product development get challenged by new methods claimed to be more suitable for new ventures. Different approaches promise to bring a reduction of uncertainty and failure by providing a systematic procedure to the chaotic process of creating something new. Examples for tangible products are the traditional stage-gate systems with origins in the manufacturing industry or traditional development methods with sequential phases and upfront planning (Cooper, 1990). Very early software development showed phases of an evolutionary change in software development methods such as the code-and-fix method, stagewise method, waterfall method, transform method and spiral method. Those methods still have limitations to use them for quick learning and adaption to specific requirements (Misra et al., 2012). The traditional approaches are now being challenged by new concepts such as Design Thinking, Agile Software Development and Lean Startup. **Design Thinking**, a creative approach for the development of human-centric solutions promoted by the design company IDEO (Brenner and Uebernickel, 2016) uses tools of designers to solve problems which have not been addressed using traditional problem-solving techniques (Brown, 2009). **Agile Software development**, involving different methods like Scrum and Kanban, is a systematic and iterative approach to develop digital products dealing with unpredictability and having a closer customer focus (Abrahamsson et al., 2002).

The **Lean Startup approach** is the new hot topic in this area. The term lean startup was coined and trademarked by Ries (2011) as an innovative methodology for developing businesses and products. The method is based on Ries' work in the early-stage startup IMVU to create 3D avatars and his blog startuplessonslearned.com where he collected and shared his experience. It became a widely-applied methodology towards new venture creation using hypothesis-driven experimentation and iterative product releases for shorter and cheaper development processes. Moreover, having a clear focus on the needs of early customers by building a product and service iteratively based on customer feedback reduces the market uncertainty and failure rate (Ries, 2011). "The only way to win is to learn faster than anyone else" (Ries, 2011, p.111). Ries (2011) believes that output driven thinking is a common reason for startup failure. Whereas so far, the focus laid on HOW to build something most efficiently it shifts towards WHAT should be built to create value for customers. He suggests going a step backward towards the understanding of the problem to be solved. Therefore, going away from the purely solution-focused and output-driven thinking to a value creation thinking (Bosch et al., 2013).

The lean startup movement has achieved widespread popularity and support across the globe, with a growing community and local Lean Startup meetups around the world. Yearly lean startup summits occur in London, Amsterdam, New York and San Francisco which help to promote the movement. The management of the Lean Startup Co. shared upon request that the flagship conference in San Francisco attracts about 2,000 and the summit in NYC and London about 300 lean startup practitioners each year (personal communication, March 15, 2018). The approach has been generally accepted and is applied in startups, boot camp programs, incubators and accelerators, and is part of the curriculum of more than 25 universities such as Oxford and Standford (Blank, 2013). Other sources lists over 50 universities in the US and Great Britain (Lean Startup Circle, 2018) and another list has already collected over 100 universities around the globe offering courses on lean startup (goo.gl/GM5DxZ). Furthermore, best practices of using lean startup are shared online, for example as agencies illustrate their lean startup approach to service design and mobile app development (Lie, 2017). The National Science Foundation started a program using lean startup techniques to train scientists in entrepreneurship (Satell, 2017). Most importantly, the lean startup approach hast been supported and extended by many authors, particularly Steve Blank (2013) with the article *Why the Lean Start-Up Changes Everything* (Blank, 2013) and Ash Maurya (2010) author of the books *Running lean*, *Scaling Lean* and the creation of the Lean Canvas. Even a board game called Playing Lean was published on Kickstarter in 2015 to teach the lean startup concepts in a playful manner (Rasmussen & Øxseth, 2016; t3n, 2015).

However, it’s unknown if LSM is positively related to the performance of a new venture. Existing research on the effectiveness of LSM is either scarce or indirect and direct evidence is virtually absent (Frederiksen & Brem, 2017). In conclusion, this research gap should be addressed.

1.2 Research aims and implications

The popularity across practitioners of the Lean Startup Method (LSM) is in contrast with the lack of an empirical validation of the lean startup approach. The lean startup approach is popular and widely applied. Nevertheless, research on the effectiveness of LSM is rather scarce. It is unknown if a higher lean startup orientation leads to more success for a new venture. By contributing the empirical evidence for the effectiveness of the LSM it was aimed to close this gap and advance the academic discourse on LSM and derive valuable implications for practice.

The core element of this research laid in the conceptualization and measurement of a Lean Startup Orientation (LSO) in relation to new venture success. In the early stages of a startup, the new venture success is considered equal to project performance and was connected with the "Iron Triangle" from the project management literature (Atkinson, 1999). Building on previous works by other researchers on the LSM (Patz, 2013; Rübling, 2016) a survey instrument was created to measure the LSO and project performance. The data from 100 Berlin-based software startups was analyzed using STATA to derive insights in the effectiveness of LSO. Moreover, the relationship was assumed to be moderated by the radicalness of the innovation, market and technology uncertainty, and the business type (B2C, B2B, both).

Previous research on performance implications of LSM is scarce or indirect (Frederiksen & Brem, 2017) and direct evidence is virtually absent. However, first qualitative research with practitioners (Patz, 2013) and a first leanness operationalisation instrument (Rübling, 2016) were found. The existing research was extended by the suggested LSO operationalisation, which could be used for further research. Most importantly, the existing body of research was extended by the first direct evidence on the LSM effectiveness.

According to Steve Blank, a good understanding of the lean startup approach helps businesses in all kind of sizes. "The lean startup approach will help them meet it (the pressure of rapid change) head-on, innovate rapidly, and transform business as we know it" (Blank 2013, p.9). The empirical validation of LSO activities contributes to existing management strategies by providing a strong justification for lean startup capabilities leading to a higher likelihood of success. In conclusion, the application of LSM should be fostered and measured.

2 Theoretical Background

In this section, the theoretical background for the LSO is presented. In a first step, the role of uncertainty will be discussed, followed by two different mitigation strategies of entrepreneurs to decrease uncertainty. In a further step, the roots and characteristics of LSO will be presented to provide a common understanding. Finally, based on the findings a conceptual framework will be created and suitable hypotheses derived for further testing.

2.1 The Role of Uncertainty in Entrepreneurship

Uncertainty plays a crucial role in entrepreneurship and how entrepreneurs perceive opportunities. First of all, uncertainty can be understood as the "inability to predict something accurately" due to lack of the necessary data and information (Milliken, 1987, p.136). Moreover, uncertainty can come in the form of the "unknown unknown" but as well as the "known unknown" with incomplete or conflicting information (Sull, 2004). Entrepreneurs creating something new face high levels of uncertainty. Consequently, uncertainty is closely connected to entrepreneurship (Knight, 1921) and the capacity to deal with uncertainty is a prerequisite for being an entrepreneur (Knight, 1921). The theoretical framework for entrepreneurs to deal with this uncertainty is embedded in the topics of the opportunity discovery, evaluation and exploitation which is widely discussed in entrepreneurship research (Shane & Venkataraman, 2000).

The level of perceived uncertainty influences entrepreneurial action. Entrepreneurs face uncertainty in the forms of risk and ambiguity. Risk is characterized by the decision-maker by knowing the probability of different outcomes and the freedom to choose. Ambiguity differs in that the expected outcomes are completely or partially unknown and also the probabilities are unknown for the decision-maker (Holm et al., 2013). Entrepreneurial action understood as the creation of new ventures (Gartner, 1985) or the creation of new products and services (Schumpeter, 1934), refers to a "judgmental decision under uncertainty about a possible opportunity for profit" (McMullen & Shepherd, 2006, p.134). The type of uncertainty influences the willingness to act entrepreneurially (Milliken, 1987) and is "strongly influenced by perceptions based in an entrepreneur's assessment of uncertainty related to the outcomes of his/her own actions" (McKelvie et al., 2011, p.286). Moreover, the fear of failure plays an important role in the perception of opportunities. The fear of failure is generally associated with the level of country development, which influences the rate of new venture creation and pursuit of entrepreneurial opportunities (Herrington & Kew, 2017).

New ventures face two different kinds of uncertainty which influence venture creation as well as the project success of existing startups. An emerging venture can be defined as “temporary organisation designed to search for a repeatable and scalable business model” (Blank, 2013, p.5) and “designed to create new products and services under conditions of extreme uncertainty” (Ries, 2011, p.8), whereas a startup refers to a venture which is already operating on the market. Building a new product for commercialization while developing the new organisation, these are the complex and demanding tasks while starting a new company (Trimi et al., 2012). Therefore, facing a many unknowns, venture creation and the development of new product/service is a highly uncertain undertaking. Having the right assumptions of the problems to solve and capabilities to deliver a product/service valuable enough to the customer who is willing to use and to pay for it, play an essential role for a sustainable business model (Blank & Dorf, 2012). Companies, especially startups, must deal with unknowns to solve a problem, discover hidden customer preferences and behavior or the pressure to find a technical solution with an increased rate of the invention across industries. In conclusion, two different types of uncertainty can be associated with new ventures such as the market uncertainty (will customers buy it?) and technology uncertainty (can we make a desirable solution?) (Moriarty & Kosnik, 1989; Dyer & Furr, 2014).

Market uncertainty and technology uncertainty address two different perspectives. Market uncertainty is characterized by the uncertainty about customer and market needs. It is uncertain if the new product can meet those customer needs and adapt to market changes. Moreover, new ventures face the challenge of the unpredictable speed of the diffusion on the market and the unknown size of the potential market (Kim & Vonortas, 2014; Yadav et al., 2006). In contrast, technology uncertainty is dealing with issues about a functioning product, meeting delivery times and new competing technologies cannibalizing existing technologies (Kim & Vonortas, 2014; Yadav et al., 2006). The level of technological uncertainty can be different from startup to startup depending on their business, ranging from using a state-of-the-art e-commerce platform to open an online shop towards complex tasks like the creation of materials innovations in the B2B segment. More explicitly addressing the question of the technical feasibility of a solution (Maine et al., 2005).

Market and technology uncertainty has increased and is different depending on the industry. New technologies emerge, customer demands change and in the same way companies rise and fall with an unseen velocity (Dyer & Furr, 2014). These uncertainties have increased over the past thirty years and changed the way organisations are managed. Reasons for this increase in uncertainty can be seen in two disruptive technologies: personal computing and the internet. Providing powerful tools to master problem-solving and the possibilities of low-cost marketing and distribution channel, enabling anyone to sell products online. Another reason is the establishment of capitalism in countries such as China, India, Russia and Brazil with a huge amount of potential entrepreneurs facing lower technical entry barriers (open source software, cloud technologies), lower capital barriers (crowd-funding), lower production barriers (3D printing and global suppliers) and lower distribution and marketing barriers (internet, emergence of direct shipping and social media) speeding up the product development cycles (Dyer & Furr, 2014).

Not every industry faces the same levels of uncertainty, with computer software companies facing volatile revenues and fierce competition with new entrants emerging faster than ever before, as illustrated in Figure 1:

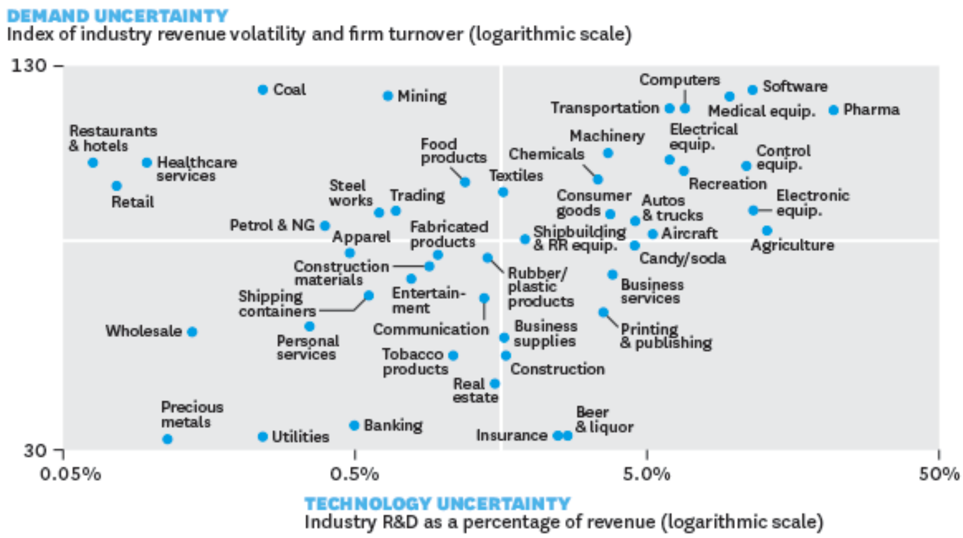


Figure 1 Demand and technological uncertainty by industry, 2002-2011
(Dyer et al., 2014).

The combination of market and technology uncertainty can be addressed by different mitigation strategies. Depending on different levels of market and technology uncertainty, different approaches to entrepreneurial action can be followed to mitigate the uncertainty. In the research for materials and science-based ventures the combination of market and technology uncertainty can be addressed by the tools of choice business planning, stage gate system, lean startup and tech stage gate / Lab-To-Market roadmap as illustrated in a simplified overview in Figure 2 (Harms et al., 2015). Lean Startup was found suitable in materials and science-based ventures for the combination of high market uncertainty and low technology uncertainty. The suitability of LSM for software startups in connection to different levels of uncertainty was not discussed yet in research and should be investigated further.

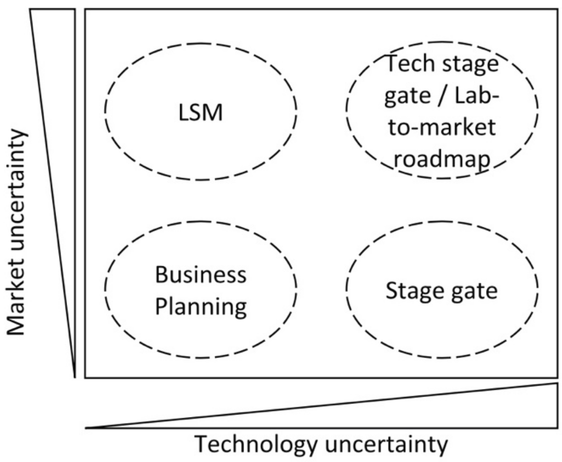


Figure 2 Combination of market and technology uncertainty defines suitable strategy (Harms et al. 2015).

2.2 Entrepreneurial action – planning versus doing

Entrepreneurial action can follow two different strategies to mitigate uncertainty. Research showed that ventures undertake entrepreneurial action with either prediction based strategies (writing a business plan) or experiential (lean startup) to face and mitigate the uncertainty in the entrepreneurial process (Honig & Hopp, 2016).These strategies can also be described as the planned and the entrepreneurial strategy (Mintzberg & Waters, 1985). The traditional startup is driven by the execution of a business plan and implementation driven with the lean startup approach based on hypothesis-driven experimentation and customer development Blank (2013).

Prediction based strategies operate their business on assumptions in a plan with predefined steps to execute. The core element is the business plan. This is a "…more predictively oriented approach and places importance on identifying an opportunity and developing a solution before proceeding" and the rigorous implementation according the predefined steps to reach efficiency and performance (Honig & Hopp, 2016, p.82). The execution follows a plan. This practice became popular in recent years by the relevance of writing a business plan promoted by the various business plan competitions at universities. The focus on writing a business plan are based on the understanding of teaching entrepreneurship as a process approach (Neck & Greene, 2011). Following a planning perspective puts the focus on the identification and evaluation of an opportunity, the needed resources and actions to exploit the opportunity (Morris, 1998). Moreover, to receive grants such as the EXIST founder grant but also to be eligible for investor funding and the acceptance in an accelerator program often requires the writing of a business plan.

In contrast, experiential strategies such as lean startup involve entrepreneurs talking to customers to seek feedback to adapt and refine their business idea. Planning is substituted by experimentation and testing of assumptions, intuition is replaced by soliciting real feedback from customers in combination with an iterative and agile design (Blank, 2013). This shows similarities to the effectual logic which is driven by the self-understanding of the entrepreneur who is aware of their means and resources, creating their environment through action (Dew et al., 2009). Moreover, this experiential strategy approach is supported by other research on bricolage (Baker & Nelson, 2005) and improvisation (Hmieleski & Corbett, 2006) by describing the creative and trial & error nature of entrepreneurship. Similarly, the work on disciplined entrepreneurship describes the critical task of entrepreneurship as the effective management of uncertainty. The creation of something new is reached by designing and running experiments in combination with the testing, revision, confirmation of hypotheses (Sull, 2004). In conclusion, the entrepreneurial strategy shows a higher adaptability than the planning one (Mintzberg & Waters, 1985). Furthermore, Honig & Hopp (2016) stressed that the lean startup method and the business model canvas (Osterwalder et al., 2005) "represent the latest effort to endorse a widely adopted under-researched paradigm" (Honig & Hopp 2016, p.76).

2.3 The Lean Startup Methodology

2.3.1 Overview

The Lean Startup Methodology has its origin in the collection of lessons learned of an entrepreneur with a new perspective on how to start a new venture. For lean startups, it is crucial to decrease the uncertainty step by step by starting with a problem/solution-fit, going towards a product/market-fit and finally reach the stage for scaling the business (Maurya, 2010). The lean startup is a practitioner-driven methodology initiated by Eric Ries (2011) based on his experience as CTO at IMVU. Ries (2011) started writing a blog about his experiences, which led to the book “The Lean Startup”, with the focus on building a sustainable organisation around new products/services. In entrepreneurial practice, the approach has gained a reputation similar to the Business Model Canvas (Osterwalder & Pigneur, 2010) or the Lean Canvas (Maurya, 2012). Ries (2011) claims that the old-fashioned business planning and forecasting are outdated because startups don’t have a stable operating history nor a relatively static environment such as established companies. Therefore, startups don’t know their customers nor their product and need to follow another process such as formulating testable hypotheses in iterative cycles.

A closer look at the Lean Startup Methodology origins show the inspiration from different methods and their connections. Ries (2011) mentions in his book that the LSM was inspired by:

(1) **Lean manufacturing of Toyota** (Liker, 2004), which is underlined by the description of lean startup as “**the application of lean thinking to the process of innovation**” (Ries 2011, p.6) with the vision to **reduce waste** of building products that no customer wants (Eisenmann et al., 2011) inspired by the methods of kaizen and continuous improvement (Mansfield, 1988).

(2) **Customer Development Model** suggested as a parallel process to Product development which is customer and market centric to learn and discover the startup’s initial customers (Blank, 2013a), therefore putting the customer in the center.

(3) **Design Thinking** (IDEO) promoting the human-centered design of solutions with phases of observation and understanding, prototyping, testing and iterating the prototypes depending on user feedback (Brenner & Uebernickel, 2016) to “match people’s

needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008, p.86).

(4) Agile software development such as continuous deployment and user experience principles (Abrahamsson et al., 2002). Agile software development consists of different methods such as crystal methodologies, dynamic software development method (DSDM), feature-driven development, lean software development, scrum and Extreme programming (XP; XP2) (Dybå & Dingsøyr, 2008). A further differentiation between the Lean Startup, Design thinking and agile software development should be given in the next table.

Looking at the differences in Table 1 it becomes clear that the approaches are well suited to link to each other through the timeline of a product development cycle as visible in Figure 3. Design thinking offers its strength in understanding the customer problem using qualitative methods, ideation and synthesis tools. The focus of Lean Startup and Agile Software Development lays on the customer solution using quantitative methods, validated learning and adaptive organisational capabilities (Blosch et al., 2016).

Table 1 Comparison of important aspects of design thinking, lean startup and agile software development (based on Mueller & Thoring, 2012, p.156; Misra et al., 2012; Dybå & Dingsøyr, 2008).

	Design Thinking	Lean Startup	Agile Software Development
Scope, Focus	General Innovations	High-tech innovations for Startups	Software development
Approach	User-centered	Customer-centered	satisfying the customer through early and continuous delivery of valuable software
Uncertainty	Solve wicked problems	Unclear customer problem	Unclear requirements, designs, processes
Focus	Strong focus on qualitative methods: elaborated ethnographic methods, user research, observations	Strong focus on quantitative methods: metric-based analysis, provides matrices and testing, iteration, validated learning	adaptive organisational capability of teams according to changing business requirements; iterative, evolutionary approaches and self-organizing teams
Typical Methods	Shadowing, Qualitative interview, Paper Prototyping, Brainstorming (with specific rules), Synthesis frameworks	Qualitative Interview, Hypothesis testing, Smoke Test, Paper Prototyping, Innovative Accounting, Split (A/B) tests, Cohort Analysis, Funnel Metrics (AARRR), Business Model Canvas, Five Whys	Product Roadmap, Product Vision, Release Plan, Sprint, Sprint Review, Reflection, On-Site Customer, User Story, Backlog, Acceptance Test, Velocity, Continuous control and testing
Project start / idea generation	Extensive user research, ideation techniques to generate ideas	Product vision of the founders	Definition features based on requirements => user stories and sprint planning

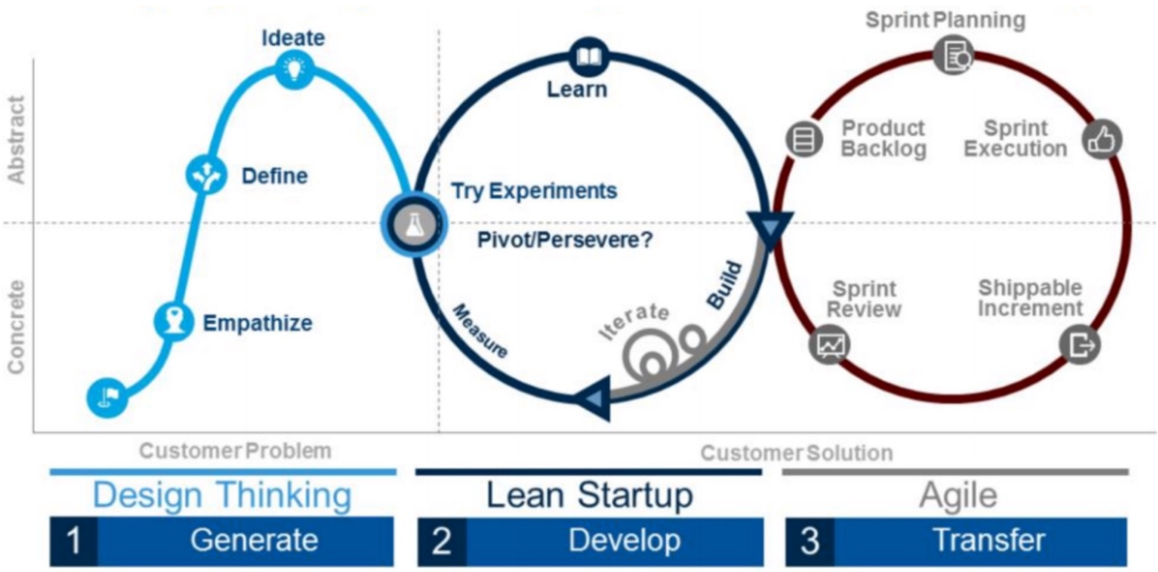


Figure 3 Gain Competitive Advantage by Learning and Experimenting, and Leveraging by combining Design Thinking, Lean Startup and Agile (Blosch et al., 2016)

Despite the popularity of the lean startup book there is a need for more empirical evidence of LSM on the venture's performance. Business books with a high popularity must be treated carefully concerning their generalizability. Certainly, as they might not be "grounded in empirical research or theory", and therefore the "wide disparity of applications and the absence of theoretical foundations and empirical verifications raise professional concerns" (Honig & Hopp, 2016, p.77). The example of once highly respected but now largely discredited business books illustrate the relevance of a grounding in empirical research and theory (Guest, 1992). Critics mention about books such as the lean startup and the business model canvas that "they are quite popular and appear to be widely endorsed, they lack theoretical underpinnings and thus, grounds for empirical testing" and underline the difficulty in evaluation of a measured effectiveness regarding instruction and the entrepreneurial success (Honig & Hopp, 2016, p.77).

