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Opportunity Recognition, Evaluation and Exploitation in the Context of Prototyping

A Multiple Case Study of Digital Solution Startups

by

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Abstract

This research advances the theoretical knowledge of the entrepreneurial process by investigating opportunity recognition, evaluation and exploitation in the context of prototyping. In particular, this thesis studies if, how and why the phenomenon changes the new venture creation process.

Eight in-depth, semi-structured interviews were conducted with founders of startups offering a digital solution. The multiple case study approach allowed us to gather rich data to shed light on this phenomenon mostly neglected in entrepreneurial research thus far.

Our results suggest that the context and the specificity of prototyping fundamentally change our understanding of the new venture creation process. Even though prototyping does not noticeably change the opportunity recognition phase, we see that both opportunity evaluation and exploitation are profoundly impacted by the phenomenon. Key regarding the evaluation is the increased opportunity confidence created through enhanced communication, feedback, and feasibility analyses, in the case of digital solutions accomplished through measurable data. Besides, for the context of this study, it has been found that prototypes are being exploited before the completion of the opportunity evaluation. Hence, we have seen that in the context of prototyping, the evaluation and exploitation phases are closely linked and inform each other. Lastly, this research delineates theoretical and practical implications based on our findings.

Keywords – Prototyping, Opportunity recognition, Opportunity evaluation, Opportunity exploitation, Entrepreneurial process, New venture creation process, Design Thinking, Lean Startup, Pretotyping, MVP

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“Sometimes, science is a lot more art than science. A lot of people don’t get it.” (Rick Sanchez).

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Glossary

EE	External Enabler
MVP	Minimum Viable Product
NVCP	New Venture Creation Process
NVI	New Venture Idea
OC	Opportunity Confidence
OE	Opportunity Evaluation
OR	Opportunity Recognition
OX	Opportunity Exploitation
PT	Prototyping

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1 Introduction

“Prototyping is problem-solving” (Kelley, 2001, p. 142). If this statement holds true, the phenomenon is as old as mankind itself. Nowadays, prototyping has become an increasingly crucial and innovation driving tool in the light of technological advancement. These developments arise from the fact that it is opening up new possibilities to rapidly build and test ideas in a creative process that helps to develop enhanced solutions (Brown, 2008).

Prototyping is the iterative learning process by building and testing a prototype (Kelley, 2001). A prototype can be defined as “anything tangible that lets us explore an idea, evaluate it, and push it forward” (Brown, 2009, p. 97). Hence, a prototype exhibits at least one aspect of the envisioned solution that the development team wants to learn about and has the potential to support their subsequent decision-making.

The following example derived from Ries (2011) serves to illustrate the usefulness of prototyping in startups with a focus on digital solutions:

In the early days of the American online shoe store Zappos, the founder refrained from planning and setting up the whole supply chain which would have required large upfront investments. Instead, Zappos’ founder Nick Swinmurn started with a simple experiment, taking pictures of shoes in local shops and putting them online. Only after people ordered from him, Swinmurn would buy the shoes from the retailer. By this means he verified his assumption that there is a market for buying shoes online, and in addition learned from the interaction with real customers rather than conducting costly market research.

Eric Ries’ practice-orientated Lean Startup model has changed the way new ventures emerge since its publication in 2011 (Blank, 2013). His model challenges the common paradigm of “build it and the customers will come” and proves to be more effective through customer feedback and experimentation (Ladd, 2016). The Lean Startup approach is built on early releases of prototypes as formalized experiments that should generate early paying customers (Ries, 2011). Besides this, we consider the design perspective a vital source of knowledge

regarding the underlying phenomenon. Its angle on prototyping helps to understand how the creative method can have a transforming effect on entrepreneurial opportunities, which are the source of emerging ventures, in a more systematic way (García, Deserti & Teixeira, 2013).

Hence, practice-oriented knowledge sources for entrepreneurial ventures and Design Thinking scholars have been acknowledging the value of prototyping regarding creating new ventures for many years (e.g. Müller & Thoring, 2012). Therefore, it is all the more astonishing that even though the phenomenon occurs abundantly in practice and shows clear links as well as provides support to the process of starting up entrepreneurial ventures, it received very little attention in entrepreneurship research up to this point.

All new ventures find their beginning in entrepreneurial opportunities respectively their underlying ideas (Davidsson, 2015; García, Deserti & Teixeira, 2013). This explains why entrepreneurial opportunities are one of the most researched and important fields within entrepreneurial academic literature (e.g. Davidsson, 2015; Baron, 2006; Shane & Venkataraman, 2000; Venkataraman, 1997; Angelsberger, Kraus, Mas-Tur, Roig-Tierno, 2017). Further, scholars have thoroughly examined the process those opportunities go through in the context of the emergence of new ventures (see also Davidsson, 2015; Baron & Shane, 2008). More precisely, literature to this point examined the recognition, evaluation and exploitation of entrepreneurial opportunities with a strong focus on research regarding the recognition phase (Wood & McKelvie, 2015). From now on, this shall be referred to as the New Venture Creation Process (NVCP).

To bring together the two elements, we emphasize the need to examine the phenomenon of prototyping with an entrepreneurial research lens concentrating on the construct of entrepreneurial opportunities. In that respect, it makes sense to focus on the observation of newly emerging entrepreneurial ventures, namely startups, instead of corporate entrepreneurship. Drawing from this, choosing startups has the following main advantage: The whole company revolves around one central business opportunity, which leads to the use of prototyping having implications not only for the development of a single product but the entire business model. This ensures the possibility to look at the phenomenon under less distorted conditions than it would have been the case for existing and stabilized organizations.

The purpose of this study is to contribute to the existing entrepreneurship literature by exploring the intersection between entrepreneurial opportunities and prototyping and open up

a scholarly discussion on the impact of the method during the emergence of new ventures. We aim to shed light on the impact of prototyping not only in product development but the whole new venture creation process. This leads us to the main question that our research seeks to answer in the course of this paper: *How does the process of opportunity recognition, evaluation and exploitation look like in the context of prototyping?*

Due to the nascent stage of this area within the field of entrepreneurship research, this study adopts a qualitative method employing a multiple case study approach to identify and understand if, how and why the phenomenon influences opportunity recognition, evaluation and exploitation. Our sample consists of eight founders of startups with a focus on digital solutions. However, the limitations of this research lie in the nature of this method. Although the approach provides complex information and new insights on the phenomenon at hand, the small sample size limits the generalizability of the findings.

1.1 Prototyping in Digital Solutions

Prototyping can be used in many fields of application. Frequently, it is rather thought of in connection with engineering and the development of physical products. In this research, however, the focus lies on prototyping in the context of digital solutions. This approach was inspired by one of the author's backgrounds in IT with its growing prototyping culture, for example, thanks to agile software development.

We define digital solutions startups as **newly emerged, technology-driven entrepreneurial ventures, which deliver products or services through software to their customers, which operate them on computers and/or mobile devices**. There are many possible business models in this space, such as online platforms, software as a service, or consumer applications. Besides, there are many startup success stories to name in that space, for instance, the hospitality platform-solution Airbnb, the fitness application Freeletics or the dating application Tinder.

Digital solutions were chosen for this study striving to examine the impact of prototyping on the new venture creation process since we are convinced of this context's potential to answer the proposed research question and its general nature of great interest and topicality.

An advantage of software development is that it relies on standardized tools and frameworks as well as platforms and environments, which innately leads to similar prototyping techniques. Even though we include a number of companies with different solutions and areas of business, the common denominator of digital solutions provides a certain degree of comparability between cases. In addition, the modularization of software and graphic assets in reusable components in combination with fast, automated deployments enable quick iterations of business models, which also seem to favor the use of prototyping. Consequently, digital solutions require comparably low initial investments in order to start a new venture, besides the human resources needed to contribute technical skills and knowledge.

Furthermore, digitalization and technology are a trend in today's economy and shape startup communities worldwide. As a consequence, the practical implications of this study will provide insights on the phenomenon of prototyping and how it is currently used in startups. Consequently, this research concentrates on startups in an innovative and fast-moving industry, where there is still much to be discovered. Representing a less-well explored industry, this creates many possibilities for new business concepts with the help of explorative methods such as prototyping.

1.2 Outline of the Thesis

Following this introduction, where we have laid out the theoretical gap in the field of entrepreneurial opportunities in conjunction with prototyping, we present an overview over prototyping explaining its most relevant facets regarding the entrepreneurial process as well as a definition of the phenomenon in order to lay the foundation for the following elaborations.

After that, we continue with our theoretical framework which is based on a previously conducted literature review explaining in detail the new venture creation process on the basis of the concepts of entrepreneurial opportunities and their recognition, evaluation and exploitation highlighting potential areas of interest in the context of prototyping.

Following the theoretical framework of this study, we transition into the presentation of the research methodology to account for the methods used to conduct this multiple case study research.

Then, we proceed to the illustration of this research's main empirical findings as well as their analysis and discussion in relation to the theoretical framework.

The paper will come to an end with our overall conclusion and future theoretical and practical implications.

2 The Phenomenon of Prototyping

The definition and application of prototyping vary in different contexts and scholarly fields. According to García, Deserti & Teixeira (2013) design as a discipline with expertise in innovative product and service development has untapped potential to be integrated into the entrepreneurial front-end. It offers valuable methods “to frame, build, prototype and assess business ideas” (Ibid, p. 338). Thus, we focus on prototyping from a design perspective.

First, we describe the design process with its underlying Design Thinking methods. Second, we derive the definition of a prototype and of prototyping from Design Thinking. In addition, we compare how Design Thinking literature, Savoia’s (2011) prototyping, and Ries’ (2011) Lean Startup model apply prototyping as a core element in the context of both, new venture creation, and product development.

2.1 Design Process & Design Thinking

Even though it seems intuitively wrong to associate creativity with a process perspective, the design process provides certain characteristics and methods leaving sufficient scope for creativity.

Every design process “has a beginning, a middle, and an end ... with a clear goal at the outset” (Brown, 2009). As shown in figure 2-1, the design process according to Laseau (2001) consists of two opposing, but overlapping funnels: First, the process starts with the elaboration phase. During this opportunity seeking an initial idea develops into multiple concepts and ideas with the help of exploration and divergent thinking. Second, there is the reduction phase which applies decision-making to narrow down the previously generated alternatives to a final solution.

“In design, problems and solutions co-evolve” (Dow, Glassco, Kass, Schwarz, Schwartz & Klemmer, 2010, p. 3), meaning that not only problems inform solutions, but also solution ideas redefine the problem space, leading iteratively to new solutions (Dorst & Cross, 2001

cited in Dow et al., 2010). Thus, the previously presented funnels cannot be seen as strictly linear.

This approach has been appreciated for narrowing down ideas ultimately leading to a best-fit concept (Dow et al., 2010; Laseau, 2001).