Although having origins in tech ventures, first research also showed a broader applicability of the lean startup methodology. Scholars started illustrating that lean startup can be applied respectively was applied in different contexts. The Polis University was found to use lean startup principles before the movement's creation by Ries (2011), with the reasoning of facing high uncertainty (Nientied, 2015). Other researchers created a conceptual framework to use Lean Startup for internal corporate ventures and large companies (Edison, 2015) and extended the lean startup concept with Axiomatic Design method providing a pattern to go from idea to MVP, prioritizing modifications and keeping a track record of the various customer tastes (Girgenti et al., 2016).

2.3.2 Conceptualisatoin of the Lean Startup Orientation (LSO)

Recently a few scholars started to define the essence of the Lean Startup Methodology, contributing elements for a further conceptualization of LSO. Researchers started to analyze the lean startup topic in a qualitative and explorative way. The goal was the identification and understanding of core elements in the lean startup approach and to derive scientific evidence for its elements (Frederiksen & Brem, 2017). Patz (2013) conducted a qualitative phenomenological research with lean startup practitioners such as Eric Ries, Ash Maurya, Alexander Osterwalder and six international entrepreneurs revealed 25 concepts related to lean startup. The main contribution of the lean startup methodology was seen in adding the element of running experiments and focus on entrepreneurial learning during the venture creation. A practitioner summarized the methodology by saying "basically Lean Startup is kind of a summarization of various approaches which increase the chance that you're successful (…) and Lean Startup really helps you to have a more structured approach" (Patz, 2013, p.32). The interview data with practitioners identified empirically the fundamental elements of lean startup such as "problem understanding, solution definition, qualitative validation and finally quantitative validation (…) referred to as the build-measure-learn feedback loop" (Patz, 2013, p.29).

The Build – Measure – Learn (BML) Loop lays at the core of the lean startup approach. Launching a new startup or product is a highly uncertain undertaken due to the lack of a business model and the confrontation with extreme uncertainty. Speed matters as time is a scarce resource for entrepreneurs. They are seeking to accelerate the tempo of innovation, reach a faster time to market which also LSM aims to offers by rapid iteration, small batches and short cycle times (Eisenmann et al., 2011). In the lean startup book the "Build – Measure - Learn Loop" was introduced with the claim to shorten product development cycles by using elements of hypotheses testing, validated learning and iterated product development. The testing of hypotheses, rapid prototyping and development of a minimum viable product (MVP), validated learning, high customer orientation, iteration on customer feedback and experimentation are tools supposed to reduce the market uncertainty (market validation), technology uncertainty and business administration uncertainty of a new venture in the opportunity development phase (Ries, 2011). Therefore, the BML feedback loop is found the key aspect of the lean startup method.

An extended version of the BML loop is considered suitable for the conceptualization of LSO. Alex Osterwalder, author of the business model canvas book, presented in his strategyzer blog an adapted BML feedback loop by adding an additional step called "THINK" (Osterwalder, 2017). This step involves the stage of formulating hypotheses about the business model as well the value proposition. A similar step was found in hypothesis-driven entrepreneurship with the stage "ENVISION" (Eisenmann et al., 2013). Having an eye on the core assumptions to test and the focus on the customer was considered a suitable stage to implement in the conceptualization of LSO as illustrated in Table 2. This is in line with other scholars such as Patz (2013), Blank (2013), Rübling (2016) underlining hypothesis formulation and the focus on the customer as core elements of the lean startup methodology.

Table 2 First conceptualization of LSO

THINK	BUILD	MEASURE	LEARN

Looking at further academic research on lean startup the extended BML loop can be defined in more detail. The lean startup methodology is an approach to realise a new idea with the aim to maximize the odds of success and mitigate risk (Patz, 2013). The BML loop was found to consist of activities such as learning, prototyping, running experiments and validating assumptions as illustrated in Figure 4. Those elements were considered a first suitable ground for the further conceptualization of LSO. Another recent study presented lean startup as a reflective construct clustered into three categories such as (1) customer learning (21 items), product/service development (15 items) and progress tracking (16 items) to measure the leanness of a startup (Rübling, 2016).

However, the proposed operationalisation has not been validated yet. Nevertheless, the top-level constructs of Ries (2011), Patz (2013) and Rübling (2016) overlap and indicate a content validity for an emerging operationalisation of LSO. A combination of overlapping dimensions describing the lean startup methodology by Patz (2013), Eisenmann et al. (2013), Rübling (2016), Frederiksen & Brem (2017) were used to conceptualize the LSO construct (visible in Table 3).

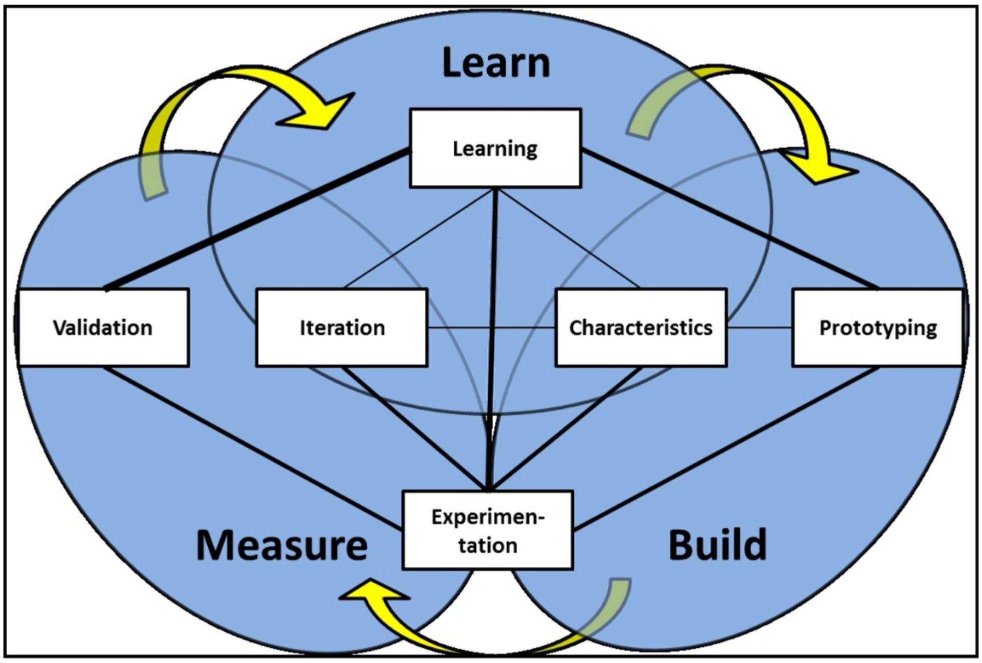


Figure 4 Visualization of the Lean Startup Elements within the BML Feedback Loop (Patz 2013, p.35)

Proposed central elements of the lean startup methodology found in academic papers from various authors were ordered concerning the THINK, BUILD, MEASURE, LEARN categories. The synthesized conceptualization of LSO is composed of the four categories THINK, BUILD, MEASURE, LEARN with each one having two items as illustrated in Table 4.

Table 3 Own synthesized conceptualization of LSO

THINK	BUILD	MEASURE	LEARN
Hypothesis testing	Experimentation	Validation	Learning
Customer Orientation	Prototyping	Knowledge Transfer	Iteration

Table 4 Academic research on Lean Startup Methodology

	THINK	BUILD	MEASURE	LEARN	OTHER
Eisenmann et al. (2013)	Envision Set vision Translate vision into falsifiable hypotheses Specify MVP tests	Build Prioritize tests	Measure Hypothesis validated / rejected	Run tests and learn from them, Perish / Revision	Decide / Persevere / Pivot
Patz (2013)	customer orientation, Hypothesis Testing	Prototyping, Experimentation	Validation	Learning Iteration	Characteristics (Maintain Flow, Cost-Efficiency, Continuous Improvement
Nientied (2015)			Innovation accounting to measure progress	Validated learning	Entrepreneurship is management Entrepreneurs are everywhere
Rübling (2016)	Customer Learning (Understanding the Customer, Building hypotheses,	Product / Service development (Building the product lean	measuring customer reaction, evaluate results, overall process, Progress Tracking (Observing drivers in current state, tuning the engine / actively improve numbers, adjusting the course of action)	learning from product tests	setting up the organisation, establishing quality
Frederiksen & Brem (2017)	User and customer involvement in product and business development	Experimentation in new product development, The minimum viable product		An iterative approach to new product development	Entrepreneurial thinking – planning versus doing

In the following sections, those LSO elements will be shortly mentioned and backed with further theoretical underpinnings to provide the necessary basic understanding for the operationalisation of LSO in a further step. It will build on existing research to explicitly derive a scientific reflection upon the elements of the LSM.

2.3.3 THINK – Hypothesis Testing and Customer Orientation

2.3.3.1 Hypothesis Testing

The Hypothesis testing logic has its origin in the deductive research approach. The deductive research approach is mostly based on quantitative testing of a hypothesis with a collection of data to find support / not support for a theory (Trochim, 2000). The development of a new theory requires rigorous testing (Saunders et al., 2009). Deductive research is characterized by (1) deducing a hypothesis from theory. Saunders et al. (2009) define the hypothesis as "a testable proposition about the relationship between two or more concepts or variables" (Saunders et al., 2009, p.124). Following the deduction of the hypothesis from theory follows the (2) operationalizing, (3) testing, (4) evaluating the outcome and modifying the theory depending on the findings (Robson, 2002).

The hypothesis-driven approach is the first step towards higher performance and success. The LSM is claimed to add the rigor of scientific methods to the chaotic nature of innovation" (Ries, 2011). This claim reveals that the lean startup approach aims to apply scientific research principles on the creation of new startups, new products and services to increase learning, knowledge generation. A startup founder faces considerable uncertainty about the viability of his/her business with many unknowns. The entrepreneur starts with the translation of the vision into explicit and falsifiable hypotheses about the numerous uncertainties. Those uncertainties require rigorous testing of elements such as the customer needs, problems, viability and feasibility of offered the solution as well as benefits and perceived value by the customers. Therefore, the LSM can be defined as a hypothesis-driven approach to investigate into an entrepreneurial opportunity (Eisenmann et al., 2011). Founders face high uncertainty whether the newly created product/service concept will be accepted by customers and if the market offers enough value to ensure the survival of the new venture. The hypothesis testing can be applied to maximize the accumulated information. In conclusion, the "thinking and developing reasonable hypotheses is, therefore, a prerequisite before one can explore a situation" (Frese, 2009, p.467) and the hypothesis testing logic leads to a higher likelihood of success (Ladd, 2016).

A suitable framework for entrepreneurs to formulate hypotheses can be found in tools such as the Business Model Canvas and the Value Proposition Canvas. Osterwalder et al. (2005) developed the conceptual tool called Business Model Canvas (BMC), where they identified nine building blocks used to understand, design and analyze the business logic of a firm, starting with the formulation of assumptions for each block which can be tested in a further step (Osterwalder et al., 2005). The BMC can serve as a framework for non-biased thinking by determining the key variables of the startup and simultaneously evaluating and assigning possible alternatives with a subjective score (York & Danes, 2014). This serves as useful linear model for decision making, found superior to intuitive judgments (Dawes, 1971), determining key variables and simultaneously evaluating them with a subjective score by adding non-biased thinking (York & Danes, 2014). Later on, another tool called the Value Proposition Canvas (VPC) was published connecting the target customer observation with the generated value proposition of the offered product to reach a customer-centered component in the development of new offerings and a so-called problem-solution-fit (Osterwalder et al., 2014). Similarly, like the BMC this second tool starts with the formulation of hypotheses. However, the focus for the VPC is a different one. Instead of looking at the parts of the business the focus lays on the customer's jobs to be done, pains, gains and the expected value creation of the product. Those assumptions on the customer and product will be tested and step by step validated or rejected. Finally, both tools visible in Figure 5 aim to reduce uncertainty by formulating and testing hypotheses. Moreover, reducing the risk of offering a product that nobody wants by focusing on learning how to build a sustainable business (Eisenmann et al., 2011).

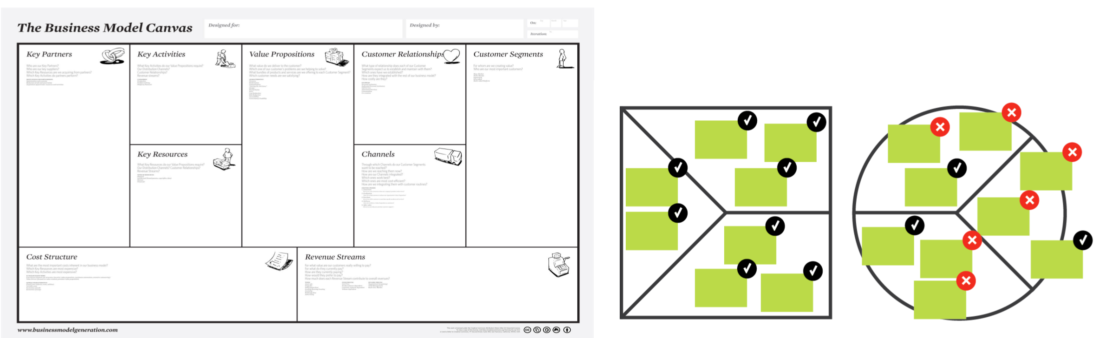


Figure 5 Tools for formulating hypotheses about the business (BMC) and problem-solution fit (VPC) (Osterwalder et al., 2005; Osterwalder et al., 2014)

2.3.3.2 Customer Orientation

The customer orientation with its explorative nature is linked to the inductive research approach. The inductive research approach is characterized by an explorative, qualitative way in which data is collected through observation to develop new models and theory (Trochim, 2000). For entrepreneurs it means before investing many resources in the development of functions and high-end products, this approach helps to find user problems (Kozbelt et al., 2010). Finding out what customers want is the first step to figure out what is worth building. It is the moment when empathy and user-centered design become important by understanding "the needs and interests of the user, with an emphasis on making products usable and understandable" (Norman, 2002, p.213) and to identify unmet needs. Following this user-centered approach it is crucial to better understand the customers and their needs to create a product or service with value for them. In Design Thinking personas are created to develop empathy for the user, their situation, problem and need (Brenner & Uebernickel, 2016). By putting yourself in the shoes of the customer, also often referred as experience prototyping (Buchenau & Suri, 2000), it is possible to find creative solutions for problems (Cross, 1982).

The customer orientation got inspired by the customer development term putting the customer in the centre. The customer development process is a four step process involving the steps customer discovery, customer validation, customer creation and company building (Blank & Dorf, 2012). This process is characterized by an early and direct interaction with the customers following the getting out of the building strategy (Blank, 2013). Different authors have followed up on this work by discovering the user problems and pain level (Maurya, 2010), users' jobs-to-be-done (Dyer & Furr, 2014). Entrepreneurs rarely have the necessary data to decide or know about the best solution. It is important to listen to the voice of the customer: Research has shown that "interviews with 20-30 customers should identify 90% or more of the customer needs in a relatively homogeneous customer segment" (Griffin & Hauser, 1993, p.23).

The focus on customer value is the key to success. Ries mentioned in his book: "We have the capacity to build almost anything we can imagine. The big question of our time is not can it be built? But, should it be built?" (Ries, 2011, p.263). This quote moves the focus from doing the things right towards doing the right things. For an entrepreneur with his new venture, doing the right things should follow the “Customer is king” attitude. For the survival of a new venture it is crucial to fulfill customer needs and create value offering a product/service for which they are willing to pay for (Anderson & Narus, 2005). For example, at Intuit they are using a technique called pain-storming, the creation of a customer journey to understand the steps followed for task completion and a reflection about potential problems and pain points and to further test their hypotheses (Dyer & Furr, 2014). This strategy underlines the importance of first understanding the customer problems and job-to-be-done as basis to build in a further step solutions addressing those needs. Although, following customer development activities may involve biases in the decision-making process such as the selection bias, representativeness bias and the confirmation bias. The application of suitable bias mitigation techniques improves the decision making and avoid failure (York & Danes, 2014). In conclusion, entrepreneurs have to understand first the customer needs to evaluate the market opportunity and perception of the new venture idea before moving forward (Honig & Hopp, 2016). Solving customer problems and fulfilling customer needs is the starting point to successful products (Griffin & Hauser, 1993).

2.3.4 BUILD – Experimentation and Medium of Learning: Prototype

2.3.4.1 Experimentation

Experimentation is the way to test hypotheses with the goal of uncertainty reduction and knowledge creation. Experimentation is a scientific process which is conducted to derive new insights and is a core principle of research in all sciences. At its core it involves the investigation into causal relationship, whether a dependent variable is influenced by a changing independent variable (Hakim, 2000). Entrepreneurs follow a similar approach of actively experimenting, learning by doing while facing conditions of high uncertainty (Alvarez & Barney, 2005). Through this transformation of experience, knowledge is created with an experiential learning process (Kolb, 1984). By iteratively testing the new product or service idea uncertainty can be decreased (Mitchell et al. , 2012). Experimentation requires planning, entrepreneurs develop hypotheses on potential action paths and test them in “purposeful and goal directed experimentation” (Frese, 2009, p.467).

Entrepreneurs have to develop experimenting capabilities to be successful. Uncertainty is found to be a pivotal driver to experiential activities. The lean startup approach puts emphasis to follow a customer learning and discovery process and “suggesting a systematic way of using experimentation and iterative learning to turn uncertainties into risks in the development of products at very early stages of a new business” (Tanev et al., 2015, p.11). Ries (2011) suggests starting with testing the riskiest assumptions first to mitigate the highest risks to an ideal. It is necessary to find out the make or break parts of the intended solution and also to figure out the critical and uncertain elements and to “conduct experiments to test the problem hypothesis with the customer” (Blank & Dorf, 2012, p. 67).Therefore, entrepreneurs start with the identification and the examination of critical hypotheses to find out market expectations, gather early and frequent customer feedback before developing a final product (Blank, 2013). Experimenting capabilities resulting from a discovery-driven approach, reveal a competitive advantage realizing faster time to market and learning at the lowest cost possible with new business models (McGrath, 2010).

2.3.4.2 Prototype – The medium of learning

Prototypes are the suitable medium of experiential learning. First of all, “a prototype is any representation of a (design) idea, regardless of the medium“ and serves the dimensions of role (usefulness in user’s life), look and feel (experience using it) and implementation (how it works) in the design of this interactive artefact (Houde & Hill, 1997, p.369). Experiential learning happens with the use of relatively low-cost prototype, the implementation of the new insights (Bingham & Davis, 2012) and validation in goal-oriented experiments (Blank & Dorf, 2012). The ‘Experience Prototype’ term coined by Buchenau & Suri (2000) emphasizes “the experiential aspect of whatever representations are needed to successfully (re)live or convey an experience with a product, space or system” with a prototype considered beneficial in (1) understanding existing user experiences and context, (2) exploring and evaluating design ideas and (3) communicating of ideas and issues to an audience with a shared point of view (Buchenau & Suri, 2000, p.425). Prototyping in combination with early adopters, user/customer involvement can play an important role such as the example of Xerox redesigning its copiers illustrates. They used an approach of “successive prototypes to create an on-going dialogue among users, designers, and business decision makers. This prototyping process helped to identify emergent design issues and opportunities” (Adler & Borys, 1996, p.68).

A prototype can have different forms and fidelity levels. Examples range from simple paper-pencil mockup with a visualization of the screens and icons towards an interactive proof-of-concept prototype. Building prototypes on those different levels involve various advantages and disadvantages for low- and high-fidelity prototypes as visible in Table 5 (Rudd et al., 1996).

Table 5 Different types of prototypes have different advantages and disadvantages (Rudd et al., 1996)

Type	Advantages	Disadvantages
Low-Fidelity Prototype	Lower development cost. Evaluate multiple design concepts. Useful communication device. Address screen layout issues. Useful for identifying market requirements. Proof-of-concept.	Limited error checking. Poor detailed specification to code to. Facilitator-driven. Limited utility after requirements established. Limited usefulness for usability tests. Navigational and flow limitations.
High-Fidelity Prototype	Complete functionality. Fully interactive. User-driven. Clearly defines navigational scheme. Use for exploration and test. Look and feel of final product. Serves as a living specification. Marketing and sales tool.	More expensive to develop Time-consuming to create. Inefficient for proof-of-concept designs. Not effective for requirements gathering.