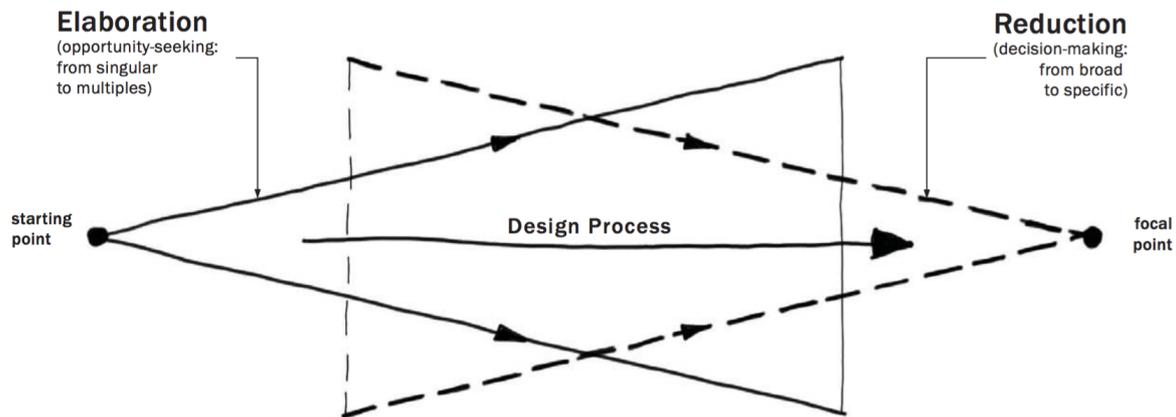


Figure 2-1: Design process according to Buxton (2007, p. 144, based on Laseau, 2001, p. 115)

The discipline **Design Thinking** summarizes how designers apply their strategies and methods and proclaim that it can be adapted to different contexts, for example, business in order to foster innovation. Design Thinking describes the design process as co-evolution of problems and solutions, cycling through the three spaces of inspiration, ideation, and implementation (Brown, 2008). Instead of only using design to beautifying the outcomes of the overall development process, the Design Thinking promotes to apply the design process and its methods already in the early front-end of the development process (Brown, 2008). Brown (2008) states that the best problem-solution-fit and highest customer value is achieved with “hard work augmented by a creative human-centered discovery process and followed by iterative cycles of prototyping, testing, and refinement.”

2.2 Prototyping

Our purpose is to study the effects of prototyping in the new venture creation process of startups offering digital solutions. Therefore, we work with with the general definition of a prototype and prototyping from Design Thinking, and blend it with Ries’ (2011) Lean Startup

model's concept of a minimum viable product (MVP) and its Build-Measure-Learn feedback loop, complemented by Savoia's (2011) prototyping, since these strategies find broad acceptance in practice. According to Müller and Thoring (2012), both strategies, Design Thinking and the Lean Startup, show many similarities and target innovations in a user-centric way. We will show that the concepts of prototyping are congruent in both disciplines and we will differentiate the scope of prototyping between the business concept and the product development, which we see as strongly interconnected in startups building their first product (Ries, 2011).

Brown (2009) states that prototyping is an “essential component of Design Thinking” (p. 94) and defines a **prototype** being “anything tangible that lets us explore an idea, evaluate it, and push it forward” (p. 97).

On the one hand prototypes guide the design exploration, supporting the divergent side in the design process, and on the other hand, prototypes are used for evaluation, informing mainly the convergent side of the design process (Brown, 2009).

“Prototypes should command only as much time, effort, and investment as is necessary to generate useful feedback and drive an idea forward. ... The goal of prototyping is not to create a working model. It is to give form to an idea to learn about its strengths and weaknesses and to identify new directions for the next generation of more detailed, more refined prototypes. A prototype should be limited” (Brown, 2009, p. 95).

Lim, Stolterman, and Tenenberg (2008) propose two key dimensions in the anatomy of prototypes: prototypes as filters and manifestation. They describe the filter dimension as limitation of a prototype to the scope of interest, which is often achieved by the resolution described with *low fidelity* (e.g. a sketch) and *high fidelity* (e.g. realistic looking interactive mockup). In addition, they define the manifestation dimension as necessary external representation such as a sketch, a (virtual) model, a website, or even a functioning product, making an idea tangible. This is important to “get a sense of eventual possibilities or limitations inherent in the idea. As an idea evolves and is refined, the need for more complex prototypes or manifestations increases” (Lim, Stolterman & Tenenberg, 2008, p. 9).

Thus, **prototyping** is an iterative method to explore a problem or test assumptions with an adequate embodiment of an idea of a possible solution (Kelley, 2001). The central outcome of a prototype is feedback, following the mantra “build to learn” (Kelley, 2001, p. 104).

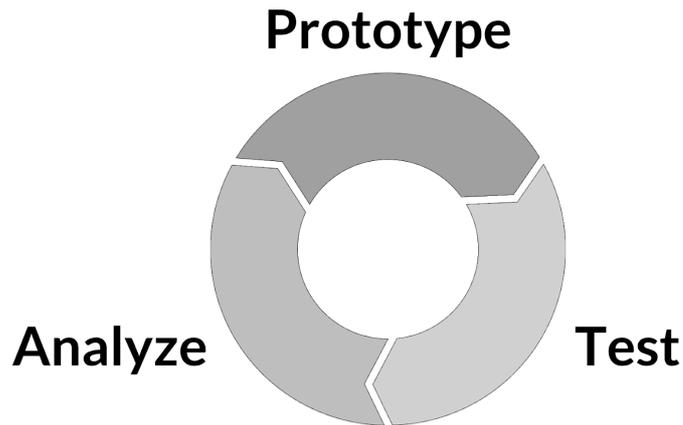


Figure 2-2: The iterative prototyping cycle (according to Brown, 2009)

The **iterative prototyping cycle** can be described as *Prototype - Test - Analyze feedback loop* (Brown, 2009). The focus is to get early qualitative feedback from users that leads to the best solution within the overlapping constraints of user's desirability, economic viability, and technical feasibility (Brown, 2009).

Design Thinking defines prototyping as a core method to converge to an optimum solution (Brown, 2009; Kelley, 2001). "You can prototype just about anything" (Kelley, 2001, p. 142), not only modeling physical products, but also services or even in a more abstract way business strategies and the launch of a full business as previously described in the introduction in the case of Zappos (Brown, 2009).

Brown (2009) already shows that Design Thinking supports prototyping in the whole new venture creation process, expanding the application of prototyping far beyond the new product development process since both processes seem to be coupled and interdependent in the emergence of a new venture.

Thus, prototyping occurs in two phases in the context of the new venture creation:

1. Testing the viability of a business idea, before
2. Developing a product or a service.

We do not see those two stages as clearly distinct processes. They are highly intertwined and depend on each other when it comes to startups building their business around their first product.

Ries' (2011) **Lean Startup** model is an innovation strategy similar to Design Thinking, aiming at digital solutions startups, and also has a prototyping element at its core (Müller & Thoring, 2012).

In line with our previously mentioned understanding that prototyping is applied in two different phases in the new venture creation, the Lean Startup captures these phases as strategy (1) and product (2), as shown in figure 2-3.

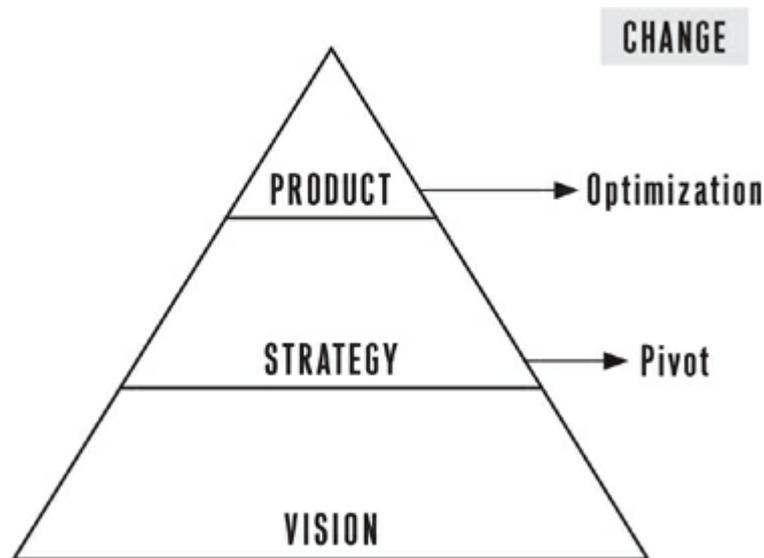


Figure 2-3: Vision informs strategy, strategy informs product (Ries, 2011)

Ries (2011) explains that startups derive a *strategy* from their vision, the general business idea concept consisting of the business model, and general ideas about the product, partners, competition, and customers. This strategy then informs the *product* development.

Regarding the validation of the business viability, the demand for a product or service, and the technical feasibility (see also Brown, 2006), both, the strategy and product need to be tested and when necessary pivoted or optimized. To do this, Ries (2011) introduces his concepts of the *Build-Measure-Learn feedback loop* and the *minimum viable product*.

With his Build-Measure-Learn feedback loop at its core, Ries (2011) suggests to rapidly enter the build phase with a minimum viable product. This MVP does not have to be a full-featured, shippable product, it can instead be seen as testing a hypothesis “with a minimum amount of effort and the least amount of development time” (Ries, 2011, p. 81), and therefore qualifies as prototyping in the scope of this thesis (see also Prototype-Test-Analyze feedback loop). Ries (2011) describes the process as iterative experimenting, so the main reason to build an

MVP is to get measurable feedback that informs a new MVP, thus constantly validating the business idea and the product.

Complementary, Savoia (2011) offers the concept of **pretotyping** to test the desirability and viability (Brown, 2006) by “building the right it before you build it right” (p. 21), leaving the test of the technical feasibility to traditional prototyping in product development. “At the time I started thinking about pretotyping I was not yet aware of Eric Ries’ great Lean Startup” (Savoia, 2011, p. 18), and therefore pretotyping supplements prototyping methods to test the business concept/idea: “Testing the initial appeal and actual usage of a potential new product by simulating its core experience with the smallest possible investment of time and money” (Savoia, 2011, p. 21). For examples of pretotyping, see appendix 8.1 table A-1.

Thus, Savoia and Ries claim that prototyping should be used to answer the question whether you are building the right product or service, before you proceed to answer the question if you are building the product right: “Unlike traditional concept tests or prototypes, they are designed to speak to the full range of business questions, not just design or technical ones” (Ries, 2011, p. 117).

3 Theoretical Framework - The Entrepreneurial Opportunity

The NVCP depends closely on the opportunities it arises out of, and the way they are discovered, evaluated and exploited (Shane & Venkataraman, 2000). It “is ... necessary to understand first how opportunities for the creation of new goods and services arise ... and second, ... how and in what ways individual differences determine whether hurdles in the process of discovering, creating and exploiting opportunities are overcome” (Venkataraman, 1997, p. 122).

The field of entrepreneurial opportunities is one of the most researched and important fields within entrepreneurial academic literature, and various definitions have been proposed for the term (e.g. Davidsson, 2015; Baron, 2006; Shane & Venkataraman, 2000; Venkataraman, 1997; Angelsberger et al., 2017; Wood and McKelvie, 2015). Baron (2006, p. 107) for instance, defines opportunities “as a perceived means of generating economic value (i.e., profit) that has not been exploited and is not currently being exploited by others”.