With the lean startup methodology, another term linked to prototypes got important: The Minimum Viable Product (MVP). Described by Ries (2011) as a product version that allows maximal learning with the least effort. A minimum viable product is a product with the minimum set of features which can be produced cheap and fast, ready to test it with early customers (Ries, 2011; Tanev et al., 2015). This is highly important as technology startups face challenges of high uncertainty and the pressure to enter the market before its competitors to ensure the commercialization and testing of the new products (Moogk, 2012). MVPs in their function as a design artifact, a boundary spanning artifact and a reusable artifact, are found to support validated learning, bridge communication gaps (between entrepreneurs, developers, customers and investors), facilitate product design and cost-effective product development activities in software startups (Nguyen Duc & Abrahamsson, 2016). Similarly to a prototype, an MVP can take different forms such as smoke tests, landing pages, letters of intent with constrained functionality (Eisenmann et al., 2011) or an easy-to-modify prototype and also demos (Maurya, 2010).

The MVP term is broad and has been defined differently by different scholars. According to Lenarduzzi & Taibi (2016), the term MVP is quite dynamic, and after being coined by Frank Robinson in 2001 the words meaning has changed over time. The "Minimum" aspect has changed over time leading to five different definitions of it: Minimum Functionalities/Features, Minimum Requirements, smallest possible implementation, Minimum Effort, Minimum Value Organisation. Interestingly in the study of Lenarduzzi & Taibi (2016), it was found that the two main key factors characterizing MVP with minimum effort and maximum customers validated learning was just found in three papers (13.6%) with remaining contributions other key factors (86.4%). In the last 16 years, different definitions were proposed but that of Ries (2011) stays the most influential and is frequently reused or rephrased. Minimum defined as minimum features definition by Blank (2010) is the most recurring one (Lenarduzzi & Taibi, 2016).

The usage of an MVP offers several benefits for the new venture. According to Eisenmann et al. (2011) the building of MVPs offers several benefits. First, learning about customer needs, collecting feedback faster and avoid wasting time in building unnecessary features. Second, releasing new features in small badges facilitates the interpretation of testing results, bug fixing and parallel testing improves the execution and time-to-market performance. The easiness of modification depends on the product. Whereas hardware products are costly and slow in modification, software can be easily modified and as simply publishing a new update. Therefore, this strategy of using prototypes, demos, MVPs allows to resolve market uncertainty, the implementation of customer feedback and further iteration, testing and fine-tuning of the product (Harms et al., 2015). Moreover, the MVP approach enables a more cost-efficient strategy by first validating as many as assumptions as possible about the features of the final product before investing resources and effort heavily in its development (Kerr et al., 2014).

2.3.5 MEASURE – Validation and Knowledge Transfer

2.3.5.1 Validation and Knowledge Transfer

The validation and rejection of hypotheses leads to new knowledge which needs to be collected and transferred. Following the testing with prototypes and MVPs entrepreneurs must evaluate the feedback. Product concept tests help as “an early screening device to obtain some consumer reaction to an idea and to predict the trial rate” (Moore, 1982, p. 285). Therefore, reactions to prototypes and MVPs regarding user satisfaction can be measured before market launch and high investments. This validated learning is supported by experimental learning which validates or rejects hypotheses with quantitative metrics such as customer conversion funnel, cohort analysis, A/B testing and derive new insights for measuring performance improvements (Maurya, 2010; Eisenmann et al., 2011). Concept testing is considered "the most effective, low-cost methods to enhance innovation" by having high leverage due to the reduction of uncertainty by quantifying information about the customer, the market and the feasibility (Dahan & Mendelson, 2001, p.114). Quantitative metrics serve as important KPIs across the customer lifecycle to measure the success of a startup. The phases acquisition, activation, retention, referral and revenue so-called *Pirate Metrics* help founders to monitor the progress in their customer conversion (McClure, 2007).

New knowledge needs to be integrated in the ongoing activities and decision making. After the evaluation of the test results and customer feedback, it is important to transfer this knowledge towards the product development activities for further refinement of product and service features. New knowledge has to be acquired, disseminated and used for the innovation process (Calantone et al., 2002). It follows the decision whether to persevere, pivot, or perish. Validating all key business model hypotheses leads to a product-market fit, a situation characterized by a validated demand of early adopters and profit potential in their value-creating activity/offering (Eisenmann et al., 2011).

2.3.6 LEARN – Validated Learning and Iteration

2.3.6.1 Validated Learning

Lean startup involves planning and even more learning. From an academic point of view the LSM is situated in the planning school as well as the learning school in entrepreneurship (Harms et al., 2015). The planning school elements are the systematic testing of hypotheses, experimentation to identify and solve uncertainties before starting

(Blank, 2013) which can be seen in the work of other scholars such as disciplined entrepreneurship (Sull, 2004), hypothesis-driven entrepreneurship (Eisenmann et al., 2011) and Entrepreneurial Ideational Process (Gemmell et al., 2012). However, although having elements of the planning school the Lean Startup approach is closer connected to the learning school. “Entrepreneurship is a process of learning” (Minniti & Bygrave, 2001, p.7) following concepts such as probe and learn (Lynn et al., 1996) and discovery-driven planning (Mcgrath & Macmillan, 1995). This flexibility not existing in the planning strategy improves the knowledge and revolves the emerging uncertainties about the latent demand and viability of the solution (Harper, 1999).

Entrepreneurial learning is a key concept of the lean startup methodology. Focusing on the learning aspect it is happening with the perspective on learning theory perspective through experiential learning. Entrepreneurs iteratively adapt their actions depending on the new insights with a rather unspecific strategy (Piaget, 1974; Vygotsky, 1980). Reflection and validated learning is used to derive valuable insights, changed assumptions and frames of reference, new perspectives and derive possible next actions from the experiential learning (Boud et al., 1985) which is also part of the transformative learning theory (Mezirow, 2000). The entrepreneur is actively exploring ways to better assess markets for potential new products and services (Dew et al., 2009). For a new venture, it is crucial to see learning as an investment for successful future and foster a commitment to learning. Understanding the customer needs and technological development creates a competitive advantage (Calantone et al., 2002), influencing the entrepreneurs’ decision-making behavior which is considered crucial to achieve successful results (Minniti & Bygrave, 2001). According to Baron & Henry (2010) “the extent entrepreneurs acquire enhanced cognitive resources through current or past deliberate practice, their capacity to perform tasks related to new venture success (…) the performance of their new ventures, too, is augmented” (Baron & Henry, 2010, p.49).

2.3.6.2 Iteration

The BML loop allows entrepreneurs to build and test new products and services in an accelerated manner. The lean startup methodology works by testing hypotheses using minimum viable products (MVPs) representing the critical functions, collecting feedback, enable the decision to persevere or feedback-induced adaptions so-called pivots efficiently and effectively (Eisenmann et al., 2011). These hypotheses are tested iteratively with a series of cheap and easy to build minimum viable products (MVP) and prototypes in interaction with real customer feedback. The customer validation approach has its origins in the customer development model presented by Blank (2007). The collected feedback allows to validate or invalidate the assumptions, reach an improved understanding of the customer problems and how far the proposed solution fits to solve those problems. Those elements were summarized in the BML loop in Figure 12 turning ideas into products by following a validated learning approach with running experiments and empirical validation of assumptions, measuring customer response, deciding to pivot or persevere with the aim to figure out how to build a sustainable business in an accelerated manner (Tanev et al., 2015). Software startups have to continually decide to pivot or persevere. The validated learning could reveal for software startups the need to react on negative customer reaction or to refine the business model to become successful. Therefore, the "Pivot is inevitable for almost all software startups to survive, grow and eventually obtain sustainable business models" and (Bajwa et al., 2017, p.2374). The classical BML loop (Figure 6) was refined by the Hypothesis-Driven Entrepreneurship Process steps as visible in the Figure 7 (Eisenmann et al., 2011, p.3).

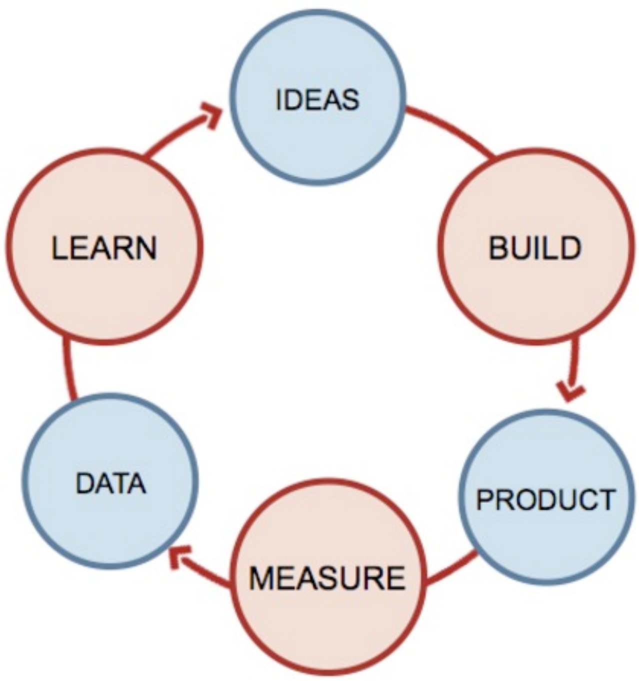


Figure 6 Build-Measure-Lean Feedback Loop (Ries, 2011)

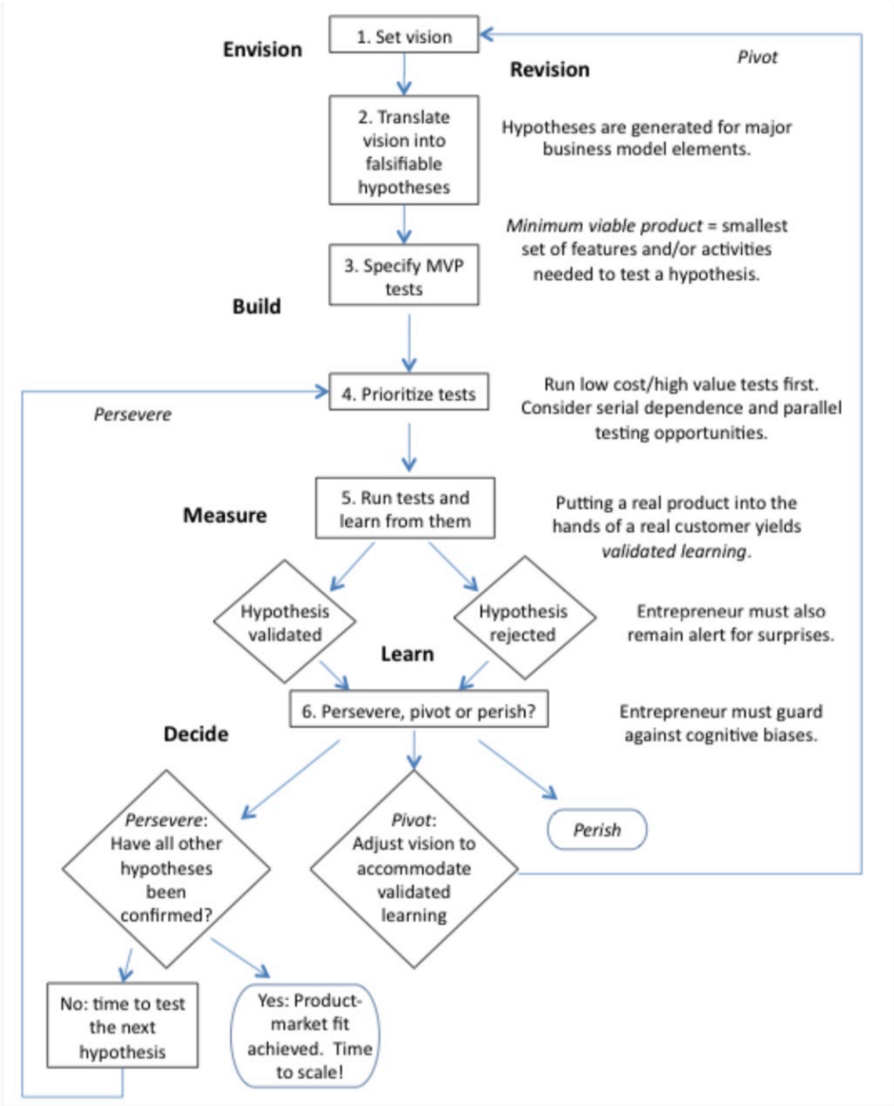


Figure 7 Hypothesis-Driven Entrepreneurship Process Steps
(Eisenmann et al., 2011, p.3)

Different possible sources of inspiration for the iterative build-measure-learn loop were found in literature. The stages of the BML loop have a striking resemblance to the (1) six steps in critical assumption planning promising benefits such as controlled risk, faster decisions, money savings (Figure 8; Sykes & Dunham, 1995), (2) the four-step learning cycle improving iteratively the initial design with marginal costs using the steps design, build, run and analyze (Figure 9; Thomke, 1998) and also the OODA loop providing a systematic decision-making tool to facilitate the course of action with its stages observe, orient, decide and act (Figure10; Boyd, 1987).

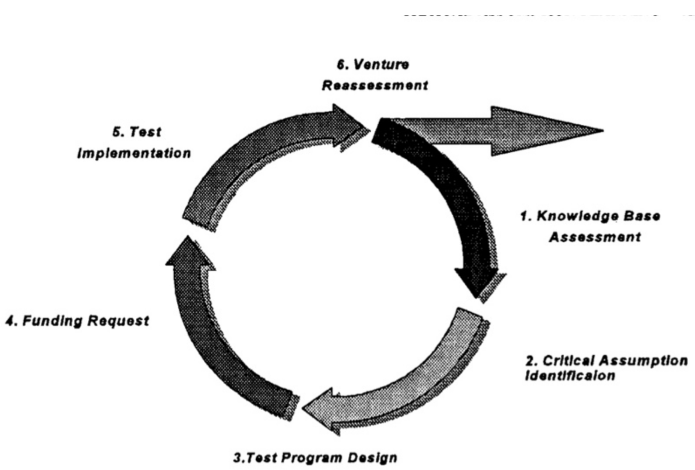


Figure 8 Six steps in critical assumption planning (Sykes & Dunham, 1995, p.415)

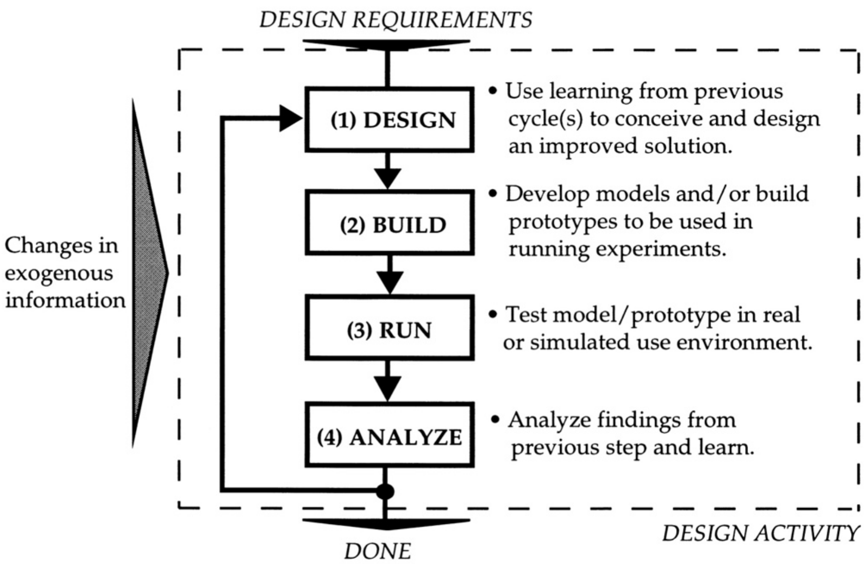


Figure 9 Four Step Learning Cycle (Thomke, 1998, p.745)

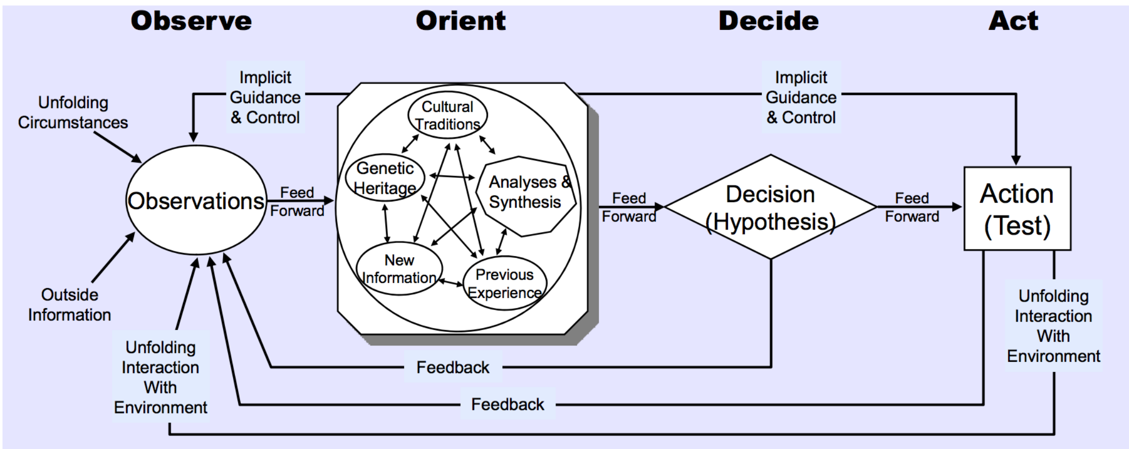


Figure 10 The OODA loop (Boyd, 1987)

2.3.7 Limitations of the Lean Startup Methodology

The Lean Startup Methodology also faces some limitations as mentioned by different scholars.

Firstly, research has shown that LSO can be applied in different industries, but the suitability depends on the degree of market and technology uncertainty. In previous research LSO was found strong in addressing market uncertainty, but less suitable to address technology uncertainty and therefore LSO might not be enough (Harms et al., 2015).

Secondly, biases can lead to misinterpretation and wrong decisions. Entrepreneurs improve their knowledge with social interactions and experimental inquiries (Gemmell et al., 2012) which are not always consciously designed and might lead to different kind of biases which are especially relevant for early-stage entrepreneurs such as the social desirability bias, cognitive biases (optimism bias, confirmation bias, planning fallacy, sunk cost fallacy), can lead to misinterpretation of testing results and therefore influence the decisions of the entrepreneurs (Eisenmann et al., 2011). Experimental methods need to pay attention to avoid those biases and false validation (Raatikainen et al., 2016).

Thirdly, Bosch et al. (2013) found in their research about the Early Stage Software Startup Development Model that Lean Startup methods are considered too vague by practitioners. Therefore, they suggested an adjusted model addressing several identified challenges to provide operational support for early-stage software startups (Bosch et al., 2013).

2.4 Conceptual model and hypotheses

Following the understanding phase in a further step the research question and the conceptual framework will be presented. In the previous part, LSO was conceptualized with suitable elements identified in academic research providing the necessary theoretical foundation.
Moreover, it became also clear that the individual elements of LSO have a positive impact on the performance of a startups' new product development. In a further step, the conceptual framework is proposed as depicted in Figure 11, and testable hypotheses about the assumed relationships were formulated. The focus is on answering the core

research question: Is a higher LSO degree positively related to new venture project performance?

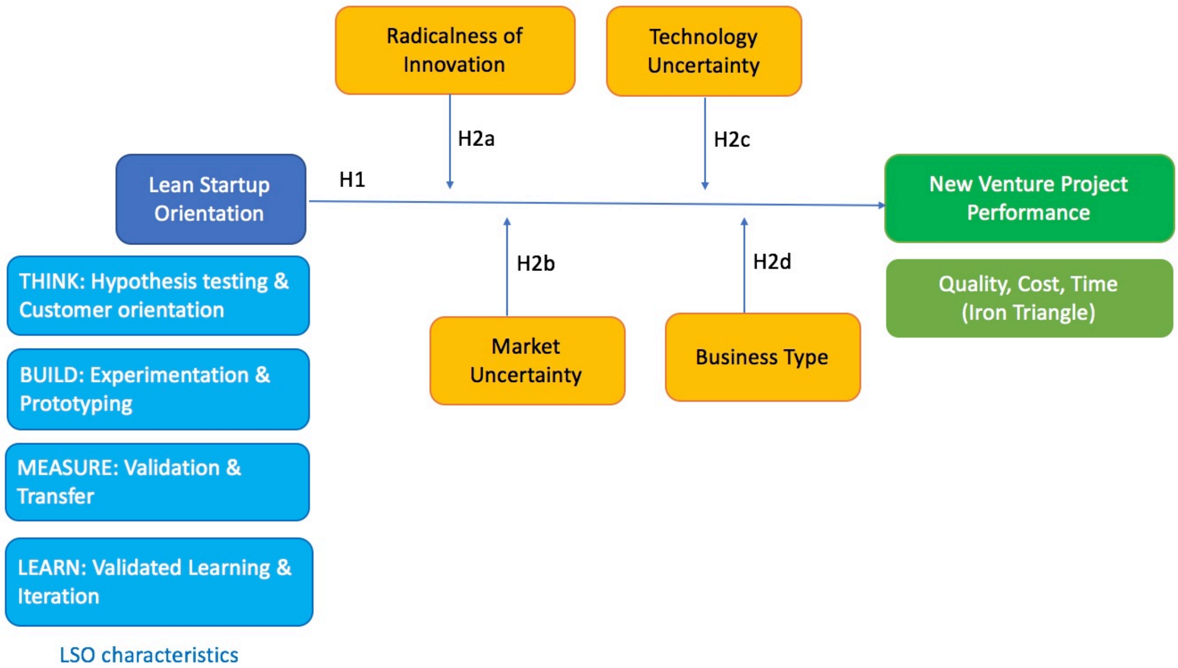


Figure 11 Conceptual Model

A higher LSO is assumed to have a positive impact on new venture project performance. Firstly, by validating hypotheses, the likelihood of success is increased (Ladd, 2016). Secondly, faster decisions, money savings can be generated (Sykes & Dunham, 1995) and the learning about customer needs is the starting point for successful products (Griffin & Hauser, 1993). Having an early focus on the customer helps to realise benefits such as faster time to market and decreased development costs (Harms et al., 2015). Third, through experimentation it is possible to reach a faster time to market and low cost learning (McGrath, 2010). Additionally, using prototypes is a cost-efficient strategy to validate assumptions, collect customer feedback and bridge communication gaps (Kerr et al., 2014; Eisenmann et al., 2011; Nguyen Duc & Abrahamsson, 2016). Furthermore, performance improvements can be measured effectively which contributes to the decision-making process (Maurya, 2010). Fourth, the commitment to learning as one of the core elements of LSO is a considered a competitive advantage (Calantone et al., 2002) and influences positively new venture performance (Baron & Henry, 2010). In conclusion, the findings in theory indicate that a higher lean startup orientation is assumed to contribute to new venture project performance.