Davidsson’s (2015) approach of dismantling opportunities into different constructs provides the theoretical foundation of this study since he succeeded to build a sophisticated framework covering various aspects and scholarly perspectives on entrepreneurial opportunities. However, it is necessary to keep in mind that his view has been critiqued by other scholars, and requires completion with other perspectives in order to make it less susceptible (Davidsson, 2017; Wood and McKelvie, 2015).

Davidsson (2015) introduces a reconceptualization of previous definitions of entrepreneurial opportunities, by using the constructs of External Enablers (EE), New Venture Ideas (NVI) and Opportunity Confidence (OC). In this chapter, those components of entrepreneurial opportunities shall be addressed in greater detail and placed into context with prototyping. According to Wood and McKelvie (2015), besides the well-researched field of opportunity recognition, there should be a bigger focus on evaluation and exploitation in entrepreneurial

research - a need we strive to address in the underlying work in conjunction with the phenomenon of interest.

Moreover, Sarasvathy (2001) embeds opportunities within the NVCP and explains the identification and pursuit of entrepreneurial opportunities through two opposing theories: effectuation and causation. Whereas effectuating entrepreneurs focus on controlling uncertainties in an unpredictable future, in causation, they focus on the predictable aspects (Sarasvathy, 2001).

3.1 Opportunity Recognition

The crucial aspect at the beginning of the NVCP is how entrepreneurs identify opportunities for the creation of new businesses. Baron and Shane (2008, p. 68) define opportunity recognition (OR) as the “process through which individuals conclude that they have identified something new that has the potential to generate economic value, i.e., future profits”. It is a distinct, initial step which is to be distinguished from both opportunity evaluation and the exploitation through new ventures (Shane & Venkataraman, 2000). We contest the statement that OR represents a distinctive step at the beginning of the NVCP, which aligns with the principle of design that problems and solutions co-evolve (Dorst & Cross, 2001 cited in Dow et al., 2010). We argue that especially when the opportunity is subject to refinement and progress, prototyping may be used in conjunction with the initial idea and might only then lead to the recognition of a complete opportunity.

Discovery vs. Creation

There are different opinions in literature, whether entrepreneurs discover or create the opportunities they recognize. Many take the view that opportunities are discovered and exist independently of the entrepreneur (Alvarez & Barney, 2007; Shane & Venkataraman, 2000; Eckhardt & Shane, 2003). In contrast, creation builds on the view that the opportunity formation is dependent of the entrepreneur (Alvarez & Barney, 2007). This is in line with effectuation, where an entrepreneur’s vision appears to involve more than the identification and pursuit of an opportunity; it seems to include the very creation of the opportunity based on the set of means and resources available to the entrepreneur (Sarasvathy, 2001).

Drivers of Opportunity Recognition

Baron (2006) claims that there are different drivers of opportunity recognition. Therein included is the **active search** for opportunities, which is the active and carefully directed search for new information (Baron, 2006). The second is **alertness**, which “refers to the capacity to recognize opportunities when they exist” (Baron, 2006, p. 112). Moreover, **prior knowledge** gathered through life experience is mentioned as the third driver and may, for instance, include market-, industry-, or customer-knowledge (Baron, 2006). In addition to that, Baron and Shane (2008) added **social networks** as fourth OR-driver. In this respect, it has been found in research that the broader an entrepreneur’s social network is established, the more opportunities they identify (Baron & Shane, 2008). We will examine further whether prototyping supports the aforementioned drivers of OR or if it may even be seen as a distinct additional one, for instance when it occurs by chance based on pivoting an idea while prototyping (so-called ‘aha-moment’) other or multiple solutions in line with Ries (2011). Brown’s (2009, p. 95) statement, that “the prototyping process itself creates the opportunity to discover new and better ideas” supports our argumentation.

External Enablers

Davidsson's first construct to explain the emergence of entrepreneurial activities are *External Enablers*, which he describes as a “single, distinct, external circumstance, which has the potential of playing an essential role in eliciting and/ or enabling a variety of entrepreneurial endeavors by several (potential) actors”, i.e. “regulatory changes, technological breakthroughs, and demographic shifts” (Davidsson, 2015, p. 683, p. 675). We are of the opinion that prototyping cannot be seen as being an EE per se. However, technological advancement provides entrepreneurs with tools, for instance, to create wireframes, which enable them to prototype in new and arguably more efficient ways.

New Venture Ideas

The second construct, *New Venture Ideas* are “‘imagined future ventures’, i.e., imaginary combinations of product/service offerings, markets, and means of bringing these offerings into existence” and stand at the very beginning of every new venture creation process (Davidsson, 2015, p. 675).

NVIs “are the contents (but not the favorability) of what others may have called ‘opportunity recognition’, ‘opportunity identification’ or ‘(entrepreneurial) discovery’” (Davidsson, 2015,

p. 684), therefore the NVIs do not require a positive evaluation at that stage (Davidsson, 2015). They can, but do not necessarily have to, arise in response to EEs (Davidsson, 2015). The NVIs are cognitions whose characteristics can be meaningfully separated from an individual actor and be shared within a group, for example, a founding team, transferred or communicated to different actors (Davidsson, 2017). At the beginning of the entrepreneurial process, actors may identify more than one idea or variations of the same idea (Barringer & Gresock, 2008). Davidsson (2015), also in line with effectuation (Sarasvathy, 2001), suggests not to clearly formulate early-stage NVIs since they usually are subject to substantial changes.

In prototyping, actors experiment with various ideas of varying quality in order to determine the different problem-solution fits (Brown, 2008). Similar to the Lean Startup approach, prototyping is closely related to changing and advancing ideas (Ries, 2011; Blank, 2013). At this point, it still is a creative phase that does not necessarily limit efforts to those ideas that will finally be pursued (Brown, 2009; Kelley, 2001). However, we argue that the ultimate goal of prototyping within the NVCP is to produce viable business opportunities based on an NVI.

3.2 Opportunity Evaluation

The phase of opportunity evaluation is seen as “the critical bridge between recognition and exploitation” (p. 258) by Wood and McKelvie (2015) and requires a better understanding of the transition from the recognition to the exploitation phase. Thus far, entrepreneurial research covers mainly the concepts of opportunity confidence and feasibility to describe the opportunity evaluation (Wood & McKelvie, 2015; Dimov, 2010; Baron & Shane, 2008).

Opportunity Confidence

Davidsson’s third component of the opportunity construct is *Opportunity Confidence*, which refers to an “actor’s evaluation of a stimulus (External Enabler or New Venture Idea) as a basis for the creation of new economic activity” (Davidsson, 2015, p. 683; Dimov, 2010). Therefore, this construct concerns subjective perceptions of individuals about the degree of favorability - ranging from low to high - and include an assessment under conditions of uncertainty and individual perceptions of risk (Davidsson, 2015; Simon, Houghton & Aquino, 2000). In the case of a positive evaluation of the opportunity at hand, action is taken or

recommended to others as a next step in the NVCP (Davidsson, 2015). The OC construct is entirely based on the individual perception and evaluation of the actor due to differences across individuals regarding, for example, knowledge, resources and opportunities (Davidsson, 2015). Consequently, the assessment of the quality of an NVI and the OC that comes with it depends on the individual actor involved, which is the reason objectivity cannot be presumed. However, we argue that with the help of prototyping, the degree of objectivity in the evaluation of an opportunity should be improved. This is in light of the fact that the method allows to test assumptions and align interpretations of different stakeholders, for example regarding how they envision the implementation of the business opportunity (Brown, 2009; Ries, 2011).

Moreover, the degree of OC may change over time, it may serve as a reference to what extent the actors were able to reduce uncertainty (Davidsson, 2015; Dimov, 2010). “Initial assumptions and intuition are gradually replaced with experiential facts and juxtaposition of circumstances that can send the gauge in either direction” (Dimov, 2010, p. 1144).

Communication and Feedback

Davidsson states that OC can emerge from social interaction (2015; see also Dimov, 2010; Gemmell, Boland & Kolb, 2011). Wood and McKelvie (2015) claim it is necessary to expand the model of self-assessment of an idea with external influences, taking into account other stakeholders’ input. Further, Dimov (2010) states that uncertainty may be resolved by engaging with stakeholders and thereby gather relevant information and consequently lead to a more informed judgement regarding the OC. In this regard, Davidsson (2015) emphasizes the importance of adding feedback loops to the model. By adding the perspectives of different stakeholders, such as the team and customers, the core idea gains usefulness and novelty (Gemmell, Boland & Kolb, 2011). Therefore, the interaction may lead to a readjustment of the evaluation of the NVI and consequently may change the actor’s (i.e. entrepreneur, startup team) confidence in it (Davidsson, 2015). We claim that prototypes facilitate social interaction by better communicating a business idea by visualizing or demonstrating it. Thereby, different individuals’ interpretations of the underlying concept can be aligned. Further, it is one possibility to gather feedback before bringing a business fully into existence. In this thesis, we aim to study the contribution of communication with and feedback from stakeholders through iterative prototyping more thoroughly. We suppose this to have a bigger impact than suggested by existing entrepreneurial theory, as indicated by prototyping literature (e.g. Ries, 2011, Brown, 2009; Kelley, 2001).

Feasibility

Furthermore, OC is influenced by the actor's conviction that it is generally feasible. In order to achieve this result, entrepreneurs can conduct analyses, which may cover the product or service, industry and market, organizational as well as financial feasibility in order to determine, whether an NVI is workable and could involve the creation of a successful business (Baron & Shane, 2008; see also Barringer & Gresock, 2008). We expect to see in the course of this study that startups use prototyping as a method in order to test the feasibility of certain aspects of a concept or product aligning with Design Thinking's goal to find a solution within the overlapping constraints of viability, feasibility, and desirability (Brown, 2009). This is due to the fact that it allows feasibility testing in a more realistic context.

3.3 Opportunity Exploitation

The ultimate aim of entrepreneurs is to form and exploit opportunities (Alvarez & Barney, 2007; Shane and Venkataraman, 2000). This section seeks to complete the opportunity construct proposed by Davidsson (2015). The scholar did include the opportunity exploitation (OX) phase as the next logical step to the proposed opportunity construct. In the case of a positive assessment of the underlying NVI, the process transitions into a phase of action which lead to outcomes, such as the emergence of a new venture (Davidsson, 2015; Dimov, 2010). In line with that, Wood and McKelvie (2015) argue that opportunity evaluation differs from exploitation in the sense that the entrepreneur moves on from cognitions to actions. Entrepreneurs need to take an active decision to capitalize on the opportunity and choose the respective approach, for instance the creation of a startup or the sale of the opportunity (Shane and Venkataraman, 2000). The approach in exploiting an opportunity differs depending on various factors, such as the nature of the opportunity itself as well as its appropriability (Shane and Venkataraman, 2000). However, further explanations regarding the phase of OX are hardly provided (Wood and McKelvie, 2015). For this reason, it is to be determined, if and in which ways opportunity exploitation changes, and possibly is enhanced in the context of prototyping and thereby add knowledge in the area of opportunity exploitation.

The stage gate model implies that after passing through the stations of preliminary assessment, detailed investigation, development as well as testing and validation, a new

venture eventually moves on to full production and market launch (Barringer & Gresock, 2008; Cooper, 2011). In this context, the production of a prototype is classified as a part of the development and precedes the validation and commercialization of the opportunity. An opportunity only is exploited subsequently to the creation of a fully tested product or service (Barringer & Gresock, 2008). In contrast, we do not expect new ventures to complete all steps of the process thoroughly before launching their business on the market. This aligns with the statement that prototypes themselves can be considered as an early phase of opportunity exploitation when they are distributed on the market (Foss, Lyngsie & Zahra, 2013). Consequently, prototyping might have a bigger influence on the exploitation of entrepreneurial opportunities than the stage gate model implies.

Regarding OX, the entrepreneur has two options of entrepreneurial action: causation and effectuation (Sarasvathy, 2001). “Causation processes take a particular effect as given and focus on selecting between means to create that effect. Effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means” (Ibid, p. 245). Therefore, the process of causation involves planning and decision making in previously predicted situations, while the process of effectuation follows a non-linear approach assuming situations of uncertainty (Ibid).

Sarasvathy (2001) introduces four key principles of effectuation, of which three show links to the fundamentals of prototyping. First, with the principle of *affordable loss* as many strategies as possible should be explored with the given limited means, basing the entrepreneurs’ actions on the loss they can afford instead of taking future returns for granted (Sarasvathy, 2001). Brown’s (2009) Design Thinking and Ries’ (2011) Lean Startup literature propagates to build efficient prototypes that allow to test a hypothesis and learn for the next prototyping iteration, instead of overinvesting in full product development without user feedback (Brown, 2009; Ries, 2011). Second, Sarasvathy (2001) includes the *exploitation of contingencies* instead of building upon preexisting knowledge. In this context, we argue that prototyping can uncover new insights. Conversely, it can be argued that in a space where the actors dispose over full information, prototyping does not need to be applied. Third, effectuation builds upon *controlling an unpredictable future* (Ibid). Through prototyping “the founder, along with others, creates the market by bringing together enough stakeholders who ‘buy into’ the idea to sustain the enterprise” (Sarasvathy, 2001, p. 252), thus controlling uncertainty in the opportunity exploitation (OX) as far as possible. Here, we see a close relation to Blank’s (2013) customer development in lean startups that leads to iterative co-creation of prototypes

with stakeholders and therefore controlling uncertainties by taking into account the user's needs in the product development stage by further refining and optimizing the offered features and solutions according to constant feedback through prototyping.

4 Methodology

The aim of this chapter is to account for the choice of research method used for this study. This includes the description of the research design including a justification of the qualitative approach, information on the sample selection, a delineation of the limitations of the underlying method, and an outline of the data collection and analysis.

4.1 Research Design

This work takes up on existing research on entrepreneurial opportunities and how they are recognized, evaluated and exploited (e.g. Davidsson, 2015; Baron, 2006; Shane & Venkataraman, 2000; Venkataraman, 1997; Dimov, 2010; Eckhardt & Shane, 2003; Wood & McKelvie, 2015). We argue that the phenomenon of prototyping is a necessary addition to this current frame of literature since the context and the specificity of prototyping changes the understanding of the NVCP. Consequently, we aim to examine if, how and why prototyping influences the entrepreneurial process.

Quantitative and qualitative methods are best used to achieve different goals and address different kinds of questions (Maxwell, 2013). Whereas the first method aims to explain the statistical relationship between variables, the second „tends to see the world in terms of people, situations, events, and the processes that connect these; explanation is based on an analysis of how some situations and events influence others “ (Ibid, p. 98). As a consequence and due to the nature of this study, this research takes a qualitative approach well suited to identify, understand and explore meanings, contexts, processes, unanticipated phenomena as well as drawing causal explanations (Maxwell, 2013; Gemmill, Boland & Kolb, 2011).

The phenomenon of prototyping is well established in other areas of research such as product development and design. Conversely, the phenomenon has not yet been a significant part of entrepreneurship literature. However, we find many elements within our theoretical framework that attach greater potential importance of prototyping at different stages of the

entrepreneurial process. Therefore, we follow an exploratory approach, which is “typically associated with the generation of, rather than the testing of, theory” (Bryman & Bell, 2011, p. 35). This study design enables us to create a certain level of knowledge and understanding and thereby lay the groundwork for prototyping in entrepreneurship literature.

Drawing from the aforementioned, we decided to employ a multiple case study design, where each case is conducted as a complete study providing convergent evidence regarding the research question (Yin, 2009). For all cases, we follow the replication logic by using approximately identical methods and by testing conclusions drawn across cases (Yin, 2009; Bryman & Bell, 2011). Consequently, this allows us to compare the cases and bring out the commonalities and differences and thereby gain a better understanding of the phenomenon. One advantage of the case study is the possibility to gather rich data, which makes it an adequate mean to study unexplored topics without an extensive body of prior research and literature (Cornford & Smithson, 1996).

We have selected semi-structured, in-depths interviews to conduct the case studies. This approach favors a detailed and intensive analysis of a case by allowing comparisons as well as granting the necessary flexibility to explore a topic and thereby uncover the underlying motivations, beliefs, attitudes and feelings of the participant on a topic (Bryman & Bell, 2011; Malhotra & Birks, 2007). Semi-structured interviews enable to obtain both retrospective and real-time accounts by those people experiencing the phenomenon of theoretical interest, in our case prototyping in a startup and digital solutions context (Gioia, Corley & Hamilton, 2012).

4.2 Sample Selection and Argumentation

Based on our preparatory work and conviction that it would enable us to truly examine the impact of prototyping on the entrepreneurial process, we chose the startup and the digital solutions context. The main advantage of selecting startups rather than corporate entrepreneurial activities is the fact that usually, the whole company revolves around one central business opportunity, which leads to the use of prototyping having implications not only for the development of a single product but the entire business model. This ensures the

possibility to look at the phenomenon under less distorted conditions than it would have been the case for existing and stabilized organizations.

Our study follows a theoretical sampling approach since the focus lies on the refinement of ideas rather than boosting the sample size excessively (Bryman & Bell, 2011). Theoretical sampling provides the flexibility to take the most promising information sources into consideration concerning answers to the questions that arise prior to and during the analysis (Corbin & Strauss, 2008). In order to find our initial interview partners, we made use of our networks in the Skåne region (including Ideon Science Park, Lund University, Sten K. Johnson centre for entrepreneurship). Being responsive to the data we collected from our first respondents, we chose additional participants. Besides, at a later point, we included interviewees from Denmark and Germany, due to our expectations to receive new insights as a result of different surroundings and because our networks provided us with promising cases.

The selection of interview partners was based on the following three main criteria:

First of all, the intersection of prototyping with entrepreneurship literature is in a nascent stage, which makes it necessary to limit oneself to a specific part of the spectrum in order to generate meaningful research outcomes. Choosing digital solutions makes the insights more comparable, and findings can be generalized to a greater extent. The area is of the tremendous current relevance, has standardized working methods as well as the low initial resource requirements to build the business. The advantages of this area are delineated in detail in section 1.1 of this paper. Interestingly, all startups with digital solutions focus we contacted in the course of our search for participants, including the ones we ultimately did not interview, used prototyping. Therefore, it could be speculated that prototyping is very common for this type of companies.

The second criteria is that the startup's solution is already being sold. This can take several different forms, for instance, pilot projects and MVPs, which differ from the envisioned digital solution. The reason for this is that the commercialization serves as proof that the opportunity exploitation phase will be reached.

The third criteria is that the interview partner needs to be a (co-)founder and a key actor concerning prototyping and business model as well as product development. The reasoning behind this is that the interviewee should be able to provide information throughout the whole process from opportunity recognition to exploitation.

For the purpose of this study, eight entrepreneurs were interviewed. In light of our theoretical sampling, we have refrained from interviewing more entrepreneurs, because we came to believe to have reached theoretical saturation, the point “when no new categories or relevant themes are emerging” regarding a category from the data collected (Corbin & Strauss, 2008, p. 148; Bryman & Bell, 2011). Our sample provided us with answers to the questions raised both, in the theoretical framework and during the collection itself. The results showed patterns and additionally delivered deep individual insights regarding the objectives of this study.

A list of the interview partners of this study is stated in the figure below. For confidentiality purposes, the startups’ and interviewees’ identities remain undisclosed. The reason for this is our assumption that doing so, the answers would be more insightful and the entrepreneurs would share unflattering information more openly.

Table 4-1: Detailed overview over the interviewees and their startups

Company	Interviewee	Gender	Background interviewee	Product (digital solution)	Location	Status
A	Founder/CEO	Male	Technical	Health app	Sweden	Published MVP (1st version with minor updates)
B	Co-Founder	Male	Technical	Chatbot for hotel industry	Sweden	Published MVP (1st version in 2016)
C	Founder	Male	Technical	Fitness app	Denmark	Published (3rd version)
D	Founder/CEO	Female	Non-technical	Social app	Sweden	Published MVP (1st version with minor updates)
E	Co-Founder	Male	Technical	Chatbot for the rental market	Germany	MVP, remunerated pilot projects
F	Co-Founder/CTO	Male	Technical	Crawler for finding professionals online	Germany	MVP, remunerated pilot projects
G	Founder/CEO	Male	Non-technical	Parking App	Sweden	Published app 1.0 (2nd core functionality planned)
H	Founder/CEO	Male	Technical	Online platform for second hand goods	Denmark	Published MVP (1st version in 2018)

We have also considered, but rejected, the following other potential samples. First, business incubators could have been examined, being a place where prototyping takes place, and related knowledge is typically disseminated. We have disregarded this option since the prototyping approaches and requirements (i.e. between physical and digital products) could have differed significantly. Second, we contemplated the category of 3D printing. Ultimately

we chose not to concentrate on this niche, since it would have narrowed the scope significantly and this method is frequently used outside of a business context, making it inadequate to shed light on the intersection between the entrepreneurial process and the phenomenon. Third, we considered collecting our data at a startup weekend by observing the participants while working on a business opportunity. However, those participants frequently do not partake with the intention to pursue the business idea after the event, which prevents insights on the true nature of prototyping in conjunction with entrepreneurial opportunities.

4.3 Limitations of Methodology

The limitations of this study can arise from the chosen sample and the method used. Maxwell (2013, p. 383) describes validity as “the correctness or credibility of a description, conclusion, explanation, interpretation, or other sort of account“. In line with Maxwell (2013), we do not argue that our study reaches full objectivity, however, our results are useful and believable in within the context of our scope.