H1: *The degree of LSO is positively related to project performance in startups.*

This LSO-performance relationship is assumed to be moderated by (a) the radicalness of the innovation, (b) the uncertainty of the market and technology and (c) the business focus of the startup.

Innovation can be "an idea, practice, or object that is perceived as new by an individual or another unit of adoption"(Rogers, 1983, p.11). Two types of innovation can be distinguished. Depending on the newness of the innovation, respectively its radicalness, the radical innovation and incremental innovation can be distinguished. Whereas "radical innovations are fundamental changes that represent revolutionary changes in technology", (…) "incremental innovations are minor improvements or simple adjustments in current technology" (Dewar & Dutton, 1986, p.1422 & 1423) First, LSO is claimed to be especially suitable to boost user-driven incremental innovation by building easy to modify prototypes, fast iteration and validated learning activities (Ries, 2011; Popowska & Nalepa, 2015). Second, the BML model is considered "a vehicle for incremental innovation" (Fagerholm et al., 2017, p. 298).

H2a: *The LSO-performance link is moderated by the radicalness of the innovation. Lower levels of radicalness strengthen the LSO-performance relationship.*

The level of market and technology uncertainty influences the effectiveness of LSO. Whereas startups developing a new business model, new products and services based on a new technology are facing more uncertainty. Startups doing a copy-cat business or licensing based on a successful concept are assumed to have a lower uncertainty to manage. First, LSO activities such as customer development, hypothesis testing, market validation and the fine-tuning of the product help to mitigate the market uncertainty (Eisenmann et al., 2011; Harms et al., 2015; Dahan & Mendelson, 2001). Second, LSO activities such as experimental learning, easy to modify prototypes, validated learning and fast iteration to proof feasibility help to mitigate the technology uncertainty (Moogk, 2012; Dahan & Mendelson, 2001). In conclusion, the effectiveness of LSO is assumed to be influenced by the level of market and technology uncertainty the new venture is operating in.

H2b: *The LSO-performance link is moderated by the market uncertainty.*

H2c: *The LSO-performance link is moderated by the technology uncertainty.*

Finally, the business type of the startup is assumed to influence the effectiveness of LSO. Business-to-Business (B2B) focus requires a different approach than Business-to-Consumer (B2C). B2B requires a closer collaboration with the customer organisation which can be the source of obstacles hindering the effectiveness of LSO. The customer organisations' culture was found to be a challenge for experimentation activities. Qualitative research revealed challenges such as the lack of feedback, lack of time and participation in development activities and experiments, as well as limited access to end users which impedes data collection (Lindgren & Münch, 2015). In conclusion, the business type is assumed to influence the LSO-performance relationship.

H2d: *The LSO-performance link is moderated by the business type of the startup.*

3 Methodology

The suitable research design, data collection and data analysis method should be defined in this section. Accordingly, the collection strategy will be illustrated and the elements of the assumed relationships in the conceptual model operationalized.

3.1 Research Design

Although there are studies on startups, empirical data on the usage of lean startup was not available. Evidently, studies on startups were found on the European level, such as the yearly published European startup monitor (http://europeanstartupmonitor.com/). This research initiated by the German Startups Association, European Startup Network and European & Israeli associations involved data from 2.515 startups from all 28 European member states and other important startup ecosystems such as Israel as well as on the country level for Austria, Belgium, Cyprus, Germany, Greece, Hungary, Portugal, Slovenia, Switzerland and Spain. Those examples represent the most significant efforts in collecting data from the startup scene in Europe. Studying the data of the European Startup monitor 2016 as well as the German startup monitor 2017 (http://deutscherstartupmonitor.de/) both initiated by the German Startups Association provide various insights on essential characteristics such as economic data, information about the founders, teams, gender, sources of financing, employment trends and some internal processes found in the startups. Despite mentioning product development as a challenge as well as a strategy of high importance those studies don't include the necessary more in-depth analysis such as product development strategies or other data connected to any of the LSO aspects.

The lack of theoretical underpinnings and empirical evidence for the lean startup approach was the starting point for the quantitative research and the conceptualization and operationalisation of LSO. First, investigating on the theoretical foundations it became clear that little research has been done on the lean startup topic. Elements of LSO were identified in academic research which served as the basis for the requested theoretical foundation, although the specific term of "lean startup" hasn't been researched or mentioned widely in academic terms yet. Searching the keyword "lean startup" offered only a few search results in databases such as Scopus, the web of science and similar databases of academic research. Nevertheless, other studies without a focus on lean startup principles revealed the importance of this approach in developing products in high technology startups (Tanev et al., 2015) or digital products (Wimmer, 2016). Undoubtedly, the first explorative study about Lean Startup by Patz (2013) served as a starting point to reveal the core elements and were used for the conceptualization of LSO.

The lack of suitable secondary data on the usage of lean startup elements, required the collection of primary data on the LSO concept. Consequently, a quantitative approach was chosen to test the formulated hypotheses and to derive generalizable results concerning the impact of LSO on new venture success. With the purpose of analyzing the efficacy of LSO, a cross-sectional survey design with the measurement at a particular time has been chosen (Saunders et al., 2009). The survey research was selected regarding the advantage to generalize inferences from a smaller sample to a population in a highly economical way (Fowler, 2009; Saunders et al., 2009). Following the decision for the survey research design in a further step, a suitable sample had to be selected.

3.2 Selection and Sample

The startup Ecosystem of Berlin was selected as a suitable location for the sample based on its importance as a major startup hub on the European level. The European Startup Monitor 2016 identified the regional startup hotspots such as Berlin, Brussels, London, Madrid, Rome, Tel Aviv and Vienna (T. Kollmann et al., 2016). According to startuphubs.eu Berlin is considered the 2nd most significant European startup hub after London with over 169,000 startups that employ over 653,000 employees. The startups in the Berlin ecosystem have accumulated over 3.9 billion € in the past years. The Global Startup Ecosystem Report 2017 Berlin moves up their ecosystem rankings from #9 in 2015 to #7 in 2017 with significant growth in fintech, digital health, artificial intelligence, mobility, food technology, and cybersecurity (Startup Genome, 2017). Moreover, besides those numbers Berlin also scores in the awareness and perceived quality of the startup hubs in Europe. Berlin ranked at the first place in 2016 and on second place in 2017 in the Startup Heat map Europe, an annual online survey among founders initiated by the European Startup Initiative (startupheatmap.eu).

Within Germany, Berlin is considered a suitable cluster to measure the LSO. First of all, Berlin is claimed to be the most significant startup hotspot in Germany (Tobias Kollmann et al., 2017). In fact, Berlin-based startups received in the first half year of 2017 with 68% also the highest share of venture capital invested in Germany (Ernst &

Young, 2017). Furthermore, the 1,800-2,400 actively operating tech startups in Berlin (Startup Genome, 2017) are considered a suitable cluster for the intended research by providing enough geographic concentrations of interconnected companies (Porter, 1998). Therefore, startups based in Berlin were selected with the goal to avoid differences in the business environment. This aims to ensure an LSO measurement having a low interference with other variables. To sum up, the focus on one startup ecosystem, hereby Berlin, provides the required homogeneity and focused observation of the LSO phenomena.

The sample consisted of 100 startups in Berlin. The adequate sample size for doing research is a highly-discussed topic in research (Guadagnoli & Velicer, 1988; Fowler, 2009). Different recommendations are available regarding the minimum sample size concerning a sample-to-variable. Namely, as a rule, a ratio 5:1 was found as adequate, whereas a 10:1 ratio is considered a more acceptable sample size. Other researchers also suggest a minimum of 20 cases and preferably the sample size should be at least 100 (Hair et al., 2014; Guadagnoli & Velicer, 1988). A survey instrument was designed to measure the five constructs such as LSO (8 sub-dimensions), Success (3 sub-dimensions), Radicalness of the Innovation (1 variable), Uncertainty (2 variables), Business (1 variable). All those elements together equal 5 aggregated variables, which reach with a 10:1 sample-to-variable ratio 50 respondents, 20:1 equals 100 respondents. Therefore, the sample size of n=100 was chosen based also on minimum sample sizes recommendations. Different age ranges have been used to describe new ventures. The widely accepted threshold of 6 years and younger as appropriate to define a company as a new venture (Zahra et al., 2000). Thus, the population for this research are 100 new ventures younger than 6 years from the Berlin startup ecosystem.

The startups of interest are developing software, thus digital products and services. This focus on digital product and service development was based on the following three reasons:

First, LSO roots are seen in the software industry, summarized by Eric Ries' experiences in his software startup IMVU which motivated him to write his book which created the Lean Startup movement (Frederiksen & Brem, 2017).

Second, several papers were found discussing the application of Lean Startup methodologies in software companies (Marcus, 2015; May, 2012; Thomke, 1998; Tyrväinen & Saarikallio, 2015). Hence this underlines the choice of the industry. Further, Harms et al. (2015) argue that e.g. software ventures can effectively apply LSM by having a low technology uncertainty due to the availability of established programming languages and wide-spread market diffusion. Nevertheless, they face a considerable market uncertainty. It is easier to mitigate this risk using the possibility to investigate into problem and solution fit by fast iterating on their software-based products in combination with a smooth modification upon user feedback. Startups developing a physical only product such as hardware are considered to have different product development requirements and aspects of market & technology uncertainty which are not comparable to software companies and were therefore excluded in favor of higher comparability of the results.

Third, the digital economy is considered a highly interesting field to investigate on LSO. For instance, the latest discussion in academia about Digital Entrepreneurship (Giones & Brem, 2017; Richter et al., 2017) underline the influence and importance of the digital economy for innovative European Startups. In this perspective, the European Startup Monitor reported that out of eighteen industry the digital economy accounted for a significant stack of accumulated 45.8% of the population. This includes startups operating in the categories IT/software development (15%), Software as a Service (12.2%), Consumer mobile/web application (6.8%), E-commerce (6.6%) and Fintech (5.2%) (Kollmann et al., 2016). Similar insights were derived from the German Startup Monitor 2017. The development of digital products and services is considered a fast growing and at the same time vital field to investigate in by representing 43.6% of the startups business field of German startups. They are active in industries such as IT/Software development (19.4%), Software as a Service (12%), E-Commerce (6.8%), Online Marketplace (5.4%) (Kollmann et al., 2017).

The requirement for reflection on a project level is at least a recently published Beta version of a digital product / service, an early but uncomplete version of a program or application containing the major features. The quality of responses was ensured by selecting startups with at least one published Beta version. Emerging ventures being in early or seed stage are mostly working still in the development phase of their concept. Without at least a Beta version of their digital product or service they won’t have the required level of experience to share their LSO activities. In consequence, they may deliberately choose the answers and this strategy known as uninformed response is expected to reduce the data's reliability (Saunders, 2009) and are therefore excluded.

The startup founder served as key informant to reflect on the LSO and evaluate the project performance. Startups are the focus of interest; therefore, one respondent per startup had to be chosen having the necessary knowledge of the new venture activities and performance insights. The startup founder was considered the key informant (Starbuck & Mezias, 1996; Chandler & Lyon, 2001) and was requested in a questionnaire to reflect on the application of lean startup elements. The respondents were instructed to identify a recently finished project/Beta version as defined in the previous section, to answer the items for LSO applied in this project and evaluated the effectiveness, satisfaction with the result of the specific LSO project.

3.3 Operationalisation

Prior research provided suitable elements to construct LSO. Prior qualitative (Patz, 2013) and the operationalization of the leanness of a startup (Rübling, 2016) were considered to build up the conceptual framework. Suitable scales building on a theoretical rationale were identified for the operationalisation of the LSO. Founders might have different perceptions concerning their lean startup orientation, due to the missing clear definition or awareness of lean startup activities. Instead of asking them directly about their lean startup orientation, several reflectives were used to facilitate the judgement by the founders. A survey instrument was created to capture the essential elements of LSO, measuring the venture's degree of LSO (independent variable) and to empirically validate the impact on the success of a LSO project / new product development or uncertainty reduction (dependent variables). Therefore, the survey touched six constructs of interest: (1) Lean Startup Orientation, (2) Project Performance, (3) Radicalness of the innovation, (4) Market Uncertainty, (5) Technology Uncertainty and (6) Business Type. Suitable measures must be found in literature to reach empirical validation of the research question and hypotheses under investigation.

Likert scale measures were adapted from existing literature. Wherever possible, measures were adapted or borrowed from existing literature of past empirical research to ensure the validity and reliability, ensuring the meaningful interpretation of data. For items of each construct, a 5-point Likert scale was used anchored by 1 = strongly disagree and 5 = strongly agree. This research was conducted by creating a survey based on the operationalisation of the reflective constructs. In the understanding of this study, the constructs refer to actions in the past. Lean startup considered as a strategic orientation and to find out how this LSO influences the project / new product development success. It is explicitly assumed that the LSO level stayed stable during a LSO project to enable the measurement. All measures of this study were retrieved from existing sources or created based on existing literature. Appendix 1 shows the questionnaire with the items used to measure the constructs in this study. Appendix 2 shows the operationalization of the variables used in this research and their source in academia. In the following sections, each construct and its items will be shortly presented.

3.3.1 Lean Startup Orientation

The independent variable LSO is understood as a higher-order formative construct (Diamantopoulos & Winklhofer, 2001). Formative constructs are caused by measuring lower-order reflective constructs. Therefore, the lower-order constructs shape the characteristics of the higher-order formative construct (Jarvis et al., 2003). In conclusion, LSO was operationalized as a second-order order formative construct composed of first order reflective sub-dimensions (Jarvis et al., 2003). Following the guidelines for formative indicators eight reflective measures were used “to capture fully the construct’s domain of content” (Diamantopoulos & Winklhofer, 2001, p.272). Based on the LSO definition the sub-dimensions are Hypothesis Testing, Customer Orientation, Experimentation, Prototyping, Validation, Knowledge Transfer, Learning and Iterative Cycles. These eight reflective measures caused by the latent constructs were included in the higher-order, formative LSO construct. Items for those reflective measures were self-developed based on the lean startup book (Ries, 2011), the qualitative definition of the Lean Startup approach from the view of practitioners (Patz, 2013), the scientific reflection of LSM (Frederiksen & Brem, 2017) and some elements were drawn on the startup’s degree of leanness items (Rübling, 2016) as visible in Appendix 2.

3.3.2 Success

In the early stages of a startup, new venture success is considered equal to project performance and was connected with the "Iron Triangle" from the project management literature (Atkinson, 1999). Due to the potential lack of suitable objective data or the difficulties getting those regarding investors interests, subjective measures were chosen. Subjective measures are widely used in research and considered as equivalent to objective measures (Wall et al., 2004). The project success was measured with the formative construct of the traditional Iron Triangle from project management literature (Atkinson, 1999). The Iron Triangle defines the project success with the elements cost, quality and time. The items for cost were drawn from Mishra and Shah (2009), Naumann and Jenkins (1982) and Atkinson (1999). The items for quality were drawn from Atuahene-Gima et al. (2006). The items for time were drawn from Lynn et al. (2000) and (Tanev et al., 2015).

3.3.3 Radicalness of the Innovation

The radicalness scale items of Gatignon et al. (2002) were adapted to measure the potential mediator or moderator effect. The incremental and radical innovativeness level of innovations in projects is assumed to moderate the relationship between LSO and success. Therefore, the startups were asked to derive the innovativeness, respectively the radicalness of their technology or product. Higher values indicate a higher radicalness of the innovation.

3.3.4 Level of Uncertainty

The perceived uncertainty before starting a new project was measured with market and technology uncertainty. The perceived uncertainty concerning market and technology is assumed to influence the link of LSO towards new venture success. The development of digital products / services is a costly and risky endeavor as different / conflicting interests and goals of end users, programmers and programmers have to be taken into consideration (Andres & Zmud, 2001). Suitable measures from Jaworski et al. (1993) and Desarbo et al. (2005) were included.

3.3.5 Business Type

The business type was differentiated between Business-to-Consumer (B2C), Business-to-Business (B2B) and the combination of both. The entrepreneur selected via self-evaluation the suitable business type. A value of 1 represents B2C, a value of 2 represents business that cater to both, and 3 refers to B2B.

3.3.6 Descriptive and Control Variables

Five contextual descriptive and control variables were included that might help to explain the hypothesized relationships such as founding year, number of employees, type of the digital product/service, business (B2C, B2B, both), company stage. For the digital product/service the options of Software, App, Web application, Website/platform and the option Other (please specify) were provided. For the company stage an ordinal item was used based on the following five stages as adapted from Scott & Bruce (1987) and Pittsburg's Future (2018).

Idea Development: We created the idea for the company and beginning of prototype development.

Startup: We created the 1st generation product/service with initial market testing.

Early growth: We refined the product/service and having sales to early adopters.

Rapid growth: We have accelerated growth and customer adoption.

Maturity: We have an established customer base and flattening growth.

3.3.7 Reflection on product / service development

The LSO was reflected on a project which reached at least a published Beta version. Eric Ries (2011) describes the continuous deployment found in the software industry. Therefore, LSO could be understood as strategic orientation on venture level guiding every decision based on an ongoing process and for new product development efforts. However, for the measurement a suitable cut needed to be found as an ongoing process is considered complicated to measure the effectiveness of the project. Having mentioned this, in the software industry such a suitable cut can be seen in the launch of a "Beta" version. Launching a Beta version was also found a strategy to occupy the market as fast as possible while still further developing the product and launching new versions and updates. Parallel activities allow to generate first demand and to improve the product on feedback based on the Beta versions (Salerno et al., 2015) which is in line with the iterative learning suggested by Ries (2011). The digital product/software is assumed to have reached a level where no significant structural changes are planned (more features) and improvement is happening rather on an incremental scale (fine-tuning). Data was collected cross-sectional, therefore at one point in time based on the startups' reflection on a project level.

3.4 Pre-testing

Pre-testing is an important step to improve the survey instrument before the data collection. Following LSO principle of iterative learning, after the initial creation of the questionnaire and before data collection, the survey was pretested as suggested by research textbooks (Fowler, 2009; Babbie, 1990; Saunders et al., 2009). The trial run was considered a valuable investment to figure out whether the questionnaire would succeed and proof to its face validity. This strategy to iterate on the questionnaire by implementing feedback on confusing elements, other ambiguities, suggestions and aims to obtain an assessment of the items towards representativeness and suitability(Saunders et al., 2009). It also ensures that there are no problems in recording the data. In conclusion, testing the research design helps to discover unexpected errors before starting the primary research effort (Babbie, 1990).

The pre-test with eight entrepreneurs revealed potential for improvement. The entire survey instrument was pretested as suggested by Babbie (1990) in the form that it would be used, namely a self-administered online survey with appropriate respondents. The results of the pretesting were used to iterate on the questionnaire revealing unclear items or ambiguous ones. Therefore, the questionnaire undertook a learning process among earlier subjects (Babbie 1990) with the aim to reach question clarity, as questions should make sense to respondents to ensure the creation of useful data (Babbie 1990). Following this method, it was ensured that the respondents could understand and complete the survey instrument. The survey instrument got pre-tested by eight entrepreneurs based in Switzerland, Germany (outside of Berlin) and the Netherlands. The pre-test provided insights into an unclear formulation of questions, survey design, logical structure etc. and revealed several minor changes to improve the survey instrument in an iterative approach as visible in Table 6. Changes due to the feedback of founders in the pretesting led to following iterations/improvements in the survey instrument:

Table 6 Iterations in the survey instrument

Feedback	**Iteration**
Specify market research further	Market research (talked to real customers)
Rearrange the order of the questions/pages	Startup information first to create an involvement of the founders
Combination of B2C and B2B was missing	Adding the mix of B2C and B2B
Survey Cover letter was not convincing enough what outcomes to expect and how much time is needed to complete the survey	Underlining the benefits for the entrepreneurs, adding the average time of the pretests to the cover letter
Complicated terms were confusing, e.g. The term hypothesis was not well understood or unclear.	A more simplified language and word structure was used. E.g. The term assumption was used instead.
Text fields for describing the technology and venture stage were found inappropriate	Text fields with the request to describe the technology and stage of the venture were replaced by easy to use items to select.
Clicking through the questions was lacking a feeling for progress	Adding progress bar

Additional findings and advice contributed to the evaluation and improvement of the survey instrument. First, the cover letter was improved based on different feedback from professional communication people. The first page is crucial as it is the first thing the participants see and inform them about the goals, purpose of my study and the expected benefits as a participant. A storytelling structure leading through the first page was applied and essential elements highlighted (Appendix 3). Second, the pretesting also helped to indicate the time required to fill out the questionnaire, which was on average 12 minutes and considered for further communication. Third, the pretesting also revealed the necessity to apply reverse coding seeing some extremely positive answer pattern by one participant. Reverse-coding was applied to include attention traps for participants to test if they are engaged answering the questions. With this strategy, unengaged respondents can be identified by them answering reverse-codded questions in the same ways as normal-coded questions, and therefore must be eliminated. Although some researchers are critical about using reverse coding, the practice is widely used in research to ensure that the participants are concentrated enough to fill out the survey and to identify the ones with a specific pattern (Hinkin, 1995). Finally, the survey instrument was perceived highly valuable by two pretest participants by writing in the feedback section: “The survey got me thinking about how we have structured our company, so participating has even value to me” (Startup Founder based in the Netherlands) or “the questionnaire was very well done and really helpful for us to reflect. Some good questions we should ask ourselves more often. Could you provide us with a PDF of the questionnaire?” (Startup Founder based in Hamburg).

3.5 Data Collection

Different channels were used to receive maximize the response rate from startups. Being aware of the low response rates from online-surveys for startup founders, a multi-pronged approach was used. First, the social media sites of communities such as the German Startup Association, Silicon Allee, etventure Startup Hub and START Berlin were used to create the awareness for this research. Second, the personal network of the author helped to connect to startup founders in co-working spaces and accelerators such as Axel Springer Plug and Play, Innogy, Betahaus, wework, ahoy, rainmaking loft and startupbootcamp. Third, suitable startups were identified through online databases such as Tracxn, a large data platform of startups globally, and local lists such as found on Gründerszene and from the German Startup Association. Finally, referrals via snowball sampling by the personal contacts of the author were used.

Landing pages were created to collect potential research candidates even before the survey was ready for distribution. While constructing the research instrument, a first landing page had been launched to collect first respondents email addresses to contact them as soon as the survey was pretested, created an online survey and ready to be sent to them.

As illustrated in Appendix 4, the topic of the research was on purpose kept a little bit hidden on the landing page. New digital products development was addressed instead of Lean Startup to avoid a biased selection effect of the lean startup affine ventures and to exclude those ventures not aware of the term. Nevertheless, still measuring the application of lean startup principles in a project. The first landing page didn’t show the wished conversion rate for survey participants. Following a lean startup approach also the landing page was iterated based on feedback from founders. A clearer communication what should be done after signing up, such as indicating the time needed for the survey instead of the quite general and unspecific description. The 2nd version of the landing page is visible in Appendix 5 and had a higher conversion rate. Nevertheless, although this conversion rate was slightly higher with 20%, a different strategy had to be taken into consideration.

The low conversation rate required a pivot in the data collection strategy. The conversation with one founder made it clear by saying “I'd highly recommend you attend the networking events hosted by co-working spaces and ask the leaders to share your info or give you a slot to talk about it. They are usually quite kind and helpful”. In consequence, based on this insight the acquisition strategy was changed. The assumption that a landing page shared via email and social media would be enough to attract the attention of 100 startup founders had to be invalidated, after measuring its conversion rate. This insight from this small test showed clearly that the data collection needs a combination of online and offline channels.

An online survey was created and distributed. The survey was created with an online survey tool such as surveymonkey.com to automate the capture and input of data and allowing fast iterations during the creation phase. The Survey Monkey questionnaire was sent online in a personalized way via Email or LinkedIn to the founders in the sample. The cover page of the survey illustrated the research aim and its importance. Startup founders face a lot of visibility and pressure from their investors which restricts them in the willingness to participate in such research. It was essential to find the right incentives to increase the return rate. Full confidentiality was assured and just necessary information such as founding year, the category of digital products and services, their business sector (B2B, B2C, both) was requested to overcome this barrier. The name of the venture and the number of employees were not made compulsive, information which could help to identify the venture. However, the return rates were still not enough.

Higher return rates were achieved by following the Total Design Method and the role of incentives. The data collection followed the Total Design Method (TDM) (Dillman, 1978) to maximize the return rates. The initial TDM approach has the goal to incentivize the participation in a survey by a following social exchange approach to create trust and perceived higher rewards and lower costs for the respondent. The TDM was updated over the decades with the new technical possibilities from mailing and phone interview towards email and online tools (Dillman et al., 2008). Follow-up emails, phone calls, personal visits followed the initial survey distribution to obtain higher response rates. The role of incentives had to be taken into consideration. Therefore, upon completion of the study, it was promised to provide the findings to the participating founders. Additionally, other non-monetary benefits considered attractive out of a founder’s perspective were provided, such as winning tickets for the Startup Camp Berlin 2018, the chance to speak at the authors curated lean startup track or a free of charge job posting to find motivated working students and interns.

Data of 100 participants was collected with a mix of online and offline collection strategies. The data collection started with using digital touchpoints in the form of a landing page, email message or request in LinkedIn. This strategy was supported by offline touchpoints such as visiting and talking to founders. Preventing from technical issues with self-administered internet-based surveys and enable a customer development situation such as in the lean startup way following the get out of the building claim (Blank & Dorf, 2012), meeting the founders in their co-working spaces, offices. Thus, filling out a questionnaire during a personal meeting ensured the common understanding of the items and collecting filled out surveys. This strategy supported the efforts to find suitable survey participants showing a higher perceived social exchange which resulted in more available time and willingness to fill out the survey. On the one hand, the personal visits required more time than self-administered only based surveys, but on the other hand, there was an expected higher return rate of completed surveys (Saunders, 2009). Therefore, adding to the online touchpoints also offline ones such as visiting different startup events, pitching at meetups, co-working spaces, incubators and accelerators helped to collect the required 100 filled out surveys.

4 Data Analysis

The data analysis will follow different steps to test the assumed relationships and answer the research question. Starting with a data description, followed by addressing topics such as non-response bias and common method bias, multicollinearity, validity and reliability checks and data distribution necessary before testing the hypotheses with the collected data and suitable statistical tests.

4.1 Data Description

The questionnaire contains 69 items measured with 5 point Likert scales and additional items for information such as company founding year, number of employees, type of digital product and the stage of the venture. A descriptive analysis for all variables should be presented in this section.

The survey research achieved the satisfactory effective response rate of 22,22%. In more detail, 450 startup founders were contacted and 154 questionnaires received. 41 had to be excluded due to missing data. 113 were completed and yielded a response rate of 25.11%. However, 13 of those were deselected as they were either mainly active in the hardware industry or located outside of Germany. Resulting in the sample of n=100 matching the inclusion criteria and were used for the analysis with an effective response rate of 22,22%. This response rate is considered satisfactory considering that other quantitative studies on startups show similar or even lower response rates (e.g. Gruber, 2007: 28.7%; Deligianni et al., 2017: 23%; Chandler et al., 2011: 17,8%; Chandler & Hanks, 1993: 15%).

The satisfactory response rate can be explained through different factors. This satisfactory response rate was achieved by following the social exchange approach as suggested by TDM (Dillman, 1978) and actively promoting it on online (e.g. guest posts on Facebook pages such as START Berlin, German Startup Association and other local startup communities as well as on LinkedIn) and offline channels (startup events, meetups in Berlin) and the perceived importance of the results by the founders. Creating successful digital products and services was considered by them as highly important. This is in line with other studies which identified the successful digital product / service development as one of the most prominent challenges startups face in Germany (Kollmann et al., 2017).

The startups in the sample show a suitable variety in their characteristics for the analysis. First, the startups in the sample (n=100) were 92% based in Berlin, 2% having offices worldwide including one in Berlin and 6% from other German cities but with connection to Berlin as being in an accelerator program such as Axel Springer Plug & Play, working in a Berlin co-working space or attending a local Berlin startup event. Second, the startups had an average age of 1.78 years (s.d.= 1.56) with a mean size of 19 employees (maximum=350, minimum=2). The average young age can be explained by 22% startups of the sample founded in 2017. Third, the startup stage was indicated with 12% in idea development stage, 29% startup stage, 33% early growth stage, 24% rapid growth stage and 2% maturity stage. The sample seems to spread quite equally on the different startup stages, which is considered important for the testing of the hypotheses. Fourth, the sample was operating in the following business context: 43% B2C, 38% B2B and 19% stated they are having B2C as well as B2B customers. Fifth, the startups developed different kind of digital products and services such as 26% software, 39% smartphone apps, 33% web applications, 17% website / platform and 8% other things such as a chatbot or artificial intelligence application (the sum is higher than 100% because some startups developed products and services in more than 1 category). In conclusion, the sample of startups showed a diversity which is considered suitable for the planned analysis.

4.1.1 Nonresponse bias

The nonresponse bias regarding a potential significant difference between respondents and non-respondents was found absent. First of all, a non-response bias can be found in data when respondents refuse to participate in a research or answer the questions (Saunders et al., 2009). Startup data was continuously collected over a period of two months. The assessment of nonresponse bias was done with the help of a wave analysis by comparing the difference between early and late responses (Rogelberg & Stanton, 2007). Instead of comparing the waves, a correlation analysis with the response day (after the first response) and the key construct values was performed. Resulting in only 1 of 14 correlations was found to be significantly related to the response day. In conclusion, the nonresponse bias was found absent.

4.1.2 Common Method bias

The potential threats of a common method bias needed to be addressed. A common method bias is considered one of the main sources of measurement error, which threatens the goal to infer causality among the constructs and therefore influences the interpretation (Podsakoff et al., 2003). The survey research was conducted with a cross-sectional sample with 100 startup founders. In this connection, the chosen survey research strategy reveals one potential area of common method bias.

The self-reported data by startup founders could be biased and were addressed by mitigation strategies. First, the use of self-reported data must be treated carefully in regarding common method variance bias as mentioned in other research (Podsakoff & Organ, 1986; Chen et al., 2005). As a result, interviewing the startup founders as the key informant with strategic knowledge of the venture particular caution was exercised to minimize the distortion problems (Kumar et al., 1993). This strategy was chosen with the opinion found in comparable research that the “views of the founders are the same as the average views of the venture’s staff” (Delmar & Shane, 2003, p.1170).

Asking the founders/product owners to focus on the latest new product development project it was aimed to minimize the retrospective bias. Nevertheless, the founder could be biased by answering the questions towards social desirability instead of the own opinion. To address this bias the survey was filled out anonymously and the confidentiality of the research was emphasized to avoid any pressure from shareholders. Moreover, the problem of answering in a specific pattern was addressed with the reverse coding of items to reveal biased answers and to delete them from the sample.

Other techniques such as using a second responder or relying on objective data were not feasible in the context of this study (Podsakoff et al., 2003).

4.1.3 Validity and Reliability: Scales and Reliability Check

A meaningful interpretation of data requires the validity and reliability of the scales. The combination of items into scales asks for checks of reliability and internal consistency. Validity of the measures was established through an exploratory factor analysis. Internal consistency and reliability was calculated by the most frequently used method: The Cronbach's alpha coefficient (Saunders et al., 2009).

Initially LSO was conceptualized as an 8-dimensionnal construct and was refined to a few item formulations. Bartlett's test of sphericity indicated sufficiently large correlations for the analysis and therefore the appropriateness of the dataset for the application of factor analysis. An exploratory factor analysis (EFA) was performed to verify scale construction and 63perationalization (visible in Appendix 6). Experimentation and Iteration were combined as they were loading on the same factor and are also theoretically linked. Previous qualitative research on LSM activities revealed relatively high co-occurrence factors (Patz, 2013). Similarly, Knowledge Transfer and Prototyping did not emerge as empirically distinct dimensions as they were found loading with almost all other LSO elements and were considered as omnipresent and conceptually covered in the other constructs. The original item pool was tested with the sample which led to the refinement of a few item formulations for the further analysis (see Table 7).

Table 7 Refined Conceptualization of LSO

THINK	**BUILD**	**MEASURE**	**LEARN**
Hypothesis testing Customer Orientation	Iterative Experimentation	Validation	Learning

The five items of the constructs of LSO were taken to conduct a principal component analysis restricted to a 5-factor analysis based on the Scree plot analysis of the EFA with orthogonal rotation (Promax). Promax allows potential correlations between the factor's dimensions as LSO activities were found to be often used simultaneously (Patz, 2013). EFA revealed a 5-factor solution with few cross-loadings >.3 (Field, 2013).

To eliminate cross-loading the Cronbach's alpha was calculated to test the internal consistency and reliability (Cronbach, 1951). The internal consistency and construct reliability was tested by measuring the Cronbach's alpha to improve the subscales (Gliem & Gliem, 2003). For basic research, the instruments should have a reliability of .70 or higher (Nunnally, 1978). The LSO items were analyzed on subscale level showing a good reliability (Table 8). However, Hypothesis Testing was boosted by eliminating the weakest element. Similarly, for the other sub-dimensions the item pool was refined.

Table 8 Correlation between dimensions of LSO

	Alpha	(1)	(2)	(3)	(4)
(1) Iterative Experimentation	.838				
(2) Customer Orientation	.747	.363**			
(3) Validation	.716	.433**	.297**		
(4) Learning	.724	.348**	.458**	.135	
(5) Hypothesis Testing	.578	.329**	.272**	.232*	.233

Evidence for discriminant validity was found to exist but it is weak (Table 9). The Average Variance Extracted (AVE) for the constructs Iterative Experimentation, Customer Orientation and Validation is above .4, which is acceptable (Huang et al., 2013). For the constructs Learning and Hypothesis Testing, this value is just below threshold. The AVE of each of the latent constructs is higher than the highest squared correlation with any other latent variable (Fornell & Larcker, 1981). These findings are in line with the statement that LSM activities are often used simultaneously and therefore the usage may correlate (Patz, 2013).

Table 9 Squared correlations between dimensions of LSO and AVE

	AVE	(1)	(2)	(3)	(4)
(1) Iterative Experimentation	0.460				
(2) Customer Orientation	0.570	.132			
(3) Validation	0.540	.187	.088		
(4) Learning	0.390	.121	.209	.018	
(5) Hypothesis Testing	0.370	.108	.007	.053	.054

The indicator collinearity was addressed with confirmatory factor analysis. For each factor, the factor score (with a mean of 0 and a standard deviation of 1) was calculated. Those factor scores were then added to form a reflective first order – formative second order construct (Jarvis et al., 2003).

The new venture project performance was measured with the Iron Triangle elements Quality, Cost and Time. The three-item scales of Quality had an Alpha of .639, Cost was boosted by eliminating the weakest element reaching an Alpha of .619 and Time had an Alpha of .436.

Table 10 Cronbach's alpha to measure internal consistency and construct reliability

Scales	**Cronbach's alpha initial**	**Cronbach's alpha boosted**
Quality	.639 (no improvement possible)	
Cost	.412 (eliminating 1 item)	.619
Time	.436 (only low improvement possible .448)	
Radicalness	.673 (only low improvement possible .691)	
Market Uncertainty	.55 (eliminating 1 item)	.635
Technology Uncertainty	.694 (eliminating 1 item)	.715

As potential moderators of the LSO-Performance relationship, four constructs were used:

(a) Market uncertainty based on items from market turbulence scale (Jaworski & Kohli, 1993) had a Cronbach Alpha of .635 and reflects the perceived market uncertainty at the beginning of the project.

(b) Technology uncertainty based on items from the technological turbulence scale (Jaworski & Kohli, 1993) had a Cronbach Alpha of .715 and reflects the perceived market uncertainty at the beginning of the project.

(c) Radicalness of the Innovation based on the 4-items scale by Gatignon et al. (2002) had a Cronbach Alpha of .673.

4.1.4 Data Distribution

The distribution of the data sets leaded to the decision for parametric tests. First of all, the data distribution influences the choice for parametric and non-parametric tests in the further analysis. In the case of detecting normality issues of the data, non-parametric tests for correlation analysis should be used (Saunders et al., 2009). Consequently, the

LSO construct (independent variable) and new venture Project Performance (dependent variables) sum scores were analyzed regarding skewness and kurtosis (Sposito et al., 1983).

The LSO construct (see Figure 12) is found not significantly different from a normal distribution. The LSO construct is found to be negatively (left) skewed (Skewness=-.470; Std. Error of Skewness=.241), showing a mesokurtic curve with a kurtosis less than three times the standard error as (Kurtosis=1.396; Std. Error of Kurtosis=.478). Similarly, The Project Performance construct (see Figure 13) was found not significantly different from a normal distribution. It is negatively (left) skewed (Skewness=-.690; Std. Error of Skewness=.241), showing a mesokurtic curve with a kurtosis less than three times the standard error(Kurtosis=.771; Std. Error of Kurtosis=.478). The application of the Kolmogorov-Smirnov Normality test with the H0 of “LSO being significantly different from normal distribution” reveals the same result for both constructs. Having a statistically significant value the H0 can be rejected, resulting in a distribution not different from a normal distribution. Taken all this information into account, it can be deducted that LSO and Project Performance are not significantly different from a normal distribution. In conclusion, for further analysis parametric tests with more statistical power such as the Pearson correlation were applied given the required normal distribution (Nahm, 2016).

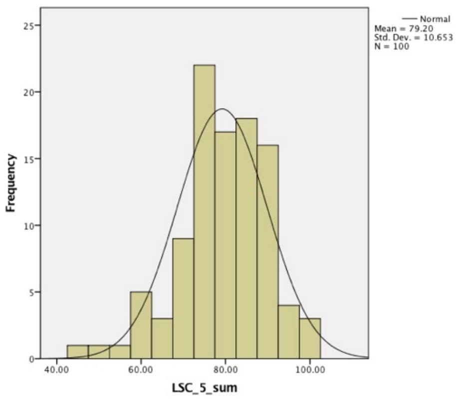


Figure 12 Histogram LSO

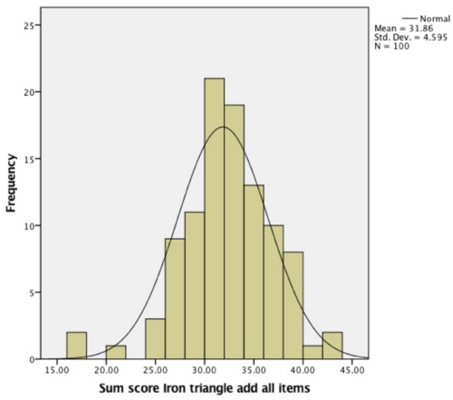


Figure 13 Histogram Performance

The test for homoscedasticity showed no elements for concern. For the planned analysis with linear regression models, the assumption of homoscedasticity had to be tested. Homoscedasticity is looking to which extent the variables have equal variances (Saunders et al., 2009). The visual inspection of the P-P plot revealed a normal distribution of residuals. Therefore, data points of the dependent variable showed a similar variance and a consistent pattern. Illustrated below in Figure 14 the scatterplot for project success. Showing homoscedasticity, there is no need to transform or split the data (Hair et al., 2014).

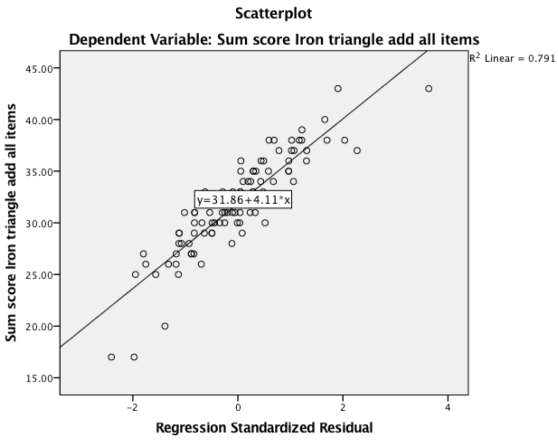


Figure 14 Scatterplot Project Performance with standardized residuals

4.1.5 Multicollinearity

No problematic multicollinearity was found in the data. The case of strong multicollinearity of the data would decrease the ability of the LSO construct (independent variable) to predict the dependent variable (Hair et al., 2014). Following the steps suggested by Hair et al. (2014) first a correlation analysis between the independent variables was performed to identify the first indication of substantial collinearity. Due to the theoretical interconnectedness of the LSO elements, significant correlations were found, but they were lower than the general rule of .90 for a strong correlation. In a further step, variance inflation factors (VIFs) were used to test the threat concerning multi-collinearity in the independent variables of the LSO construct. Although rules of thumb might be treated with caution (O'Brien, 2007), the VIFs associated with the independent variables were low from 1.186 to 1.877 and ranged within acceptable limits. Having those low VIFs suggest no need for concern and no variable had to be dropped by being problematic (Hair et al., 2014).

4.2 Analytical Procedures

The assumed relationships and correlations of the independent variable (LSO) on the dependent variables (Project Performance) were calculated with STATA based on data from the selected sample of the population. Sum scores of the key constructs were calculated for the analysis. LSO was defined as a 2nd order formative construct composed by the five sub-dimensions which were summed up to represent the LSO sum score. Similarly, Project Performance is characterized by the elements of the traditional Iron Triangle (project success) such as cost, quality and time. The data were looked at graphically in scatterplots to identify outliers and searching for biases before running any analysis (Field, 2013).

STATA and suitable statistical tests were chosen for testing the major inferential research question and hypotheses to relate variables and draw inferences from the sample to a population. The hypotheses were tested using statistical analysis such as bivariate Pearson correlation (Table 6) and linear moderated regression (Table 7).

First to reveal the relation of LSO on the venture project success (H1), the collected survey data was analyzed with the help of an ordinary least square analysis. This linear regression analysis was simulated to estimate the relationship between the dependent (project performance) and the independent variable (LSO). In this analysis, first the independent variable (LSO) and the control variables were entered into the model and the explained variance was examined.

Secondly, the moderating impact of the radicalness of innovation (H2a), market uncertainty, technology uncertainty and business type on the LSO-Performance link were analyzed. The moderated regression analysis was conducted using a continuous moderator variable following the instructions of Krüger et al. (2012). Testing for a continuous moderator the cross-product term of z-standardized values for LSO and each Moderator was entered in the model. (1) The potential moderator variable (Market uncertainty) was then entered into the model. The partial F associated with the resulting change in R2 was then examined to statistically test whether or not market uncertainty moderates the LSO-Performance link. (2) The cross-product term LSO*Technology uncertainty was entered into the model. (3) The cross-product LSO*innovation and (4) LSO*business type was entered into the model. The partial F with the resulting change in R^2 were examined whether or not a moderating effect exists.