A small and unrepresentative **sample** might constitute a constraint for the generalizability of a study (Bryman & Bell, 2011). In light of the fact that the answers show patterns, we are confident that our findings and its outcomes reached a point of saturation and consequently are generalizable and reliable for the specific context of this study (Ibid). This is in line with Gioia, Corley and Hamilton (2012), who state that by choosing good cases, general principles can be exemplified. One might argue that the field of digital solutions might not be representative of prototyping in a startup context in general. Despite of this viable criticism, the establishment of an industry focus was necessary in order to derive comparable results, and we judge the space of digital solutions adequate based on the reasoning outlined in section 1.1.

Qualitative **methods** often are criticised for being too subjective by building upon the “researcher’s often unsystematic views about what is significant and important” (Bryman & Bell, 2011, p. 408). In our case, there is increased exposure to this limitation due to the personal embeddedness of one of the authors in the space of prototyping created through great personal and professional interest. We attempt to mitigate this limitation with the two very different profiles of the authors when it comes to their backgrounds and interests. Thereby we ensure to include facets of the phenomenon of concern to various stakeholders.

“Limitations of the case study approach include the lack of control of individual variables and the difficulty of locating causality” (Cornford & Smithson 1996, p. 60). Our research question implies that there is a causal relationship between prototyping and entrepreneurial opportunities and we naturally interpret our findings accordingly. By including the pilot study and interviews with prototyping experts, we aimed to confirm our assumptions prior to the data collection.

Regarding the data collection and analysis, potential biases caused by a process only conducted by a single interviewer were mitigated by both authors conducting the first interview round together, except for the interview with participant F. This further ensured that all crucial questions would be asked and the course of conversation not be controlled by one individual (Bryman & Bell, 2011). Further by the division into two interview phases we were able to cover all topics arising throughout all cases and complement data where necessary. In addition to that, it is possible to formulate the questions too narrow and early (Maxwell, 2013). This was obviated by the semi-structured and phased interview approach. However, we are aware that the interviewers have a big influence on the interview process and represent a limitation that cannot be fully mitigated.

4.4 Data collection and Analysis

Good qualitative research includes multiple data sources (Gioia, Corley & Hamilton, 2012). Taking this into consideration we have initiated several steps to begin this study and lay its foundation. First of all, we have undertaken a pilot study where we gained practically oriented insights on the topic from a startup founder and a prototyping practitioner. Second, we conducted an extensive review of the existing body of literature on entrepreneurial opportunities as well as prototyping. This has been particularly important in order to derive the research question of this empirical work. Third, we consulted experts in practice and research that are concerned with prototyping (e.g. researchers at Sten K. Johnson Centre for Entrepreneurship and Lunds Tekniska Hogskola; Sigma Connectivity employee; a user experience designer in a startup) throughout the whole research process.

To collect the necessary data, a qualitative approach consisting of semi-structured in-depth interviews was chosen. The aforementioned steps allowed us to develop an interview guide

(Appendix 8.2), which changed over the course of our data collection, due to new insights and upcoming questions. In addition, the collected data influenced our further choices of subsequent interview partners. All this was supported by our theoretical sampling approach.

Unlike conventional methods of sampling, the researcher does not go out and collect the entire set of data before beginning the analysis. Analysis begins after the first day of data gathering. Data collection leads to analysis. Analysis leads to concepts. Concepts generate questions. Questions lead to more data collection so that the researcher might learn more about those concepts. This circular process continues until the research reaches the point of saturation (Corbin & Strauss, 2008 , pp. 144-145).

Hence, a first round of interviews was carried out face-to-face or per video call with interviewees from eight startups based in Sweden, Germany and Denmark. The broadly targeted time frame was one hour, which in some cases has not been met, in others exceeded. All interviews were audio recorded.

After completing the interviews, the cases were split between the two authors, who transcribed them individually and developed a first interpretation of the themes, patterns and answers to the research questions. This was followed by a review of the transcript by the respective other author, who developed his/her own view on the interviewees' statements.

In a next step, the authors concluded a joint analysis of the interviews and highlighted the main themes, patterns and conclusions. Based on that, the areas with the need for further clarification have been identified. Individual interview guides for every participant were created to go into further detail in the areas of respective need.

After the completion of the first interview round with all 8 participants, a second round interview was conducted face-to-face, by phone or video call and audio-recorded. In line with the theoretical sampling, we clarified remaining points and questions that arose in retrospect based on our reflections and conversations with all interviewees and the gradual narrowing down of our research scope. We did not set a timeframe for this second conversation since we assumed that there are varying gaps in the information received from the interview partners in the first step. In addition, this occasion gave the interviewees the opportunity to reflect

upon the statements made during the first interview. We thereby ensured to cover all crucial aspects and mitigate gaps in the data collection as well as attenuate if the entrepreneurs turn out to be less responsive on one of the occasions. We repeated the transcription process described for the first interviews.

The recordings of the interviews turned out to be a crucial part of our process. First, they served a reminding function, meaning that the transcription and mapping of the contents would have hardly been possible without being able to revisit the interviews in detail. Second, listening to the interviews again at a later time with another focus helped with the identification of new topics that did not become evident during the interview itself. Third, we were constrained to conduct one first-round interview and some second-round interviews with only one interviewer, whereas the recordings enabled the non-present author to partake in the subsequent steps fully.

Based on the above, we concluded our final results and findings, which we based our analyses upon.

5 Findings & Analysis

Our empirical focus is motivated to understand the influence of prototyping on the opportunity recognition, evaluation and exploitation stages in startups offering digital solutions. In this chapter, we delineate the findings of this study, each subsequently followed by our respective analysis. An overview of the data derived from the interviews can be found in the appendices (annexe 8.3 - 8.6).

5.1 Prototyping in Digital Solution Startups

As delineated in literature review and theoretical framework, the purpose of this study is to explore the effects of prototyping on the NVCP. Due to the qualitative nature of this study, it was important to determine the participants' definition of prototyping. This lay the foundation for understanding each participant's perspective on the phenomenon. Table A-2 (annexe 8.3) summarizes each participant's definition of prototyping and shows that every participant is familiar with the concept of prototyping. For the participants, Design Thinking, the Lean Startup, and for some also pretotyping were familiar concepts, and thus they applied prototyping in their venture creation and product development.

We observed that founders with technological background and prior knowledge in programming started rather quickly to prototype. We assumed that for them it is less effort to build a high fidelity functional prototype than for non-technical founders, and thus they can cycle faster through the prototyping iterations. As interviewee H illustrates:

“I think it is easy enough to develop high fidelity prototypes. You don't waste that much more time developing high fidelity vision of what you want to see. And I think when you see it in full HD it's much easier to see where the problems are and where the success points are.”

In contrast, he further explains: *“Now even people who aren't graphic designers know how to use these tools on a basic level. And it is easy to do a high quality vision of*

what you want to do in a couple of hours. And I think it would take equally the same amount of time to do a low fidelity version, it doesn't speed up things that much."

We found out that founders can easily use prototyping tools like Sketch or InVision to design high fidelity prototypes as visualizations and mockups. In comparison to founders with the necessary technical skills to translate these prototypes in functional code by themselves, founders with missing technological skills can start quickly with designing and thereby improve the communication with developers, also leading to faster iterations. Furthermore, participant D, for instance, used such tools to build first prototypes of her idea due to the lack of programming skills, and later could apply and learn prototyping more effectively in the development process with the help of a more experienced user experience designer, which in the end saved her development costs. In comparison to technical founders we see both, ones that "start to code rather quickly" (interviewee B) with more functional prototypes and also ones who see that "starting with design is mostly to save costs ... in development", and adding that "there are things you need to code by yourself to get the feeling for the interaction" (interviewee C).

Analysis

In our sample, we observed as many different understandings of prototyping as we had participants. They all have in common the key characteristics of prototyping being experiments to test assumptions by building or sketching something tangible to get feedback for further iterations (Brown, 2009; Kelley, 2001).

Regarding product development, prototyping can compensate for the lack of technical skills to a certain degree. While founders with the ability to code seem to have an advantage, founders lacking this skill can use prototyping tools to visualize ideas and build digital mockups of their products. It is possible to construct detailed and realistic looking prototypes, that can improve the communication with stakeholders such as developers. The latest tools show a steep learning curve leading also technically inexperienced users to a usable prototype, thus mitigating potential disadvantages regarding prior knowledge and skills. These tools providing entrepreneurs with new possibilities to shape the creation of their venture could be seen as external enablers according to Baron (2006).

Furthermore, putting in the minimum effort in prototyping to achieve the necessary learning, and omitting costly development iterations where a more or less functional mockup is already sufficient, also leads to savings independent from the founder's background (Brown, 2009; Kelley, 2001).

Generally speaking, even for some founders with the necessary technical skills to develop a functional prototype a *design first* approach seems to be favorable, where others still prefer to start coding rather quickly and see big advantages or savings by omitting a distinct design phase. Other founders again see the advantages of both, designing first to save costs and being able to code to test things on a functional level. Hence, we see different approaches to prototyping, chosen according to the respective means, conceptions and capabilities available in the startups, which is in line with Sarasvathy's (2001) effectuation principles.

We conclude that these findings cannot be linked to a single distinct phase of the NVCP, but rather relate to Sarasvathy's (2001) effectuation approach, and thus, we see them as overarching effects in the NVCP in the context of prototyping.

5.2 Opportunity Recognition in the Context of PT

One central finding validated throughout all eight interviews is that **opportunity recognition does not change noticeably in the context of prototyping**. Our empirical data shows that the phenomenon cannot be clearly linked to the opportunity recognition within our sample. Rather, sources of opportunity recognition that could be observed are related to prior knowledge, experience, as well as background, an entrepreneurial mindset, external enablers et cetera.

Interviewee A, illustrating own background as source of the OR:

“My father has high blood pressure. I have gotten into the topic. I had this idea and it's matured for a long time.”

Consequently, **initial ideas and associated value propositions remained basically unchanged** throughout the new venture creation process and unaffected by the use of prototyping, even though all entrepreneurs applied prototyping methods.

Interviewee A:

“I always have an idea of what I want to reach in the back of my mind.”

Yet, we were able to observe that prototyping was used by the participants to conduct further research within the defined boundaries of the underlying NVI. Their motivations were to fully understand the customers’ problems and needs as well as refining the opportunity, mostly regarding its features and usability.

Interviewee D:

“[The characteristics] evolved, as you show [the app to] more people. People have ideas how they interpret something, what they want, what they need... Things shifted a lot. Also, I have inspiration from other apps, ... that also changes things a lot ... The concept was the same.”

Analysis

According to entrepreneurial literature, OR refers to the process through which individuals come to a conclusion to have identified a new possibility to generate economic value (Baron, 2006; Baron & Shane, 2008). Within our sample, we found that prototyping was only used after this conclusion. As a consequence, we refrain from conjecturing whether opportunities are created or discovered in the context of prototyping (see also Alvarez & Barney, 2007; Shane and Venkataraman, 2000; Eckhardt & Shane, 2003).