4.3 Results

4.3.1 Descriptive Statistics

Table 11 provides an overview of the means and bivariate correlations of the constructs for the collected data. The strength of the correlation depends on the correlation coefficient r, which is having a small effect for values from 0.1 - 0.3, medium effect for 0.3 - 0.5 and a large effect for values > 0.5 (Cohen, 1992). The results of the Pearson correlation analysis show several significant correlations with small, medium and large effects.

Most importantly the results concerning the Project Performance and LSO should be taken into consideration. LSO is intertwined with Project Performance having a medium effect ($r = .449$; $p < 0.01$). For the moderators, the Radicalness of Innovation is correlated with Project Performance having a small effect ($r = .250$; $p < .05$). The Radicalness of Innovation shows a small correlation with LSO ($r = .195$; $p < .10$). Moreover, only technology uncertainty ($r = .220$; $p < .05$) and not market uncertainty is significantly interrelated with LSO. Market uncertainty and technology uncertainty seem to occur simultaneously for new ventures as the significant but low correlation indicates ($r = .257$; $p < .01$).

The other correlations should be shortly mentioned but are not in the focus or logically connected. Year and stage are largely negative correlated ($r = -.573$; $p < .01$) as the higher the year (e.g. 2017 vs. 2014) the younger the venture and the lower is the venture stage on a nominal scale (1-5). Similarly, the younger the venture the higher is the market uncertainty ($r = .178$; $p < .10$). The small correlation between venture stage and performance ($r = .202$; $p < .05$) can be explained that a new venture by moving to higher startup stages (e.g. from early growth to rapid growth) the experience of startups grows and the knowledge of how to manage projects. The significant correlation of radicalness and technology uncertainty ($r = .469$; $p < .01$) is logic. The more radical the innovation the more technology uncertainty is involved.

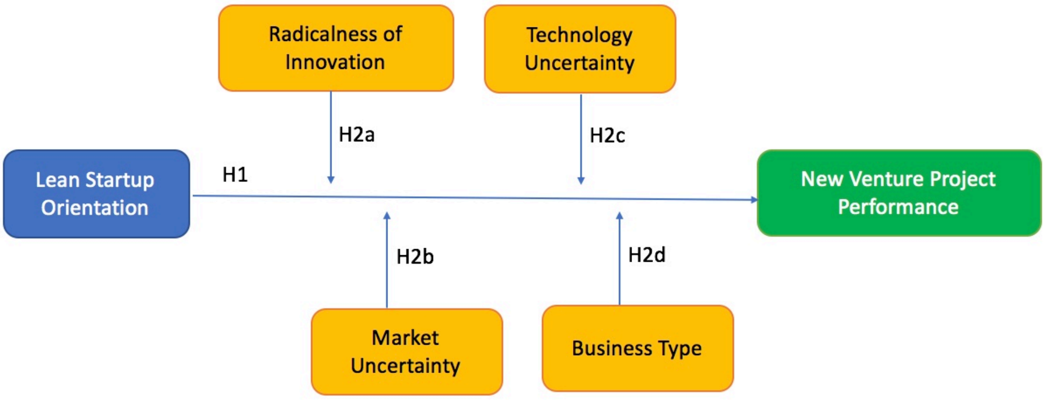
4.3.2 Hypothesis Testing

Table 12 summarizes the moderated regression analysis for testing the hypotheses.

H1: *The degree of LSO is positively related to project performance in startups.*

In the basic model (0) the predictors such as the independent variable (LSO) and the control variables (Venture stage, Founding Year) were entered and the explained variance R^2 for Project Performance was found 31.2%. Support was found for H1 such as the results show a strong, robust, and highly significant relationship between LSO and project performance (Standardized B coefficient = .392; p < 0,001). In conclusion, we have enough evidence to accept Hypothesis 1.

In a further analysis, the impact of potential moderators should be tested. A real mediator effect would alter the direction or magnitude of this LSO-Performance relationship.



H2a: *The LSO-performance link is moderated by the radicalness of the innovation. Lower levels of radicalness strengthen the LSO-performance relationship.*

Adding the potential moderator Radicalness of Innovation into the model (3) leads to a minimal increase of R^2 to 31.4%. The cross-product term LSO*innovation, representing the radicalness of the innovation, was found to be significantly negative related to Project Performance (Standardized B coefficient = -.181; p < 0,05). Considering the current data, we have enough evidence to accept Hypothesis 2a, the more radical the weaker the LSO-Performance link.

H2b: *The LSO-performance link is moderated by the market uncertainty.*

The cross-product term LSO*Market uncertainty in model (1) was not found to be significant. Therefore, considering the data there is not enough evidence to accept Hypothesis 2b.

H2c: *The LSO-performance link is moderated by the technology uncertainty.*

The cross-product term LSO*Technology uncertainty in model (2) was not found to be significant. Therefore, considering the data there is not enough evidence to accept Hypothesis 2c.

H2d: *The LSO-performance link is moderated by the business type of the startup.* The cross-product term LSO*business type in model (4) was not found to be significant. Therefore, considering the data there is not enough evidence to accept Hypothesis 2d.

Adding all moderators to the model increases the R^2 of 31.4 % from the model (3) with the radicalness of innovation moderator to 36.7%. Therefore, with the full model (5) 36.7% of the variance of venture performance can be explained.

In conclusion, the results of the statistical analysis provide evidence for the LSO-Performance link and the moderation through the radicalness of innovation. All the other moderators were found not to be significant. LSO was in all models strong, robust and highly significant. The mediator Radicalness of Innovation was just able to alter the magnitude on a small level.

Table 11 Pearson Correlations

	Mean	1	2	3	4	5	6	7
(1)Year [V_Year]	2015							
(2)Stage[V_Stage]	2.75	-.573**						
(3)Performance [ITR_SS1]	3.54	.165	.202*					
(4)LSO [LSO_5F]	3.96	.017	.125	.449**				
(5)MU [	3.18	.178#	-.143	.089	.011			
(6)TechU [TUT_SS]	3.97	.093	-.174	.084	.220*	.257**		
(7)Inno[ID_Score]	3.33	.059	-.058	.250*	.195#	.116	.469**	
# p < 10%; * p < 5%; ** p < 1%; Means for scales: values represent the mean of an additive index of the scale items (5-point scale).								

Table 12 Moderated regression analysis

	(0)	(1)	(2)	(3)	(4)	(5)
Venture stage [V_ST_REC]	.268*	.250*	.253*	.219*	.275*	.300
Founding year [V_year]	.286**	.251*	.289*	.253*	.291**	.228*
LSO [LSO_5F]	.392***	.396***	.379***	.383**	.396***	.394***
Market uncertainty [MU_FS3]	.066	-.805	.101	.112	.0616	-.953
Technology uncertainty[TU_FS3]	-.093	-.122	-.091	-.094	-.089	-.122
Inno [ID_Score]	.206*	.192	.211*	.214*	.206*	.120
B2B/B2C [V_BUS_1]	-.002	-.002	-.000	-.001	.002	.007
LSO*Market uncertainty		.105				.013
LSO*Technology uncertainty			-.121			-.065
LSO*innovation				-.181*		-.163
LSO*business type					-.053	-.122
R^2 (full model)	.312	.323	.322	.314	.314	.367
Dependent variable: Project performance [ITR_SS1]; Standardized coefficients; n.s.: not significant; # p < 10%; * p < 5%; ** p < 1%; *** p < 0.1%						

5 Findings and Discussion

In this section, inferences and conclusion will be drawn from the results by discussing each hypothesis to answer the research question on how the degree of LSO influences the success of a new venture. In a further step, theoretical and managerial implications will be discussed and an outlook for future research provided.

5.1 Summary of Key Findings and Derived Conclusions

The research aim laid in providing empirical evidence for the effectiveness of the LSM. The following Table 13 gives a short overview about the hypotheses and the findings which should be discussed in further detail.

Table 13 Hypotheses & Findings

H1: *The degree of LSO is positively related to project performance in startups.*	Confirmed
H2a: *The LSO-performance link is moderated by the radicalness of the innovation. Lower levels of radicalness strengthen the LSO-success relationship.*	Confirmed
H2b: *The LSO-performance link is moderated by the market uncertainty.*	n. s.
H2c: *The LSO-performance link is moderated by the market technology*	n. s.
H2d: *The LSO-performance link is moderated by the business type of the startup.*	n. s.

As expected the results show that the degree to which entrepreneurs utilize LSM is positively related to new venture project performance. This is in line with the beneficial elements of the LSM found in theory. The benefits in theory were confirmed that activities such as validation of hypotheses (Ladd, 2016), learning from customers (Griffin & Hauser, 1993), experimentation, usage of prototypes (Kerr et al., 2014; Eisenmann et al. 2011; Nguyen Duc & Abrahamsson, 2016) and the commitment to learning (Baron & Henry, 2010) leads to faster decisions (Sykes & Dunham, 1995), faster time to market (McGrath, 2010) and decreased costs (Harms et al., 2015). In conclusion, first direct evidence for the performance implications of LSM was found. Activities such as iterative experimentation, customer orientation, validation, learning and hypothesis testing are positively linked to a higher project performance.

Based on the literature it was assumed that lean startup orientation is more suitable for incremental innovation (Ries, 2011; Popowska & Nalepa, 2015; Fagerholm et al., 2017) (Quellen). The LSO-performance link is negatively influenced on a 5% level as expected by the radicalness of the innovation and supports the claim that LSO is more suitable for incremental innovation.

The results also showed some unexpected results. The correlation analysis showed that LSO is only correlated with technology uncertainty and not market uncertainty. This is in contrast with previous research which claimed LSO to be more applicable concerning the situation with market uncertainty (Harms et al., 2015; Eisenmann et al., 2011; Dahan & Mendelson, 2001). The study by Harms et al. (2015) was done on material and science-based ventures which face a different environment than software startups. The ventures in the sample were technology-based businesses with a certain degree of market and technology uncertainty. Surprisingly, the analysis revealed that market uncertainty and technology uncertainty don't have an impact on the LSO-Performance relationship. In conclusion, LSO performs well in low and high uncertainty. However, this might be not the case for extreme situations. Finally, LSO was found to perform well in B2B and B2C context. This is unexpected as researchers suggested the B2B context to have some additional challenges regarding the effectiveness of LSO (Lindgren & Münch, 2015).

5.2 Theoretical and Managerial Implications

The Lean Startup Method (LSM) is highly popular across practitioners and applied all over the world for new venture creation and venture projects (Sources). However, academic research just took the first steps to solve the mystery around LSM. Researchers started to describe and understand the essence of the LSM by talking to practitioners (Patz, 2013), deriving a first scientific reflection of LSM (Frederiksen & Brem, 2017), creating a first but untested operationalisation of the leanness of a startup (Rübling, 2016). Besides discovering the crucial elements of LSM research on the effectiveness of LSM is rather scarce (Frederiksen & Brem, 2017). It is unknown if LSM activities lead to more success for a new venture as suggested in the business books by Ries (2011) and Maurya (2010). Success was reported on individual cases but not with empirical data from a suitable sample of the population to derive a broader generalizability of the results. The lack of empirical evidence is unfortunate such as the discovery of elements for successful entrepreneurship is considered highly important. The core contribution of this thesis is the operationalisation of LSO that future research can build on and refine to advance the academic discourse on LSM. Building on previous works by other researchers on the LSM (Patz, 2013; Rübling, 2016) a survey instrument was created to measure the LSO and project performance. The data from 100 Berlin-based software startups was analyzed using STATA to derive insights in the effectiveness of LSO. Using the operationalisation on a sample of 100 Berlin-based software startups, direct empirical evidence was provided that LSM is positively related to new venture project performance. In conclusion, the existing body of research got extended by the highly needed first direct evidence on the effectiveness of LSM. This supports the positive performance implication of experiential entrepreneurship in the debate of how entrepreneurs create and manage their venture (Honig & Hopp, 2016).

By contributing the empirical evidence for the effectiveness of the LSM it was also aimed to derive valuable implications for practice. The findings reveal the beneficial impact of LSO on new ventures. Moreover, first results concerning the moderating effects of the LSO-performance link were found. LSM was empirically found to be more suitable for incremental innovation, performing well facing low and high market and technology uncertainty and surprisingly found equally suitable in B2C and B2B context. This indicates several implications for practice. First, an experimentation mindset should be fostered with a focus on learning. Validation of hypotheses and developing new products / services in an iterative fashion with the BML loop. Therefore, a more systematic LSO application helps new ventures to be more successful. LSO is suitable to be applied for entrepreneurs creating incremental innovations in the B2C or B2B context.

Finally, a tool to test the leanness of the own venture with concrete indications on how to improve the lean startup capabilities is considered highly beneficial (see Appendix 7).

5.3 Limitations

The research on elements with impact on new venture success is a complicated phenomenon. Therefore, this research faces several limitations due to an oversimplification of the research model to several key elements such as LSO and new venture project performance. In consequence, it’s a limited reproduction of the reality. In this section, the most important limitations should be introduced.

The derived insights are only based on empirical data from Berlin-based Software startups developing digital products and services, this fact might limit the generalizability of the findings towards one specific industry: software startups.

One limitation of the current research is that the insights derived from the relationship between the degree of LSO on new venture project performance are limited by the cross-sectional design of this study. It may be uncertain how much performance can be contributed to the lean startup approach and the possibly big gap between implementation and performance impact should be considered. Moreover, to reduce the common method bias of the current research characterized by a cross-sectional design the questionnaire could have been divided into two parts to send the LSO and the success part to the respondents in two waves. This approach following a longitudinal study design could have additionally verified and complemented the findings of this study.

Another aspect which shouldn’t be neglected is that the results depend on the understanding and perception of the founders. There might be perceptual errors and biases as well as misunderstandings of the elements resulting from a different point of view from the founder and the researcher (Starbuck & Mezias, 1996). Moreover, potential recall bias may occur by judging the output of NPD strategies more positively due to the reflective nature and “independent variables (that) may be less influenced by memory than by reconstruction that connects standard story lines with contemporaneous awareness of performance results” (March & Sutton, 1997, p.701).

Given the limitations of this study, it would be highly valuable to conduct further research illustrated in the next section.

5.4 Directions of Future Research

Future research might build on and refine the suggested LSO operationalisation. Further empirical research could explore and provide further evidence on the suitability of LSO across different industries. Which industries are most suited for LSM? Having found that LSO is positively related to performance, future research could investigate in the LSO activity contributing the most towards new venture project performance. Moreover, the question of the "right" application of LSO could also to be addressed. Using a longitudinal research design could reveal a wider perspective and extend the generalizability of the findings.

Speaking to the founders over the collection period it became clear that the conceptual model should be expanded by other factors considered as important in the implementation of LSO such as: availability and source of funding, differences in industries, participation in an acceleration program, corporate venturing, potential founder bias (overconfidence in own judgement resulting in less testing), a missing failure culture (working towards a perfect product rather than a launching early an imperfect prototype to iterate on and learn) and as well as the degree of a good or bad implementation of the LSO activities.

The conceptual model of LSM could take further elements into consideration such as the impact of different cultures (missing "failure culture"), startup size, infrastructure and environment, role of funding and the experience of the entrepreneurs. Especially also cultural biases might influence the effectiveness and suitability of LSO (Honig & Hopp, 2016). In Germany is said to miss a failure culture and companies would not launch a Beta version which is not perfect. Instead of experimenting and having fast cycles going for perfection with the aim to deliver the best quality. The size of the startup, the experience of the founders and the team, the participation in an incubator and accelerator program might play an important role or incentive to use more LSO. The experience of the founder and the startup team might also have an important influence.

Bibliography

Adler, P. S., & Borys, B. (1996). Two Types of Bureaucracy : Enabling and Coercive. *Sage Publications*, *41*(1), 61–89.

Aldrich, H. E., & Ruef, M. (2017). Unicorns , Gazelles , and Other Distractions on the Way to Understanding Real Entrepreneurship in America. *Academy of Management Perspectives*, 1–36.

Alvarez, S. A., & Barney, J. B. (2005). How do entrepreneurs organize firms under conditions of uncertainty? *Journal of Management*, *31*(5), 776–793.

Anderson, J., & Narus, J. (2005). Business Market Management: Understanding, Creating and Delivering Value. Chapter 1: Business Market Management Guiding Principles. New Jersey: Pearson education.

Andres, H. P., & Zmud, R. W. (2001). A contingency approach to software project coordination. *Journal of Management Information Systems*, *18*(3), 41–70.

Andries, P., Debackere, K., & Van Looy, B. (2013). Simultaneous Experimentation as a Learning Strategy: Business Model development under uncertainty. *Strategic Entrepreneurship Journal*, *7*, 288–310.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, *17*(6), 337–342.

Atuahene-Gima, K., Li, H., & De Luca, L. M. (2006). The contingent value of marketing strategy innovativeness for product development performance in Chinese new technology ventures. *Industrial Marketing Management*, *35*(3), 359–372.

Babbie, E. R. (1990). *Survey Research Methods*. Belmont, California: Wadsworth.

Bajwa, S. S., Wang, X., Nguyen Duc, A., & Abrahamsson, P. (2017). “Failures” to be celebrated: an analysis of major pivots of software startups. *Empirical Software Engineering*, *22*(5), 2373–2408.

Baker, T., & Nelson, R. E. (2005). Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage. *Administrative Science Quarterly*, *50*(3), 329–366.

Baron, J. N., & Hannan, M. T. (2002). Organizational Blueprints for Success in High-Tech Start-Ups: Lessons from the Stanford Project on Emerging Companies. *California Management Review*, *44*(3), 8–36.

Baron, R. A., & Henry, R. A. (2010). How entrepreneurs acquire the capacity to excel: Insights from research on expert performance. *Strategic Entrepreneurship Journal*, *4*, 49–65.

Bingham, C. B., & Davis, J. P. (2012). Learning Sequences: Their Existence, Effect, and Evolution. *Academy of Management Journal*.

Blank, S. (2010). Perfection By Subtraction – The Minimum Feature Set. Retrieved January 14, 2018, from https://steveblank.com/2010/03/04/perfection-by-subtraction-the-minimum-feature-set/

Blank, S. (2013a). *The Four Steps to the Epiphany* (2nd edition). K&S Ranch.

Blank, S. (2013b). Why the Lean Start Up Changes Everything. *Harvard Business Review*, *91*(5), 63–72.

Blank, S., & Dorf, B. (2012). *The startup owner's manual: The step-by-step guide for building a great company*. K&S Ranch.

Block, Z., & Macmillan, I. C. (1985). Milestones for successful venture planning. *Harvard Business Review*, 184–196.

Blosch, M., Osmond, N., & Norton, D. (2016). *Enterprise Architects Combine Design Thinking, Lean Startup and Agile to Drive Digital Innovation*. Retrieved from https://www.gartner.com/doc/3200917/enterprise-architects-combine-design-thinking

Bosch, J., Olsson, H. H., Björk, J., & Ljungblad, J. (2013). The Early Stage Software Startup Development Model: A Framework for Operationalizing Lean Principles in Software Startups. *Lean Enterprise Software and Systems*, 1–15.

Boud, D., Keogh, R., & Walker, D. (1985). *Reflection: turning experience into learning*. London & New York: Routledge Falmer.

Boyd, J. R. (1987). *A discourse on winning and losing (Report No. MU43047)*. Maxwell AFB.

Brenner, W., & Uebernickel, F. (2016). *Design Thinking for Innovation, Research and Practice*. Springer International Publishing Switzerland.

Brown, T. (2008). Design Thinking. *Havard Business Review*, (June), 84–95.

Brown, T. (2009). *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. New York: HarperBusiness.

Buchenau, M., & Suri, J. F. (2000). Experience prototyping. *Proceedings of the Conference on Designing Interactive Systems Processes, Practices, Methods, and Techniques - DIS '00*, 424–433.

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, *31*(6), 515–524.

CB Insights. (2017a). 242 Startup Failure Post-Mortems. Retrieved January 14, 2018, from https://www.cbinsights.com/research/startup-failure-post-mortem/#2017update3

CB Insights. (2017b). The Top 20 Reasons Startups Fail. Retrieved January 14, 2018, from https://www.cbinsights.com/research/startup-failure-reasons-top/

CB Insights. (2017c). Venture Capital Funnel Shows Odds of Becoming a Unicorn Are Less than 1%. Retrieved January 14, 2018, from https://www.cbinsights.com/research/venture-capital-funnel-2/

Chandler, G. N., DeTienne, D. R., McKelvie, A., & Mumford, T. V. (2011). Causation and effectuation processes: A validation study. *Journal of Business Venturing*, *26*(3), 375–390.

Chandler, G. N., & Hanks, S. H. (1993). Measuring the performance of emerging businesses: A validation study. *Journal of Business Venturing*, *8*(5), 391–408.

Chandler, G. N., & Lyon, D. W. (2001). Issues of Research Design and Construct Measurement in Entrepreneurship Research: The Past Decade. *Entrepreneurship Theory and Practice*, *25*(4), 101–113.

Chen, J., Reilly, R. R., & Lynn, G. S. (2005). The impacts of speed-to-market on new product success: The moderating effects of uncertainty. *IEEE Transactions on Engineering Management*, *52*(2), 199–212.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159.

Cooper, R. G. (1990). Stage-Gate Systems: A New Tool for Managing New Products. *Business Horizons*, *33*(3), 44–54.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.

Cross, N. (1982). Designerly ways of knowing. *Designerly Ways of Knowing*, *3*(4), 221–227.

Crowne, M. (2002). Why software product startups fail and what to do about it. Evolution of software product development in startup companies. *IEEE International Engineering Management Conference*, *1*, 338–343.

Dahan, E., & Mendelson, H. (2001). An Extreme-Value Model of Concept Testing. *Management Science*, *47*(1), 102–116.

Dawes, R. M. (1971). A case study of graduate admissions: Application of three principles of human decision making. *American Psychologist*, *26*(2), 180–188.

Deligianni, I., Voudouris, I., & Lioukas, S. (2017). Do Effectuation Processes Shape the Relationship Between Product Diversification and Performance in New Ventures? *Entrepreneurship: Theory and Practice*, *41*(3), 349–377.