In addition, the interviews lay out that the overall NVIs do not change in the context of prototyping, and its use has been limited to further examinations and a better understanding of the problem space. Therefore, we were not able to link the phenomenon with entrepreneurship literature at this point.

According to the presented findings, our sample is very much related to Baron’s (2006) drivers as the sources of opportunity recognition. However, since this takes place prior to the start of prototyping within the companies, we negate our considerations that the phenomenon influenced those drivers.

Besides, we have suspected the possibility prototyping could be a distinct OR-driver itself, in case the recognition takes place by chance. The underlying assumption was “once you start drawing or making things, you open up new possibilities of discovery” (Kelley, 2001, p. 106).

According to literature, this occurs based on a well-executed exploratory process which leads to unexpected discoveries along the way (Brown, 2009; Laseau, 2001). The fact alone that prototyping starts after the initial OR is hardly surprising because an incentive is needed for an individual to take action. However, based on our review of literature, we would have expected more changes and pivots of the initially determined concepts due to the use of prototyping. Our findings indicate, however, that the initial concept keeps pointing the way throughout the entrepreneurial process. As a consequence, we reject our previous assumptions. Prototyping does not constitute a driver of OR, nor does it noticeably add to the formulation of the opportunity.

In contrast with our original assumptions, the above supports that OR in the context of prototyping represents a distinctive initial step and therefore aligns with literature which places the OR at the beginning of the NVCP. This is based on the fact that the entrepreneurs' decision to pursue the opportunity was triggered by a belief to have recognized a business opportunity prior to having prototyped anything (Shane & Venkataraman, 2000). Our sample committed to their initial concept. This is opposed to Savoia's (2011) recommendation to prototype early in order to determine whether the right solution has been chosen before transitioning into the execution.

5.3 Opportunity Evaluation in the Context of Prototyping

In the previous section, we have shown that opportunity recognition does not noticeably change in the context of prototyping. This section delineates the main findings within the subsequent evaluation stage, which indicate a central role of prototyping. Hence, we have found that our understanding of this part of the opportunity constructs as developed by Davidsson (2015; 2017) and complemented with the views of other scholars (e.g. Wood & McKelvie, 2015; Dimov, 2010) fundamentally changes in the context of prototyping. The specificity of the situation is predominantly characterized by opportunity confidence created with the help of communication, feedback and analyses of the NVI's feasibility.

Overall, the founders of our sample predominantly used prototyping in order to evaluate their business ideas. The entrepreneurs of the sample used it as an affordable mean to validate their previously conceived NVIs.

Interviewee D, illustrating gaining OC before fully developing a product:

“Prototyping is a good tool for testing your idea. Trial and error ... A step that keeps things cheaper. Trying it to some extent without developing it ... Then you have a good way to not spend a lot of money on something that doesn't work out.”

Analysis

Davidsson (2015, p. 675) states the following: “Opportunity Confidence refers strictly to a particular actor's subjective evaluation of the attractiveness - or lack thereof - of a stimulus (External Enabler or New Venture Idea) as the basis for entrepreneurial activity”. According to Davidsson (2015), subsequent actions and outcomes are affected by the evaluation of opportunity confidence. Since our participants kept working on their opportunities, they came to a favorable assessment in the context of prototyping. We propose that the phenomenon has a strong influence on the opportunity evaluation, assumably by adding clarity regarding the filter dimension of the prototype (see also Lim, Stolterman & Tenenberg, 2008). In the cases at hand, prototyping supported the OC of the founders. Possible explanations are that the underlying NVIs were of good quality innately, a negative assessment still lies in the future, or that prototyping helped the entrepreneurs to enhance the business opportunities based on the insights it provided. We have not been able to determine whether the use of prototyping accelerated the opportunity evaluation.

The degree of favorability is created through different variables for example where conclusions are drawn from, this could be for instance the actor's perceptions or a proven eventual outcome (Davidsson, 2015). We argue that prototyping is a source for OC, which is valued by entrepreneurs since it can be seen as a proven outcome of the entrepreneurial action to some extent and reliably increases objectivity by clarifying unknown variables of an opportunity.

Nevertheless, the evaluation of opportunities changes over time, especially in the case new information and insights appear (Davidsson, 2015; Dimov, 2010). However, as stated previously we could not observe a total loss of OC within our sample due to prototyping. It should be added that reasons unrelated to prototyping have been declared by founders who have previously abandoned other opportunities, such as team conflicts (interviewees E & G) or a product unable to meet customer preferences (interviewees A, E & G).

As we will show in the succeeding findings, prototyping fosters opportunity confidence by supporting communication (see section 5.3.1), providing feedback (see section 5.3.2) and enhancing feasibility analyses (see section 5.3.3).

5.3.1 Prototyping as Support for Communication

Throughout the interviews, it became evident that prototypes were used to communicate with internal and external stakeholders, such as team members, potential customers, or investors. The tangible prototypes served as a starting point for discussions. The reason for this is that in some cases, the startup's concept, product, or solution can be clarified with the help of a prototype.

Interviewee D stated the following: *"When you have feedback on something that's not tangible, it sounds more like ideas"*. She further explained that having a prototype and showing it to people helps to engage them more in the conversation and supports being taken more seriously as a company.

Interviewee F: *"Maybe you notice right now, that it is difficult to get it [the idea] across like this [through mere explanation]... In general, there are two things that help: ... One is to really show a result, so a list of profiles how we would also generate it, because there the customer can see what he gets back. The second is a clear picture of the process ... [of] the steps that he [the customer] is involved in."*

Analysis

Through our empirical results, we found that OC is created through communicating with the help of prototypes. The method allows establishing a conversation based on something tangible. A new venture typically includes various actors who are consulted during different stages of the NVCP and according to their capabilities and position (Gemmell, Boland & Kolb, 2011). This is important, since having multiple people included supports the refinement of ideas, helps to both create and process feedback and unites diverse functional knowledge (Ibid). To conclude, the participants made use of prototyping for communication purposes and thereby used the advantages it provides to include the input of various individuals.

As a consequence, our findings align with the scholarly opinion that social interaction influences the evaluation phase (Davidsson, 2015; Dimov, 2010; Gemmell, Boland & Kolb, 2012; Wood and McKelvie, 2015). We see prototypes as a catalyst for social interaction that impacts OC. In all cases at hand, prototypes facilitated social interaction by better communicating a business idea through visualization or demonstration and thereby aligning different individuals' interpretations of the underlying concept.

Even though communication within a team has been mentioned in this context, the predominant aspects most valued were customer feedback and the ability to develop a customer-centric solution. In that respect, all participants stated the importance of prototyping. Prototypes are considered a solid base for enhanced communication and are treasured by the interviewees for generating realistic and sophisticated feedback (see section 5.3.2).

5.3.2 Prototyping as Support for Feedback

For all respondents, feedback represents a central reason to prototype. Many participants were of the opinion that prototypes help to get in **early customer feedback** and thereby validate their concept while ensuring customer-centricity in the further development.

Interviewee A:

“It is important to keep the market in mind when you develop a product. We have been in an accelerator in Lund at the time and the mentors pressured us to get in feedback ... I think it is important to come up with many variations and ask if your assumptions are right. This helps to be right in the end.”

Interviewee C:

“The whole point is to once we are making mockups to present that to [the customers]... And really try to dig deep into people's emotions and feelings, and why they start training and what is motivating them.”

Founder H aimed to proof his idea for a platform-centred business concept. Over the course of five weeks, he talked to “hundreds of people”, whom he showed the following prototype: He blocked the prices for items on an online classifieds market and thereby simulated the bidding

process of the future platform. In this context, he emphasized that “simulating the experience was important”. He tested user behavior and validated the foundation of his concept, more precisely the experience the user would get from it.

Interviewee H, illustrating very early stage validation:

“I found ... that people when they shop ... know what they want and how much they are willing to pay... It's the same kind of psychology [as the platform he is now developing], just a different way”.

Nevertheless, not all participants prototyped early on to gather customer feedback. Interviewee G, for instance, stated: “Directly after our internal feedback we made an app out of it. A functional app”. External stakeholders were asked to provide feedback mostly in a later unreleased development stage. The feedback was then followed by numerous corresponding adjustments during subsequent development stages.

We have observed that with the support of prototypes **highly qualitative feedback** can be produced. This refers for example to more detailed data, which is less biased by individual perceptions.

Interviewee D, illustrating how they get feedback within their team from prototypes:

“I think it [prototyping] helps you to work out your ideas ... You can really work things out, try different things. It ... lets you take it in your hands, which is very helpful because you can see it close to its true form. I think that ...gives you a feel for what you are about to create.”

Besides, the quality of the feedback is ensured through **realistic feedback** with the support of prototypes. More precisely, high-fidelity interactive prototypes, such as MVPs create a situation close to reality rather than low-fidelity representations of the business idea such as explanations or sketches. Based on this, a different level of feedback can be reached. Additionally, this way of prototyping frequently provides the startup with measurable and quantifiable data derived from its users.

Interviewee H's team implemented Dummy-buttons on their platform indicating functionalities that were not yet coded into the platform. If their users would click on them

frequently, they found measurable evidence that users desire that new function, whereupon H's team would build it. Regarding realistic feedback, he further states that he prefers "giving them [the customers] your product and see what they do with it... If I guide people through, they could do exactly what I want them to do", and that prototyping is "Helping you get data on the way users break your site", which he regards as one of the richest information sources.

Interviewee D:

"Some things don't function unless you have multiple users doing it [the digital solution] at the same time ... Circumstances ... arise that you would never think of ... Finding those circumstances only arises when you are testing it with real people. Because you can't think of endless possibilities all the time".

Interviewee F:

"You can't test that manually, for this you need to have already build it! ... [O]nly then you get more or less realistic feedback."

Interviewee E:

"With the functional prototype we were able to test immediately whether people enter this sensitive data into the chatbot"

Excepted from the aforementioned practice of some startups to gather realistic feedback through measurable data insights provided by coded prototypes is interviewee F, whose company does not find itself at a stage yet where this approach could be applied and interviewee B, whose company does not use formal tracking yet, however the startup does observe their customers using the chatbot and therefore follow a more subjective approach to this finding.

Analysis

The findings above show that feedback has been a recurring and important theme throughout all of our interviews. For the participants of this study, it played a central role in the entrepreneurial process. This feedback ultimately is used to evaluate the underlying business opportunity and enhance it conceptually and functionally.

Even though Davidsson's (2015) perspective includes feedback loops, the impact of the **quality of the feedback** and the value of realistic and measurable feedback in our opinion is not emphasized sufficiently. Existing research acknowledges that the contact with potential customers and intermediate outcomes influence how entrepreneurs assess the opportunity (e.g. Davidsson, 2015; Dimov, 2010). Our observations in the context of prototyping and its inherent feedback are in line with Dimov (2010, p. 1124), who declares that "an opportunity is continuously re-evaluated in the light of the nascent entrepreneur's actions and their outcomes". Our sample informed its evaluation phase by the steady feedback inflow from prototypes, which creates intermediate outcomes. These results contributed to the opportunity confidence of the entrepreneurs we interviewed and in the following influenced their subsequent actions, strategies and decisions.

Concerning concept validation and a **customer-centric approach**, Gemmell, Boland and Kolb (2011) indicate that business opportunities, more precisely the underlying concepts, gain usefulness and novelty by adding the perspectives of different stakeholders (see also Dimov, 2010; Wood and McKelvie, 2015; Sarasvathy 2001). In line with Davidsson's (2015) view that opportunity confidence also emerges through social interaction, we have observed that when prototyping is applied during early stages where business models are still flexible, the phenomenon and the feedback generated from it adds an objective element that allows an entrepreneur to shape his business model closer to customer needs beyond his perceptions and assumptions. However, since these adjustments are made within the boundaries of the overall concept of the NVI, we argue that this early feedback takes place in the opportunity evaluation, not recognition, stage.

Blank is a proponent of testing business opportunities in **realistic situations** with actual customers and learn from it, which he highlighted with his iconic phrase "get out of the building" (Ries, 2011, p.89; Blank, 2013). For instance, prototypes allow the observation of users in a realistic context without influencing the outcome of the research, for example, due to the chosen method. Besides, the startups of this study used the advantage that in the area of digital solutions actual user behavior can be tracked (e.g. app, platform, website) with the help of easy to integrate analytics services, and thereby provide measurable feedback data that would otherwise have been unattainable. Both, Ries (2011) and Savoia (2011) acknowledged the importance of getting high-quality feedback based on collecting data and defining key metrics to analyze this data. Where applicable, the interviewees seemed to prefer data-driven

insights measurability over subjective methods - in Savoia's (2011, p. 48) words: "data beats opinions". Our dataset implies that entrepreneurs value data-driven feedback to a bigger extent, which leads to a perceived better-informed evaluation and increased objectivity. Hence, Davidsson's (2015) degree of favorability profits from prototyping, in the sense that based on qualitative, realistic and/or measurable feedback, the actor feels more confident to have made a correct estimation of the favorability of the underlying business opportunity.

In conclusion, with the feedback gathered through prototyping, the interviewees were able to make a better-informed evaluation of the business opportunity. Besides, feedback supports entrepreneurs in developing their business opportunities further and thereby increasing their OC. However, the way feedback is gained has an impact on its informative value.

5.3.3 Prototypes and Feasibility Analyses

Prototypes have been used by the entrepreneurs we interviewed in order to conduct feasibility analyses. For instance, some of the startups clarified the **technical feasibility** with the help of prototyping.

Interviewee F: *"[Prototyping helped us] How you actually can access this data, or if you can even access this data legally ... and if you can use it. And like this, we then quickly passed to build the crawler. Just to test if it's technically feasible. To have a technical feasibility analysis."*

However, not all founders undertook an analysis of the technical feasibility. This was the case when founders innately assumed that the technical implementation was practicable anyhow, for example, because of similar solutions or presumed simple development requirements (interviewees A, D, E, G & H).

Other entrepreneurs deployed their prototypes in the course of a **feasibility analysis regarding viability and desirability** of the business opportunity.

Interviewee A:

"We have looked at the feasibility of the business side of the business model in particular ... In the end, if we can sell it to enough people."

Founder E, illustrating the validation of demand:

“With this prototype, you can directly go to the customer ... and present the solution to him. The crazy thing is that up to now we have talked to two big property management companies ... And it immediately clicked! They said: From now on, we don’t want to recruit any employees, we only want digital assistants. And then they listed ... use cases.”

Founder G considers sales of an MVP as “an ultimate test for feasibility”. His standpoint is that commercializing a prototype provides the most insightful evaluation of the NVI and prefers it to other methods.

Analysis

According to Baron and Shane (2008), feasibility analyses support entrepreneurs in being confident about their NVIs and thereby also favor their pursuit. They have the capacity to overcome the discrepancies between the current business opportunity and a potential enhanced one as well as validating the fit between the actor and the opportunity (Baron & Shane, 2008; Davidsson, 2015). Baron and Shane (2008) acknowledge the potential of a prototype, to validate different areas of feasibility. As illustrated in the previous section, the participants of this study used prototypes in order to test the feasibility of various components of their business models, such as technical or viability and desirability related aspects. This allowed them to adjust certain aspects of their approaches, and thereby enhance their opportunities. Ultimately, these actions led to answers regarding the attractiveness of the product/ service, if there is a market for it and if the actors are capable of implementing it (Baron & Shane, 2008). All those, if evaluated in favor of the solution, lead to a higher degree of favorability and opportunity confidence. In addition, if aspects are negatively evaluated in the course of a feasibility analysis, raises the option for enhancement and ultimately increase opportunity confidence as well.

Baron and Shane (2008) admit that even a full feasibility analysis cannot guarantee the success of the subsequent exploitation of the business opportunity. Prototypes, however, allow merging the aspect of a feasibility analysis in a realistic situation, for instance by already exploiting an opportunity with an MVP. Therefore, we judge a prototype that is successfully exploited on the free market as the best possible proof if the finished product will be accepted in the market. Drawing from Founder D’s statement, we argue that if customers

are interested in the unrefined product, they will also keep being customers once the full product has been developed. This interpretation will be developed further in the following section on opportunity exploitation (see section 5.4).

To summarize, in line with Baron & Shane (2008), we are of the opinion that prototyping adds to the theory of feasibility analyses. Especially in the context of digital solutions, companies benefit from easily implementable prototypes as an improved way to test the feasibility of different aspects.

5.4 Opportunity Exploitation in the Context of PT

All participants A-H describe their launched product as an MVP, or synonymously prototype, offering at least the core functionality.

Interviewee A:

“I see the app as an MVP. Many of the core functionalities we think we need are implemented now, to proof that the business model works. But it is far away from what we envisioned with it.”

Interviewee B:

“The product is never finished ... You just iterate ... Some features are more developed, others are more MVP state. ... Actually, we haven’t finished one feature really. So, these features work, we are improving and stabilizing them.” Thinking back at the early phase, he further illustrates: *“In the beginning, we had too much ambitions. You are not going to reach that. So you try to get it down to few core things.”*

Interviewee H:

“I think we were really good in setting a clear MVP, and then executing on it, and pushing it out, Lean Startup style. We knew a minimum amount of features and things we needed to make the experience we had pictured. And then we have implemented new features as we go.” He further elaborates: *“As it stands right now, we have about 90% of the features that we wanted to implement as the version 1.0 ready to be pushed*

out at scale. The stuff that is missing right now is not related to the basic flow of buying or selling something.”

Interviewee H states that this early released product needs to include the minimum feature set that not only solves the problem but offers the essential functionalities like the payment transaction handling, looking polished enough to be trustworthy. Many of the participants describe their MVP as being refined enough to compete to the industry standards.

Like interviewee C explains:

“Everyone is so used to perfectly designed products so that even if people know that it’s a beta, they will always compare it to whatever app they are also using ... So, unless you’re not in a pen&paper stage, I think that it is really hard to get people think that it is still a prototype. As soon as you are downloading an app on your phone, you do not really think about it as being a prototype ... People will always judge on their experience with ... real apps where a hundred or a hundred and fifty developers were working on it and having done iterations for years and years. And it is just so few that have access to beta apps.”

“It’s only been a month and a half and we have about six or seven sales”, participant H claims, adding: *“My goal for this month actually is 30 sales.”* This is quite similar to participant E, who explains: *“Right now, we finish the platform for the landlords with a minimum of features and offer a one-month beta version ... and will generate the first revenues in June.”*

All participants already have first customers with their launched prototypes. Many of them focus now on growth and try to gain more users and therefore improve details by releasing updates of their prototypes as participants H and A explain exemplarily:

Interviewee H:

“What we focused on is what actually makes a sale happen. That’s like the driving factor for what prioritizes the next feature in line. Like how do we get to our first kind of sales and what stopped a sale from going through?”

Interviewee A:

“I rather do bootstrapping, I always did. I think this is the more sustainable method, even though it's slower. It [his app] was free from the beginning and also included a

subscription model. Money is secondary at the moment and we focus more on the balance of staying solvent while growing at the same time.”

Analysis

Literature to this point implies that evaluation and exploitation are separate phases of the entrepreneurial process (Shane and Venkataraman, 2000). However, regarding prototyping in the opportunity evaluation and exploitation stages, we see it is hard to draw a clear line between them. Thus, both stages are not perceived as distinct anymore. All participants publicly launched their prototype and therefore entered the exploitation phase. Besides the fact that they decided to act on the identified opportunity, we see the preceding incorporation as a complementary indicator for positive OC (see also Dimov, 2010; Shane and Venkataraman, 2000; Davidsson, 2015).

In addition, we observed that going public with a prototype instead of a fully developed product contradicts Cooper's (2011) stage gate model. He claims to enter the market with a thoroughly tested and built product, and sees the prototype as part of further later-staged feasibility analyses, after conducting thorough market research. Instead, our observations align with the statement that prototypes themselves can be considered as an early phase of opportunity exploitation (Foss, Lyngsie & Zahra, 2013).

First, we notice that prototyping enables an **earlier start of the exploitation process** of startups with digital solutions while the evaluation process is still ongoing. By commercializing a prototype (MVP) and achieving early sales, the participants validate their value proposition: solving a customer's problem with the least amount of core functionalities. The founder's exploitation focus then shifts to validate if their solution can scale and attract new customers. For instance, they continue with iterative prototyping to improve the onboarding process or identify where they lose users (e.g. interviewees A, B, D & H). According to Ries (2011), the opportunity evaluation tries on the one hand to test the value hypothesis and on the other hand the growth hypothesis, which we can relate to our findings. As he further states, founders want to test the value hypothesis to approve if they deliver real value and keep a high retention rate. With the growth hypothesis, they test the product discovery and scalability “from initial early adopters to mass adoption” (Ries, 2011, p. 66). Thus, prototyping leads to the proposed ultimate feasibility analysis, covering the user's desirability, the technical feasibility, and economic viability (Brown, 2009). We are of the

opinion that previous literature on entrepreneurial opportunities does not establish sufficient explanations for this finding.

Second, even though there is no sufficient support in entrepreneurial opportunity literature, we relate the hard to distinguish phases of OE and OX to Sarasvathy's (2001) non-linear characteristic of effectuation processes. As mentioned in the theoretical framework, we see that prototyping supports her principles of effectuation. Launching a prototype only with the core functionalities to test the value hypothesis also relates to the principle of **affordable loss**. It aims at not overinvesting in more development of features than necessary, which we observed in the overly ambitious planning of features and envisioning the unfeasible in the beginning. Consequently, certain planned product attributes and functions were abandoned during the process. This happened when they were unnecessary, and the costs were too high compared to the potential benefits. Putting something into practice helped startups to realise what the core of their business opportunity is.

Moreover, looking at how the sample used prototyping shows a certain level of **co-creation** of the product and market (Sarasvathy, 2001), having direct user feedback through tracking and analytics, and therefore gaining new insights into further customer needs and handling uncertainty through user-centric product development, already backed up by findings in prototyping in the context of OE (see 5.3.2).