Delmar, F., & Shane, S. (2003). Does business planning facilitate the development of new ventures? *Strategic Management Journal*, *24*(12), 1165–1185.

Desarbo, W. S., Di Benedetto, C. A., Song, M., & Sinha, I. (2005). Revisiting the miles and snow strategic framework: Uncovering interrelationships between strategic types, capabilities, environmental uncertainty, and firm performance. *Strategic Management Journal*, *26*(1), 47–74.

Dew, N., Read, S., Sarasvathy, S. D., & Wiltbank, R. (2009). Effectual versus predictive logics in entrepreneurial decision-making: Differences between experts and novices. *Journal of Business Venturing*, *24*(4), 287–309.

Dewar, R. D., & Dutton, J. E. (1986). The Adoption of Radical and Incremental Innovations : An Empirical Analysis. *Management Science*, *32*(11), 1422–1433.

Diamantopoulos, A., & Winklhofer, H. M. (2001). Index Construction with Formative Indicators: An Alternative to Scale Development. *Journal of Marketing Research*, *38*(2), 269–277.

Dillman, D. (1978). Constructing Telephone Questionnaires. In *Mail and Telephone Surveys: The Total Design Method* (pp. 200–231). New York: Wiley & Sons.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2008). *Internet, mail, and mixed-mode surveys: The tailored design method*. *Internet Mail and MixedMode Surveys The tailored design method* (3rd ed.). John Wiley & Sons.

Dybå, T., & Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and Software Technology*, *50*(9–10), 833–859.

Dyer, J. H., & Furr, N. (2014). *The Innovator's Method. Bringing the Lean Start-up into Your Organization.* Boston, MA: Harvard Business Review Press.

Edison, H. B. (2015). A Conceptual Framework of Lean Startup Enabled Internal Corporate Venture. In P. Abrahamsson, L. Corral, M. Oivo, & B. Russo (Eds.), *Product-Focused Software Process Improvement* (Vol. 9459, pp. 607–613). Springer International Publishing Switzerland 2015.

Eisenmann, T., Ries, E., & Dillard, S. (2011). Hypothesis-Driven Entrepreneurship : The Lean Startup. *Harvard Business School Entrepreneurial Management Case No. 812–095*, 1–26.

Ernst, H. (2002). Success Factors of New Product Development: A Review of the Empirical Literature. *International Journal of Management Reviews*, *4*(1), 1–40.

Ernst & Young GmbH Wirtschaftsprüfungsgesellschaft. (2017). Start-up-Barometer Deutschland.

Evanschitzky, H., Eisend, M., Calantone, R. J., & Jiang, Y. (2012). Success factors of product innovation: An updated meta-analysis. *Journal of Product Innovation Management*, *29*(1994), 21–37.

Fagerholm, F., Sanchez Guinea, A., Mäenpää, H., & Münch, J. (2017). The RIGHT model for Continuous Experimentation. *Journal of Systems and Software*, *123*, 292–305.

Field, A. P. (2013). *Discovering statistics using SPSS (and sex and drugs and rock "n" roll)* (3rd Edition). Sage Publications.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39.

Fowler, F. J. (2009). *Survey research methods*. *Applied social research methods series*. Sage Publications Inc.

Frederiksen, D. L., & Brem, A. (2017). How do entrepreneurs think they create value? A scientific reflection of Eric Ries' Lean Startup approach. *International Entrepreneurship and Management Journal*, *13*(1), 169–189.

Frese, M. (2009). Towards a Psychology of Entrepreneurship: An Action Theory Perspective. *Foundations and Trends® in Entrepreneurship*, *5*(6), 437–496.

Gartner, W. (1985). A conceptual framework for describing tha phenomenon of new venture creation. *Academy of Management Review*, *10*(4), 696–706.

Gatignon, H., Tushman, M. L., Smith, W., & Anderson, P. (2002). A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type, and Characteristics. *Management Science*, *48*(9), 1103–1122.

Gemmell, R. M., Boland, R. J., & Kolb, D. A. (2012). The socio-cognitive dynamics of entrepreneurial ideation. *Entrepreneurship: Theory and Practice*, *36*(5), 1053–1073.

Giardino, C., Wang, X., & Abrahamsson, P. (2014). Why Early-Stage Software Startups Fail : A Behavioral Framework. *International Conference of Software Business*, 27–41.

Giones, F., & Brem, A. (2017). Digital Technology Entrepreneurship : A Definition and Research Agenda. *Technology Innovation Management Review*, *7*(5), 44–51.

Girgenti, A., Pacifici, B., Ciappi, A., & Giorgetti, A. (2016). An Axiomatic Design Approach for Customer Satisfaction through a Lean Start-up Framework. *Procedia CIRP*, *53*, 151–157.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, (1992), 82–88.

Griffin, A., & Hauser, J. (1993). The Voice of the Customer. *Marketing Science*, *12*(1), 1–27.

Griffith, E. (2014). Why startups fail, according to their founders. Retrieved January 14, 2018, from http://fortune.com/2014/09/25/why-startups-fail-according-to-their-founders/

Gruber, M. (2007). Uncovering the value of planning in new venture creation: A process and contingency perspective. *Journal of Business Venturing*, *22*(6), 782–807.

Guadagnoli, E., & Velicer, W. F. (1988). Relation to sample size to the stability of component patterns. *Psychological Bulletin*, *103*(2), 265–275.

Guest, D. (1992). Right enough to be dangerously wrong: an analysis of the In Search of Excellence phenomenon. *Human Resource Strategies*, 5–19.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate Data Analysis*. *Prentice-Hall, Inc* (Seventh Ed). Pearson education.

Hakim, C. (2000). *Research Design: Successful Designs for Social and Economic Research* (2nd edn). London: Routledge.

Harms, R., Marinakis, Y., & Walsh, S. T. (2015). Lean startup for materials ventures and other science-based ventures: under what conditions is it useful? *Translational Materials Research*, *2*(3), 35001.

Harper, D. A. (1999). How entrepreneurs learn: a Popperian approach and its limitations. *Research in Strategy, Process and Economic Organization, Department of Industrial Economics and Strategy*, 1–28.

Henard, D. H., & Szymanski, D. M. (2001). Why Some New Products Are More Successful Than Others. *Journal of Marketing Research*, *38*(3), 362–375.

Herrington, M., & Kew, P. (2017). *The Global Entrepreneurship Monitor: Global report 2016/2017*. Wellesley, MA.

Hinkin, T. (1995). A review of scale development practices in the study of organizations. *Journal of Management*, *21*(5), 967–988.

Hmieleski, K. M., & Corbett, A. C. (2006). Proclivity for improvisation as a predictor of entrepreneurial intentions. *Journal of Small Business Management*, *44*(1), 45–63.

Holm, H. J., Opper, S., & Nee, V. (2013). Entrepreneurs Under Uncertainty: An Economic Experiment in China. *Management Science*, *59*(7), 1671–1687.

Honig, B., & Hopp, C. (2016). New venture planning and Lean Start-up activities: A longitudinal empirical study of entrepreneurial success, founder preferences and venture context. In *Models of Start-up Thinking and Action: Theoretical, Empirical, and Pedagogical Approaches Advances in Entrepreneurship, Firm Emergence and Growth* (pp. 75–108).

Houde, S., & Hill, C. (1997). *What do Prototypes Prototype?* (T. Landauer & P. Prabhu, Eds.)*Handbook of Human-Computer Interaction*. Amsterdam: Elsevier B.V.

Huang, C.-C., Wang, Y.-M., Wu, T.-W., & Wang, P.-A. (2013). An Empirical Analysis of the Antecedents and Performance Consequences of Using the Moodle Platform. *International Journal of Information and Education Technology*, *3*(2), 217–221.

Hyder, S., & Lussier, R. N. (2015). Why businesses succeed or fail: a study on small businesses in Pakistan. *Journal of Enterpreneurship in Emerging Economies*, *7*(2), 148–167.

Jarvis, C. B., Mackenzie, S. B., & Podsakoff, P. M. (2003). A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research. *Journal of Consumer Research*, *30*(2), 199–218.

Jaworski, B. J., & Kohli, A. K. (1993). Market Orientation: Antecedents and Consequences. *Journal of Marketing*, *57*(July 1993), 53–70.

Kakati, M. (2003). Success criteria in high-tech new ventures. *Technovation*, *23*(5), 447–457.

Kerai, A. (2017). Role of Unicorn tag in gaining legitimacy and accessing funds. *The Business and Management Review*, *9*(2), 119–127.

Kerr, W. R., Nanda, R., & Rhodes-Kropf, M. (2014). Entrepreneurship as Experimentation. *Journal of Economic Perspectives*, *28*(3), 25–48.

Kim, Y., & Vonortas, N. S. (2014). Managing risk in the formative years: Evidence from young enterprises in Europe. *Technovation*, *34*(8), 454–465.

Knight, F. H. (1921). *Risk, Uncertainty and Profit*. Boston, MA: Houghton Mifflin.

Kolb, D. A. (1984). *Experiential Learning: Experience as a Source of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall.

Kollmann, T., Hensellek, S., & Kensbock, J. (2016). *European Startup Monitor*.

Kollmann, T., Stöckmann, C., Hensellek, S., & Kensbock, J. (2017). *Deutscher Startup Monitor 2017*.

Kozbelt, A., Beghetto, R., & Runco, M. (2010). Theories of Creativity. In J. Kaufman & R. Sternberg (Eds.), *Cambridge Handbook of Creativity* (pp. 20–47). New York: Cambridge University Press.

Krüger, C., Borgmann, L., Antonik, T., & Meyer, A.-K. (2012). Datenauswertung mit SPSS. technische universität dortmund, Zentrum für Hochschulbildung.

Kumar, N., Stern, L. W., & Anderson, J. C. (1993). Conducting Interorganizational Research Using Key Informants. *Academy of Management Journal*, *36*(6), 1633–1651.

Kuratko, D. F. (2005). The emergence of entrepreneurship education: development, trends, and challenges. *Entrepreneurship Theory and Practice*, *29(5)*, 577–598.

Ladd, T. (2016). Is Business Model Validation valid? Empirical results from a cleantech accelerator. In *United States Association for Small Business and Entrepreneurship*.

Lean Startup Circle. (2018). Innovation Courses. Retrieved March 10, 2018, from http://leanstartup.pbworks.com/w/page/51233037/InnovationCourses

Lenarduzzi, V., & Taibi, D. (2016). MVP Explained: A Systematic Mapping Study on the Definitions of Minimal Viable Product. *Proceedings - 42nd Euromicro Conference on Software Engineering and Advanced Applications, SEAA 2016*, (August), 112–119.

Lie, O. F. (2017). A Lean Startup Approach to Service Design and Mobile App Development. Retrieved January 14, 2018, from https://www.backelite.com/2017/02/lean-startup-approach-service-design-mobile-app-development/

Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill.

Lindberg, T., Meinel, C., & Wagner, R. (2011). Design Thinking : A Fruitful Concept for IT Development ? In C. Meinel, L. Leifer, & H. Plattner (Eds.), *Design Thinking: Understand – Improve – Apply* (pp. 3–18). Berlin: Springer.

Lindgren, E., & Münch, J. (2015). Software development as an experiment system: a qualitative survey on the state of the practice. *International Conference on Agile Software Development*, 117–128.

Lynn, G. S., Morone, J. G., Paulson, A. S. (1996). Marketing and Discontinuous Innovation: The Probe and Learn Process. *California Management Review*, *38*(3), 8–37.

Lynn, G., Reilly, R., & Akgun, A. (2000). Knowledge management in new product teams: practices and outcomes. *IEEE Transactions on Engineering Management*, *47*(2), 221–231.

Mansfield, E. (1988). The Speed and Cost of Industrial Innovation in Japan and the United States: External vs. Internal Technology. *Management Science*, *34*(10), 1157–1168.

March, J. G., & Sutton, R. I. (1997). Organizational Performance as a Dependent Variable. *Organization Science*, *8*(6), 698–706.

Marcus, A. (2015). Design, user experience, and usability: Design discourse: 4th international conference, DUXU 2015 held as part of HCI international 2015 Los Angeles, CA, USA, August 2-7, 2015 proceedings, part I. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *9186*, 356–367.

Maurya, A. (2010). *Running Lean* (1st ed.). O'Reilly and Associates.

May, B. (2012). Applying lean startup: An experience report - Lean & lean UX by a UX veteran: Lessons learned in creating & launching a complex consumer app. *Proceedings - 2012 Agile Conference, Agile 2012*, 141–147.

McClure, D. (2007). Startup metrics for pirates: AARRR! Retrieved March 5, 2018, from http://500hats.typepad.com/500blogs/2007/09/startup-metrics.html

McGrath, R. G. (2010). Business models: A discovery driven approach. *Long Range Planning*, *43*(2–3), 247–261.

Mcgrath, R. G., & Macmillan, I. C. (1995). Discovery Driven Planning : Turning Conventional Planning on its Head. *Harvard Business Review*, *73*(4), 44–54.

McKelvie, A., Haynie, J. M., & Gustavsson, V. (2011). Unpacking the uncertainty construct: Implications for entrepreneurial action. *Journal of Business Venturing*, *26*(3), 273–292.

McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review*, *31*(1), 132–152.

Mezirow, J. (2000). *Learning as transformation: Critical Perspectives on a Theory in Progress*. San Francisco: Jossey-Bass.

Milliken, F. J. (1987). Three Types of Perceived Uncertainty About the Environment: State, Effect, and Response Uncertainty. *Academy of Management Review*, *12*(1), 133–143.

Minniti, M., & Bygrave, W. (2001). A Dynamic Model of Entrepreneurial Learning. *Entrepreneurship: Theory & Practice*, *25*(3), 5.

Mintzberg, H., & Waters, J. A. (1985). Of Strategies , Deliberate and Emergent. *Strategic Management Journal*, *6*(3), 257–272.

Mishra, A. A., & Shah, R. (2009). In union lies strength: Collaborative competence in new product development and its performance effects. *Journal of Operations Management*, *27*(4), 324–338.

Misra, S., Kumar, V., Kumar, U., Fantazy, K., & Akhter, M. (2012). Agile software development practices: evolution, principles, and criticisms. *International Journal of Quality & Reliability Management*, *29*(9), 972–980.

Mitchell, J. R., Mitchell, R. K., Mitchell, B. T., & Alvarez, S. A. (2012). Opportunity creation, underlying conditions and economic exchange. In A. C. Corbett & J. A. Katz (Eds.), *Advances in Entrepreneurship, Firm Emergence and Growth: Entrepreneurial Action* (Vol. 14, pp. 89–123). Bingley, UK: Emerald Group Publishing.

Moogk, D. R. (2012). Minimum Viable Product and the Importance of Experimentation in Technology Startups. *Technology Innovation Management Review*, *2*(March), 23–26.

Moore, W. L. (1982). Concept testing. *Journal of Business Research*, *10*(3), 279–294.

Moriarty, R., & Kosnik, T. (1989). High-Tech Marketing : Concepts , Continuity , And Change. *Sloan Management Review*, *30*(4), 7–17.

Morris, M. H. (1998). *Entrepreneurial Intensity: Sustainable Advantages for Individuals, Organizations and Societies*. Westport, Connecticut: Quorum Books.

Mullins, J., & Komisar, R. (2009). *Getting to Plan B: Breaking Through to a Better Business Model*. *Harvard Business Review Press*.

Nahm, F. S. (2016). Nonparametric statistical tests for the continuous data: The basic concept and the practical use. *Korean Journal of Anesthesiology*, *69*(1), 8–14.

Naumann, J. D., & Jenkins, A. M. (1982). Prototyping : The New Paradigm for Systems Development Prototyping : The New Paradigm for Systems Development. *MIS Quarterly*, *6*(3), 29–44.

Neck, H. M., & Greene, P. G. (2011). Entrepreneurship Education : Known Worlds and Frontiers. *Journal of Small Business Management*, *49*(1), 55–70.

Nguyen Duc, A., & Abrahamsson, P. (2016). Minimum Viable Product or Multiple Facet Product? The Role of MVP in Software Startups. In H. Sharp & T. Hall (Eds.), *Agile Processes in Software Engineering and Extreme Programming* (pp. 118–130). Springer International Publishing.

Nientied, P. (2015). Polis University as Lean Startup Innovation. *International Business Research*, *8*(5), 19–29.

Norman, D. A. (2002). *The Design of Everyday Things*. (3rd edition, Ed.). New York: Basic Books.

Nunnally, J. (1978). *Psychometric Theory*. *New York: McGraw-Hill*.

O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality and Quantity*, *41*(5), 673–690.

OECD. (2017). *Entrepreneurship at a Glance 2017*. Paris.

Osterwalder, A. (2017). How To Test Your Idea: Start With The Most Critical Hypotheses. Retrieved January 14, 2018, from http://blog.strategyzer.com/posts/2017/5/2/how-to-test-your-idea-start-with-the-most-critical-hypotheses

Osterwalder, A., & Pigneur, Y. (2005). Clarifying Business Models : Origins , Present , and Future of the Concept Clarifying Business Models : Origins , Present , and Future of the Concept. *Communications of the Association for Information Systems*, *15*(May), 1–125.

Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2014). *Value proposition design*. *Strategyzer series*.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: origins, present, and future of the concept. *Communications of the Association for Information Systems*, *15*(1), 1–43.

Patel, N. (2015). 90% of Startups Fail: Here's What You Need To Know About The 10%. Retrieved January 14, 2018, from https://www.forbes.com/sites/neilpatel/2015/01/16/90-of-startups-will-fail-heres-what-you-need-to-know-about-the-10/#4dd9a90b6679

Patz, M. (2013). *Lean Startup – Adding an Experimental Learning Perspective to the Entrepreneurial Process*.

Piaget, J. (1974). *Der Aufbau der Wirklichkeit beim Kinde*. Klett-Cotta.

Pittsburg's Future. (2018). Supporting Entrepreneurs. Retrieved March 4, 2018, from http://www.pittsburghfuture.com/innovation/entrepreneurs.html

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, *88*(5), 879–903.

Podsakoff, P. M., & Organ, D. W. (1986). Self-Reports in Organizational Research: Problems and Prospects. *Journal of Management*, *12*(4), 531–544.

Popowska, M., & Nalepa, P. (2015). Lean Startup as a New Way of Managing Technology Ventures Illustrated by the Example of Wlcome App, *2015*(19), 7–21.

Porter, M. E. (1998). Clusters and the New Economics of Competition. *Harvard Business Review*, (November-December), 77–90.

Raatikainen, M., Komssi, M., Kiljander, H., Hokkanen, L., Märijärvi, J., & Mohout, O. (2016). Eight Paths of Innovations in a Lean Startup Manner: A Case Study. *Springer International Publishing*, *LNCS 10027*, 15–30.

Rasmussen, T., & Øxseth, S. (2016). *Playing Lean: Gamification of the Lean Startup Methodology*.

Richter, C., Kraus, S., Brem, A., Durst, S., & Giselbrecht, C. (2017). Digital entrepreneurship: Innovative business models for the sharing economy. *Creativity and Innovation Management*, *26*(3), 300–310.

Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses*. New York, NY: Crown Books.

Rodriguez, A., & Rodriguez, Y. (2015). Metaphors for today's leadership: VUCA world, millennial and "Cloud Leaders." *Journal of Management Development*, *34*(7), 736–751.

Rogelberg, S. G., & Stanton, J. M. (2007). Introduction: Understanding and Dealing With Organizational Survey Nonresponse. *Organizational Research Methods*, *10*(2), 195–209.

Rogers, E. M. (1983). *Diffusion of innovations*. *New York : Free Press ; London : Collier Macmillan Publishers* (Third Edit).

Rübling, S. (2016). How lean is a startup? Development and validation of a scale for measuring the leanness. In *Proceedings of the BKERC*. Bodo, Norway.

Rudd, J., Stern, K., & Isensee, S. (1996). Low vs. high-fidelity prototyping debate. *Interactions*, *3*(1), 76–85.

Salerno, M. S., Oliveira, D., Sergio, M., Augusto, L., Gomes, D. V., Oliveira, D., … Uchôa, T. (2015). Innovation processes : Which process for which project ?, *35*, 59–70.

Satell, G. (2017). This Program Uses Lean Startup Techniques to Turn Scientists into Entrepreneurs. Retrieved January 14, 2018, from https://hbr.org/2017/03/this-program-uses-lean-startup-techniques-to-turn-scientists-into-entrepreneurs

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for Business Students Fifth Edition*. Essex: Pearson Education Limited.

Schumpeter, J. (1934). *Capitalism, socialism, and democracy*. New York: Harper & Row.

Scott, M., & Bruce, R. (1987). Five stages of growth in small business. *Long Range Planning*, *20*(3), 45–52.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *The Academy of Management Review*, *25*(1), 217–226.

Spain, A. (2017). Das nächste 100-Milliarden-Startup? Made in Germany! Retrieved January 14, 2018, from https://www.deutsche-startups.de/2017/08/23/das-naechste-100-milliarden-startup-made-germany/

Sposito, V. A., Hand, M. L., & Skarpness, B. (1983). On the efficiency of using the sample kurtosis in selecting optimal lpestimators. *Communications in Statistics - Simulation and Computation*, *12*(3), 265–272.

Starbuck, W. H., & Mezias, J. M. (1996). Opening Pandora's box: Studying the accuracy of managers' perceptions. *Journal of Organizational Behavior*.

Startup Genome. (2017). *Global Startup Ecosystem Report 2017*. Retrieved from https://startupgenome.com

Sull, D. N. (2004). Disciplined Entrepreneurship. *MIT SLOAN MANAGEMENT REVIEW*, 71–77.

Sykes, H. B., & Dunham, D. (1995). Critical assumption planning: A practical tool for managing business development risk. *Journal of Business Venturing*, *10*(6), 413–424.

t3n. (2015). „Play fast, break things!" – Mittels Brettspiel zum Lean Startup. Retrieved January 14, 2018, from https://t3n.de/news/lean-startup-brettspiel-playing-lean-608536/

Tanev, S., Rasmussen, E. S., Zijdemans, E., Lemminger, R., & Svendsen, L. L. (2015). Lean and Global Technology Start-Ups: Linking the Two Research Streams. *International Journal of Innovation Management*, *19*(3), 1–41.