Releasing a prototype that looks like a finished product increases the acceptance of users and in the context of digital solutions is required in order to enable realistic feedback (see 5.3.2). These findings about prototyping also relate to Sarasvathy's (2001) principle of **exploiting contingencies**, with the discovery of new insights and the principle of **controlling an unpredictable future**, with co-developing the product with stakeholders instead of planning too far ahead.

In conclusion, Sarasvathy's (2001) principles of effectuation align with this iterative prototyping cycle and Ries' (2011) lean startup model with its *Build-Measure-Learn feedback loop*, but the border between OE and OX is therefore blurred by the non-linear characteristics in prototyping and effectuation, contradicting a so far assumed clear distinction between these phases in entrepreneurial literature (Shane and Venkataraman, 2000; Müller and Thoring, 2012).

6 Conclusion

Entrepreneurial research focused more on opportunity recognition, showing an imbalance in relation to evaluation and exploitation, and is missing a more detailed understanding outside the recognition phase (Wood and McKelvie, 2015). This study contributes to the theoretical understanding of the NVCP by taking into account our observations of the application of prototyping in startups with a focus on digital solutions. Prototyping is mentioned as an essential element of Design Thinking and Lean Startup, both innovation strategies to help startups create user-centered solutions instead of following the old paradigm “build it and customers will come” (Brown, 2009; Ries, 2011; Müller and Thoring, 2012; Ladd, 2016). Although these customer-centric strategies have found broad practical acceptance in startups with a focus on digital solutions, the study of effects of prototyping in the new venture creation is getting little attention to this point. Therefore, our results show *how the process of opportunity recognition, evaluation and exploitation looks like in the context of prototyping*.

Drawing from this, our findings support and add on, or contradict established theories of entrepreneurial opportunities. In our study, we identify prototyping as a complementary method usable at various stages of the entrepreneurial process, which is not solely beneficial in the product development process, but instead also supports the advancement of business models until an exploitable opportunity is formed.

In view of that, the results show that prototyping does not interfere with the opportunity recognition stage as Design Thinking literature would have suggested (Brown, 2009; Kelley, 2001). Yet, the context and the specificity of prototyping fundamentally change our understanding of opportunity evaluation and exploitation.

Regarding evaluation, our findings support the role of communication with and feedback from stakeholders and show how it adds an objective element to support the subjective opportunity assessment of the entrepreneur (see also Davidsson, 2015; Dimov, 2010; Wood & McKelvie, 2015). Getting external feedback is crucial not only to evaluate the current offer but much more to tailor the solution and value proposition to the customer’s needs.

Consequently, this work attributes greater importance to evolving the opportunity through the insights gained. Conversely, the confidence aspect partly loses priority, even though an enhanced solution created with the help of prototyping certainly results in increased OC.

It becomes noticeable within our sample that MVPs - prototypes displaying essential functionalities and delivering the core value of the opportunity - were used for an early entry of the exploitation phase. This allows startups offering digital solutions to gather meaningful feedback from a live setting, supporting the evaluation of the underlying opportunity based on hard data gathered from easy integratable data analytics services.

As a result of this, our findings in the context of prototyping contradict the traditional separation of the process following the recognition of an opportunity into the phases of evaluation and exploitation. In fact, results from our respondents show that the evaluation process is not finished when the exploitation starts. Rather, it is continuously revisited throughout the whole NVC, which aligns with Davidsson's (2015) proclamation that OC changes over time. Nonetheless, existing theory does not highlight the impact of OX on OE sufficiently, and at least in the context of digital solutions, the link between insights provided through entrepreneurial action and evaluation has not been emphasized and examined enough. In summary, the two phases are closely linked, alternate and inform each other. Thus, prototyping leads to an ultimate feasibility analysis regarding not only the economic viability and the user's desirability, but also the technical feasibility (see also Brown, 2009; Baron & Shane, 2008).

6.1 Implications for Research

By linking prototyping to entrepreneurial opportunities and the entrepreneurial process, we provide a starting point for further research, since we created new theoretical knowledge, taking into account this phenomenon, which has mostly been neglected within the field of entrepreneurship.

We have attempted to explore the research topic through an analysis of eight entrepreneurs all operating in the same discipline, namely digital solutions. Hence, given the nature of this research, results are highly confined within the boundaries of the individuals being interviewed and the specification of the discipline. While the results of this study are intriguing and show patterns despite the small sample size, generalizations beyond the scope of this study can only be taken with caution. Future empirical research should consider testing our findings to confirm or reject the assumptions we made, particularly using quantitative methods to measure the influence of the phenomenon. Besides, a similar study should be conducted in different contexts where prototyping might manifest itself differently. Further, we consider it valuable to gather similar data from professional prototypers in order to determine reliable and replicable methods to systematically search, frame, develop and assess opportunities (García, Deserti & Teixeira, 2013).

Regarding our findings, further research should consider the implications of this thesis that prototyping seems to play a more significant role in the entrepreneurial process than commonly appreciated. As a consequence, the phenomenon should be added to and examined within existing models. Moreover, this study has found that in the context of prototyping, opportunity evaluation and exploitation phases blend and interfere with each other. This aligns with existing entrepreneurial theory, which acknowledges the influence of opportunity confidence on the action path and vice versa the impact of actions and outcomes on an entrepreneur's evaluation of an underlying business opportunity (Davidsson, 2015; Wood & McKelvie, 2015). However, due to the importance of this aspect of this research, we suggest to thoroughly examine this topic further without a limitation of scope regarding the prototyping lense.

6.2 Implications for Practice

Concerning this study's implications for practice, we are of the opinion that the most insightful approach for entrepreneurs is to derive best practices from our findings and realize the potential positive impact of prototyping by acquiring its creative and explorative mindset.

For practitioners, it is crucial to keep in mind that “you can prototype just about anything” (Kelley, 2001, p. 142). Consequently, it should be possible to make use of prototyping during all stages of the entrepreneurial process. This is the case not only in the evaluation and exploitation phase, where founders predominantly undertake prototyping efforts thus far, but should also be applicable in the opportunity recognition stage.

As indicated throughout the findings of this study, feedback plays a major role in the context of prototyping. Especially in the space of digital solutions, it is possible to gather measurable data and conduct a more or less objective evaluation of the underlying aspect. With current prototyping tools available promising a steep learning curve it is possible to test the acceptance and desirability of business ideas even for actors with less technical experience.

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8 Annexes

8.1 Summary of Pretotyping Techniques

Savoia (2011, pp. 39-40) provides a summary of pretotyping techniques:

Mechanical Turk	Replace complex and expensive computers or machines with human beings.
Pinocchio	Build a non-functional, “lifeless”, version of the product.
Minimum Viable Product (or Stripped Tease)	Create a functional version of it, but stripped down to its most basic functionality.
Provincial	Before launching world-wide, run a test on a very small sample.
Fake Door	Create a fake “entry” for a product that doesn’t yet exist in any form.
Pretend-to-Own	Before investing in buying whatever you need for your it, rent or borrow it first.
Re-label	Put a different label on an existing product that looks like the product you want to create.

Table A-1: Pretotyping techniques.

8.2 Interview Guide

Can you please give us a short introduction about yourself and your background?

Can you please give us a short introduction about your firm and the product/ service you are selling?

In your own words, what is prototyping?

Is prototyping a priority for you?

Explain how you prototyped your current business idea?

Why do you use prototyping?

Who has worked on the prototype? Please explain the collaboration.

Opportunity recognition:

Can you please elaborate how you got the idea for your business?

Have you prototyped multiple approaches to solve the problem at hand? Please elaborate.

How did your business opportunity change over time? Has prototyping played a role in this?

Opportunity evaluation:

How did you know, that your idea could be a business, e.g. through prototyping?

Can you please explain how and what kind of insight you gained with prototypes?

Who do you show your prototypes to? Can you please describe the communication process?

Please explain how prototypes influenced how confident you are about your business?

Can you please describe how prototyping influences the feedback you get?

Did you use prototyping to test the feasibility of your business (e.g. technical, market, organizational)? If yes, please elaborate?

Can you please elaborate how you incorporate insights gained with the help of prototypes?

Opportunity exploitation:

To what extent has the creation of a prototype made you more or less confident about pursuing the business opportunity?

Can you please describe the role of prototyping for the actions you took to commercialize your business idea?

8.3 Participant’s Definition of Prototyping

A	“The process in which various variations of a product are tested and lead to a product that speaks to the market.”
B	“Making something quick, that works. Which would do the core jobs. You build something to prove it like an MVP.”
C	For me prototyping is a lot about design, user interfaces, user interaction, user experience and making it meaningful. From mockups to real measurements in the published product.
D	Prototyping is a good tool for testing your idea by trial and error. Trying it to some extent without developing it, which keeps things cheaper.
E	“Prototyping is to create a possible solution for a problem, that you think a user might have, and that is only testable with a prototype. You give it to a user to try it out and it doesn't have to be perfect. It could be as simple as a cardboard to test for example a camera app to show and talk about ... But it could also be just a paper sketch you photograph to make a click dummy out of it. So, creating experiments with really simple means.”
F	“Prototyping is about quickly model functionality in order to test something. This can be, as in our case, to test the market as fast as possible. It can also be to test other things. In the end, for me prototyping is about feasibility.”
G	For me, a prototype is an MVP. It covers different aspects from financial to physical, technical, and design aspects. It is a lot of trial and error, and gain as much information from potential users or customers as soon as possible. You start with a sketch and design and then you develop the product further.
H	Definition of prototyping for us was keeping the design ahead of the codebase. Balancing the technical and design sides in the prototyping phase before you going to actually trying to build something.

Table A-2 Participants’ definitions of prototyping

8.4 Feedback and Communication with Prototypes

	Customer feedback	Internal team feedback	Investor feedback
A	Focus group & in-app analytics	n/a	n/a
B	Observation, customer conversation	yes	unknown
C	In-app analytics, surveys, observation, friends & family	yes	unknown
D	In-app analytics, pilots, friends & family	yes	unknown
E	Pilots, presenting to customers	yes	Prototype required for accelerator
F	Pilots, customer conversations	yes	n/a
G	In-app analytics	yes	Prototype required for investors
H	observation, focus group, analytics	yes	Prototype was helpful

Table A-3 Feedback with prototypes

8.5 Feasibility Analyses with Prototyping

	technical FA	other FA
A	no	yes
B	yes	yes
C	yes	yes
D	no	yes
E	no	yes
F	yes	yes
G	no	yes
H	no	yes

Table A-4 Feasibility analyses with prototyping

8.6 Participant's Revenue Models

Current revenue models for opportunity exploitation

A	Freemium/Subscription
B	Subscription & pay per use
C	Freemium
D	Freemium
E	Commission
F	Commission / pilot customer
G	Commission / pay per use
H	Commission

Table A-5 Participant's revenue models

At this place a special thank you to our participant Josef Moser from Cora Health (<https://www.cora.health/>) for his support and academic as well as practical discussion about prototyping and business development.