Thomke, S. H. (1998). Managing Experimentation in the Design of New Products. *Management Science*, *44*(6), 743–762.

Trimi, S., & Berbegal-Mirabent, J. (2012). Business model innovation in entrepreneurship. *International Enterprise Management Journal*, *8*(4), 449–465. Retrieved from file:///Users/iDanny/Documents/MMM/Literature/Trimi, Berbegal-Mirabent - 2012 - Business model innovation in entrepreneurship.pdf

Trochim, W. M. K. (2000). *The Research Methods Knowledge Base. Atomic Dog Publishing, Cincinnati, OH.*

Tyrväinen, P., & Saarikallio, M. (2015). Metrics Framework for Cycle-Time Reduction in Software Value Creation: Adapting Lean Startup for Established SaaS Feature Developers. In R. Oberhauser, L. Lavazza, H. Mannaert, & S. Clyde (Eds.), *The Tenth International Conference on Software Engineering Advances* (pp. 220–227).

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wall, T. D., Michie, J., Patterson, M., Wood, S. J., Sheehan, M., Clegg, C. W., & West, M. (2004). On the Validity of Subjective Measures of Company Performance.

Personnel Psychology, *57*(1), 95–118.

Wimmer, J. (2016). *Unravelling the entrepreneurial process: Exploring the role of business models in opportunity-creation*.

WIRED. (2017). Dieses Berliner Auto-Startup ist jetzt 2,5 Milliarden Euro wert. Retrieved January 14, 2018, from https://www.wired.de/collection/business/berlin-auto-startup-2-5-milliarden-euro-auto1-group

Yadav, N., Swami, S., & Pal, P. (2006). High Technology Marketing: Conceptualization and Case Study. *Vikalpa*, *31*(2), 57–75.

York, J. L., & Danes, J. E. (2014). Customer development, innovation, and decision-making biases in the Lean Startup. *Journal Os Small Business Strategy*, *24*(2), 21–39.

Zahra, S. A., Ireland, R. D., & Hitt, M. A. (2000). International Expansion By New Venture Firms: International Diversity, Mode of Market Entry, Technological Learning, and Performance. *Academy of Management Journal*, *43*(5), 925–950.

Appendix

Appendix 1 Survey Instrument

UNIVERSITY OF TWENTE.

Survey Questionnaire Lean Startup Orientation

Venture: ______________________

Founding Year: ___________________

Based in which city? ______________

Size of the company: How many persons work for your venture full-time equivalent (including you)? ______________

Your Business is

- ◯ B2C
- ◯ B2B
- ◯ Other (please specify)

What kind of technology you developed in your business?

- ◯ Software
- ◯ App
- ◯ Web application
- ◯ Website
- ◯ Other (please specify)

How far are you with building a business around this technology?

- ◯ Idea Development: We created the idea for the company and beginning of prototype development.
- ◯ Startup: We created the 1st generation product / service with initial market testing.
- ◯ Early growth: We refined the product / service & having sales to early adopters.
- ◯ Rapid growth: We have accelerated growth & customer adoption.
- ◯ Maturity: We have an established customer base and flattening growth.

Think about your **last project** when you developed software, an app, web application and so on. Looking back at this project, judge the statements given in the next pages concerning the process and actions you applied to develop your digital product / service.

	strongly disagree	slightly disagree	neutral	slightly agree	strongly agree
Our product/service was a minor improvement over the previous technology (reverse coded).	☐	☐	☐	☐	☐
Our product/service was a breakthrough innovation.	☐	☐	☐	☐	☐
Our newly developed product/service was difficult to replace with a substitute using older technology.	☐	☐	☐	☐	☐
Our product/service represented a major technological advance.	☐	☐	☐	☐	☐
In our kind of business, customers' product/service preferences change quite a bit over time.	☐	☐	☐	☐	☐
Our customers tend to look for new products/services all the time.	☐	☐	☐	☐	☐
New customers tend to different have product/service-related needs that our existing customers.	☐	☐	☐	☐	☐

It is very easy (difficult) to predict any changes in our marketplace (reverse coded).	☐	☐	☐	☐	☐
What was the level of 'newness' or uncertainty of the technology involved in this new product / service development? (1=well established, known technology; 5=very new technology)	☐	☐	☐	☐	☐
What was the level of complexity of the technology involved in this new product / service development? (1=relatively simple technology, 5=very complex technology)	☐	☐	☐	☐	☐
How would you describe the technology shifts for the technologies used in this new product / service development project? (1=very stable/predictable, 5= very rapid change and uncertain)	☐	☐	☐	☐	☐
Technological changes in our industry are frequent.	☐	☐	☐	☐	☐
We formulated a series of hypotheses about what the market needs and how best to deliver it.	☐	☐	☐	☐	☐
We translated the vision about our product / service and its value proposition into falsifiable hypotheses.	☐	☐	☐	☐	☐
Among all the hypotheses in our business model, we tested and validated the riskiest assumptions first.	☐	☐	☐	☐	☐
We (rarely) frequently design experiments to test hypotheses on our business model (reverse coded).	☐	☐	☐	☐	☐
It is important to gain deep market insight (= talking directly to customers) to better understand our customer's problem.	☐	☐	☐	☐	☐
When we developed the solution we never (always) had the customer in mind (reverse coded).	☐	☐	☐	☐	☐
We invested significant effort in understanding of the problem and learning about the user and its social context.	☐	☐	☐	☐	☐
It is important to gain a deep insight (= talking directly to customers) into how our solution solves the customer problem.	☐	☐	☐	☐	☐
We tested assumptions about our new product/service from the beginning with potential customers.	☐	☐	☐	☐	☐
We took an experimental approach that relied on frequent trial and error to find the right product solution.	☐	☐	☐	☐	☐
We didn't test our product/service with potential customers before commercializing to the market (reverse coded).	☐	☐	☐	☐	☐
We frequently design and run experiments on elements of our business model.	☐	☐	☐	☐	☐

We used prototyping to test key assumptions about technical viability.	☐	☐	☐	☐	☐
Our customers rarely (frequently) interacted with prototypes during the development process (reverse coded).	☐	☐	☐	☐	☐
We used prototypes to validate specific product/service features and business model specifications.	☐	☐	☐	☐	☐
In developing the product/service we aim to use the simplest way to build and test our requested product features.	☐	☐	☐	☐	☐
We used metrics to measure the impact of product/service improvements on customer behavior.	☐	☐	☐	☐	☐
We didn't use data driven tests to improve our human judgement and overall decision making (reverse coded).	☐	☐	☐	☐	☐
We validated as many assumptions as possible about the viability of the product/service before expending enormous effort and financial resources.	☐	☐	☐	☐	☐
We have metrics available to test the product/service acceptance by customers and the sales performance.	☐	☐	☐	☐	☐
We used information about our gained real customers' needs in the development of the new product/service.	☐	☐	☐	☐	☐
We actively transferred information gathered from real customers to the development team.	☐	☐	☐	☐	☐
The transfer of information about customers' needs and preferences took place rarely (reverse coded).	☐	☐	☐	☐	☐
We have specific mechanisms for sharing lessons learned in our venture.	☐	☐	☐	☐	☐
The organisation's ability to learn is not considered as key to our competitive advantage (reverse coded).	☐	☐	☐	☐	☐
The basic values of our organisation include learning as key to improvement.	☐	☐	☐	☐	☐
Venture learning is an investment, not an expense.	☐	☐	☐	☐	☐
Learning in our organisation is key commodity necessary to guarantee organisational survival.	☐	☐	☐	☐	☐
We viewed new product/service development as cycles of experiments, learning and additional experiments.	☐	☐	☐	☐	☐
We didn't try many different product/service solutions before we found the right one (reverse coded).	☐	☐	☐	☐	☐

	We engaged in many trial and error processes in product/service development before we had a complete understanding of the market and technology.	☐	☐	☐	☐	☐
	We repeated the process of testing until all the key business model hypotheses have been validated	☐	☐	☐	☐	☐
	The quality of the new product/service compares well with competing offerings.	☐	☐	☐	☐	☐
	The quality of the new product/service is lower (higher) than competitor offerings (reverse coded).	☐	☐	☐	☐	☐
	Customers perceived the new product/service to be better than the competition.	☐	☐	☐	☐	☐
	Compared to our competitors, we are satisfied with the way we meet project's budget goals.	☐	☐	☐	☐	☐
	Compared to our competitors, we are satisfied with the decreased development costs using prototyping to develop new products/service.	☐	☐	☐	☐	☐
	Compared to our competitors, we are dissatisfied with our cost-efficient strategy to test and launch new products/services (reverse coded).	☐	☐	☐	☐	☐
	Our product/service is launched on or ahead of the original schedule developed at initial project go-ahead.	☐	☐	☐	☐	☐
	We are disappointed (pleased) with the time it took us from specs to full commercialization (reverse coded).	☐	☐	☐	☐	☐
	We used prototypes to enter a market before potential competitors.	☐	☐	☐	☐	☐

We would like to contact you in the future about the success of your venture development. By providing us with your email address, you agree to this. Of course, neither now nor in the follow-up survey, your identity will be disclosed.

Contact email: ____

Your Feedback

Appendix 2 Operationalisation

Construct	Definition	Literature
Independent Variables (LSO)		
Hypothesis Testing	Startup's strategy to formulate, test and validate hypotheses	Own measures based on Sykes & Dunham (1995), p.414 Eisenmann et al. (2011), p.1 Ries (2011), p.119 Eisenmann et al. (2011), p.1
Customer Orientation	Startup's willingness to understand first the market, the customer problem	Two measures adapted from Rübling (2016) Own measure based on Lindberg et al. (2011), p.8 and p.4
Experimentation	Startup's strategy to test hypotheses in an experimental approach	Honig & Hopp, (2016) p.89 Cui et al. (2017) Two measures adapted from Rübling (2016)
Prototyping	Startup's using prototypes as medium of learning and testing	Rübling 2016) , Cui et al. (2017) Tanev et al. (2015), p.9
Validation	Startup's strategy to use suitable metrics and data driven scientific tests to validate hypotheses	Two Rübling (2016) measures Own measure based on Kerr et al. (2014), p.35 and Maurya, (2010)
Knowledge Transfer	Startup's strategy to use the gained insights for the implementation in product development	Three measures Cui et al. (2017) Calantone &Cavusgil (2002), p. 520
Learning	Startup's perception of organisational learning	Four Calantone & Cavusgil (2002), p. 520
Iterative Cycles	Startup's strategy in repeated trial and error testing and working cycles to increase the learning	Three Cui et al. (2017) own measure based on Eisenmann et al. 2013, p.1
Dependent Variables Project Success		
Quality (Iron Triangle)	Perceived quality of the new product/service compared to competitors	Three measures adapted from Atuahene-Gima et al. (2006)
Cost (Iron Triangle)	Perceived budget and development costs compared to competitors	own measures based on Mishra & Shah, (2009); Naumann and Jenkins. (1982), p.38; Atkinson (1999)
Time (Iron Triangle)	Perceived satisfaction with development time	Two measures adapted from Lynn et al. (2000) One own measure based on Tanev et al. (2015), p.12
Moderator Variable		
Innovation Degree	Radicalness of the Innovation: Incremental/radical	Gatignon et al., (2002)
Market Uncertainty	Perceived Market uncertainty	Jaworski & Kohli (1993) and Desarbo et al. (2005)
Technology Uncertainty	Perceived Technology uncertainty	Jaworski & Kohli (1993) and Desarbo et al. (2005)
Business	B2B / B2C or both	
Control Variables		
Size	Number of the team/employees	
Venture Stage	Stages such as idea development, startup, early growth, rapid growth, maturity	
Descriptive Variables		
Founding Year	Age of the venture	
Digital Product / Service	Software, App, Web Application, Website, Other (please specify)	

Appendix 3 Cover letter

Lean Startup Orientation

GET READY TO LEAVE YOUR FOOTPRINT IN HISTORY! (& GET YOURSELF A COFFEE OR MATE - ENERGY TO GO!)

8%

UNIVERSITY OF TWENTE.

Dear startup founder / developer / creator of great new stuff,
my name is Mario and I'm studying MSc. Innovationmanagement & Entrepreneurship at TU Berlin and MSc. Business Administration at Universiteit Twente. Writing my master thesis about Lean Startup Orientation.

Developing successful new digital products and services is a challenging task & different approaches promise help.

My goal is to figure out which strategies from the lean startup approach are pursued the most by startups and to learn about their impact on the success & performance for the new product / service.

Learn about the Leanness of your startup by answering the questions in this survey! Takes 5-10 minutes only!

YOUR BENEFITS:

- Receive for your contribution the **insights and best practices** derived from 100 startups!

Send me an email and get your chance to:

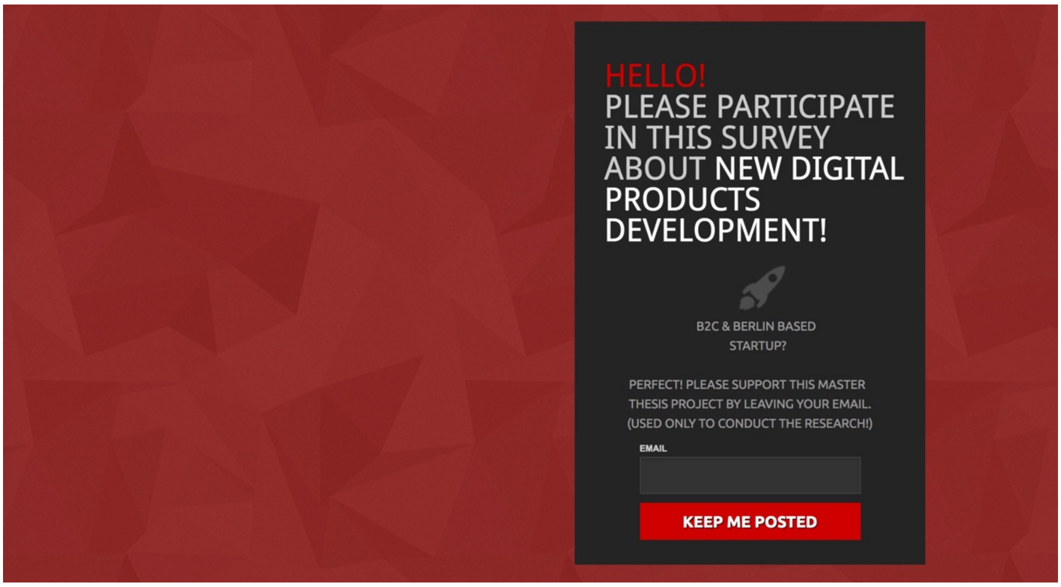
- **Win** a ticket for the Startup Camp Berlin 2018
- **Be elected** as speaker in the Young Entrepreneurs or Lean Startup Track which I will be curating at the Startup Camp Berlin 2018 (I curated the last two years the Young Entrepreneurs Track)
- **Post a job offer** on the student startup jobs Berlin Facebook page if you are looking for motivated students pushing your startup!

Thank you very much for contributing to my research project!

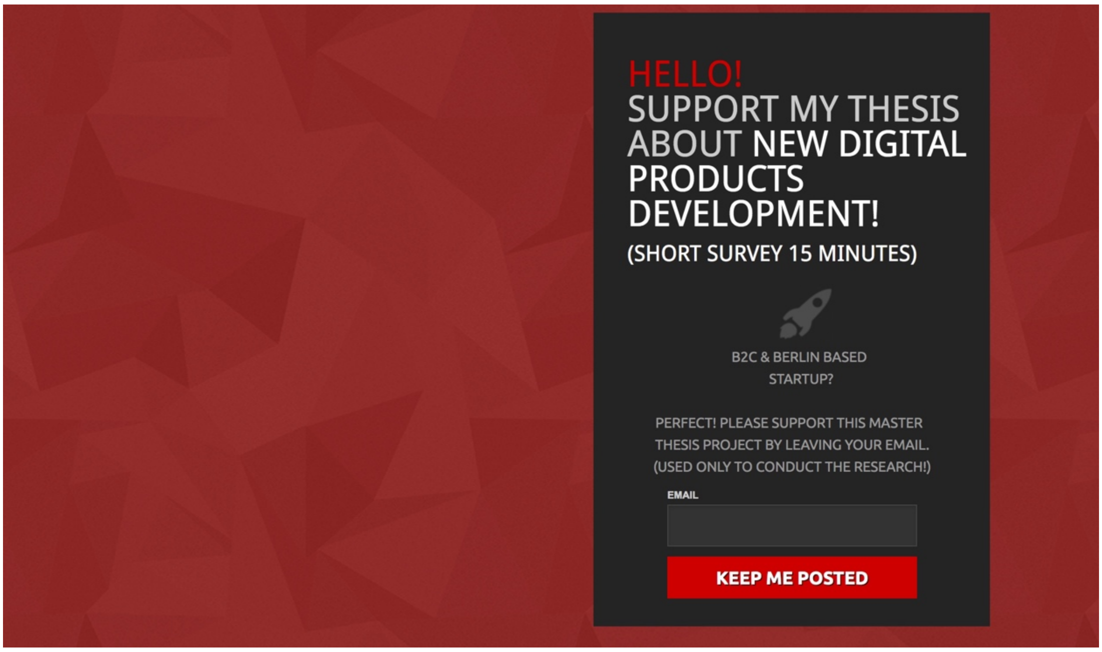
Best regards,
Mario Schwery

The research is based on your voluntary participation. The collected information is exclusively used for the purpose of this research and won't be given to any 3rd parties. The analysis will be done on an aggregated level without the connection to a single venture. For questions don't hesitate to contact me: mario.schwery@gmail.com

Appendix 4 First Landing Page



Appendix 5 Second iterated Landing Page

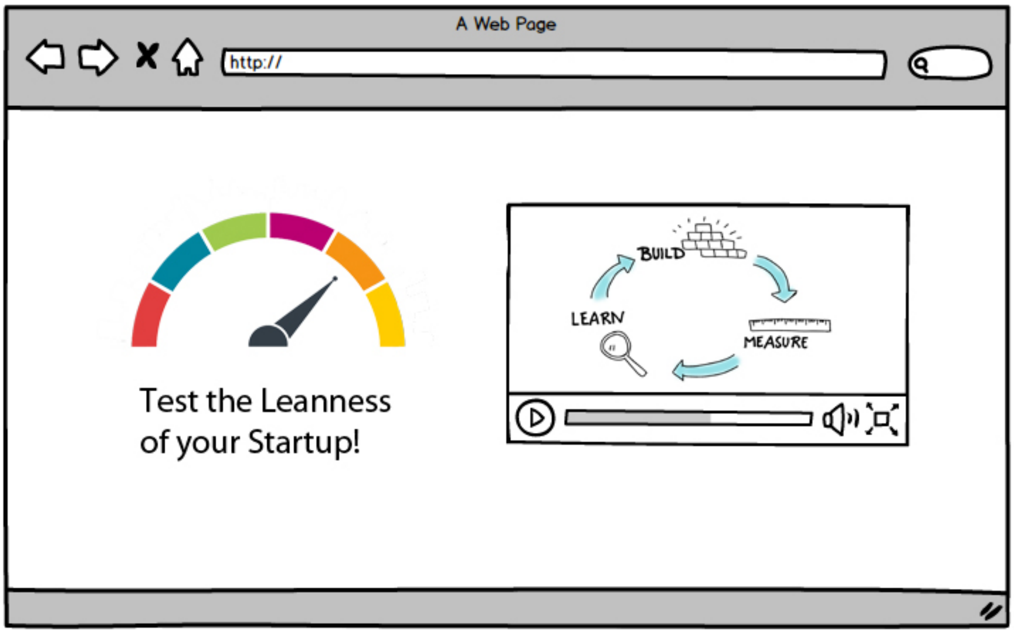


Appendix 6 Exploratory Factor Analysis

LSO Operationalisation; cross-loadings >.3 are indicated in italics (Field, 2013); ® reversed item

Iterative experimentation	IE	CO	VA	LE	HT
We viewed new product / service development as cycles of experiments, learning and additional experiments.	.597				
We did not try many different product / service solutions before we found the right one. ®	.842				
We engaged in many trial and error processes in product / service development before we had a complete understanding of the market and technology.	.768				
We repeated the process of testing until all key business model assumptions have been validated	.557				
We took an experimental approach that relied on frequent trial and error to find the right product / service solution.	.628				
We frequently design and run experiments on elements of our business model.	.623		*.305*		
Customer orientation		.962			
It is important to gain deep market insight (= talking directly to customers) to better understand our customer's problem.					
When we developed the solution we never had the customer in mind. ®		.587			
We invested significant effort into understanding the problem and learning about the user and its social context.		.588			
It is important to gain deep market insight (= talking directly to customers) into how our solution solves the customer problem.		.812	*-.308*		
Validation					
We used metrics to measure the impact of product / service improvements on customer behaviour			.712		
We didn't use data driven tests to improve our human judgement in the decision-making process. ®			.759		
We have metrics available to test the product / service acceptance by customers and the sales performance.			.737		
Learning					
The organisation's ability to learn is not considered as key to our competitive advantage. ®				.789	
The basic values of our organisation include learning as key to improvement.				.612	
Venture learning is an investment, not an expense.	*.340*			.568	
Learning in our organisation is a key commodity necessary to guarantee organisational survival.		*.471*		.490	
Hypothesis testing					
We formulated a series of assumptions about the market needs and how best to deliver it.			*.335*		.493
We translated the vision about our product / service and its value proposition into falsifiable assumptions.			*.327*		.677
We rarely designed experiments to test assumptions on our business model. ®			*.364*		.628
Our customers rarely interacted with prototypes during the development process. ®					.699

Appendix 7 Tool to evaluate the leanness of own startup



Analysis Output: Spiderplot & detailed report

- Overview about strengths, weaknesses and potential for improvement
- Concrete recommendations on how to improve the leanness of your startup
- Compare your startup with industry average
-