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IDENTIFYING THE KEY ELEMENTS OF DESIGN THINKING THAT FOSTER INNOVATIVE ACTIVITY

DOCTORAL DISSERTATION

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IDENTIFIKACIJA KLJUČNIH ELEMENTOV DIZAJNERSKEGA NAČINA RAZMIŠLJANJA, KI SPODBUJAJO INOVACIJSKO AKTIVNOST

POVZETEK

Organizacije danes iščejo načine za uspešno implementacijo kreativnih idej, da bi izboljšale svojo inovacijsko aktivnost, ki predstavlja temeljno gonilo njihovega uspeha in preživetja (Davis, 2010; Myers & Marquis, 1969). Da bi odkrili dodatne mehanizme, ki pozitivno vplivajo na inovativnost podjetja, v disertaciji raziščemo razmerja z vidika teorije dizajnerskega razmišljanja. Ta v uporabnika usmerjena inovacijska strategija organizacijam pomaga razmišljati drugače in bolj kreativno, odkriti skrite potrebe trga ter izboljšati uporabniško izkušnjo z vključitvijo dizajnerskih vpogledov v reševanje problemov. Da bi prispevali k boljšemu razumevanju dejavnikov, ki vplivajo na inovacije v malih in srednje velikih podjetjih (MSP), je naš cilj podrobno raziskati značilnosti posameznika (znanje, integrativno razmišljanje, mreža) in drugih konstruktov dizajnerskega razmišljanja (eksperimentiranje in struktura tima). Ta doktorska disertacija predstavlja enega prvih poskusov v znanstveni literaturi, ki se na ravneh podjetnika in podjetja ukvarja z empiričnim določanjem inovativnih elementov, izhajajočih iz dizajnerskega razmišljanja.

V prvem poglavju pokažemo, da znanje in način razmišljanja podjetnikov v veliki meri določata inovativnost njihovih MSP. Najprej raziščemo, kako širina podjetnikovega znanja posega v razmerje med njegovo globino znanja in inovativnostjo podjetja, kajti doslej so bile omenjene dimenzije znanja proučevane predvsem na ravni podjetij. Poglavje začnemo z analizo literature o individualnem znanju in pregledamo njegove značilnosti, ki so bile že raziskane v različnih okoljih in situacijah. Poleg tega raziščemo podjetnikove zmožnosti integrativnega razmišljanja v inovacijskem procesu, tovrstno razmišljanje podrobno analiziramo in opišemo njegove glavne dejavnike. Za dosego poglobljenega razumevanja, kako podjetniki zaznavajo proučevane konstrukte in njihovo obnašanje v podjetjih, uporabimo interpretativno fenomenološko analizo (IPA). Rezultati študije podpirajo trditve o osrednji vlogi znanja pri inovativnosti podjetja, dodatno pa pripomorejo k prepoznavanju vzajemnega delovanja dimenzij znanja na ravni podjetnika. Tako ugotovimo, da podjetnikova širina znanja igra pomembno vlogo pri krepitvi pozitivnega razmerja med njegovo globino znanja in inovativnostjo podjetja. Rezultati pokažejo tudi, da je način podjetnikovega mišljenja pomemben dejavnik v inovacijski aktivnosti. Namreč, podjetnikova zmožnost integrativnega razmišljanja v veliki meri prispeva k inovativnosti podjetja. Opredelimo tudi najpomembnejše dejavnike integrativnega razmišljanja: hitro sprejemanje odločitev, zadovoljitev z zadostno rešitvijo (pravilo 80/20), celostni pristop, sprejemanje kompleksnih problemov, zmožnost prepoznavanja nevidnih značilnosti problema, različno dojemanje tveganja, vključevanje drugih in stalna naravnanost na

prihodnost. Razmerja dodatno preverimo s hierarhično analizo v prilogi. Razvijemo tudi lestvico za merjenje integrativnega razmišljanja.

Drugo poglavje se osredotoča na vlogo eksperimentiranja in podjetnikovih mrež v razmerju do inovativnosti podjetja. Najprej raziščemo prispevke eksperimentiranja v procesu razvoja novih proizvodov in v inovacijski aktivnosti ter predstavimo njegove različne oblike. Doslej obstajajo le omejeni poskusi empiričnega preverjanja razmerja med eksperimentiranjem in inovativnostjo podjetja, zato ta odnos raziščemo kvalitativno z interpretativno fenomenološko analizo (IPA) in hipoteze s pomočjo hierarhične regresijske analize testiramo kvantitativno na vzorcu 485 podjetnikov. Ugotovimo, da eksperimentiranje samo ter metoda poskusov in napak povečuje inovativnost podjetja ter priskrbi kakovostne povratne informacije o tem, kako izboljšati proces iskanja rešitev. Natančneje, odkrijemo pomembno vlogo izdelave hitrih prototipov za pospeševanje inovativnih izboljšav izdelkov in storitev. Nadalje v poglavju proučujemo različne vidike podjetnikovih mrež v razmerju do inovativnosti podjetja. Rezultati empirične analize kažejo, da podjetnikova mreža sama še ne zagotavlja inovacijske dejavnosti v podjetju. Obstaja pa trdna povezava med širino njegovega znanja in njegovo mrežo. Podjetnikova širina znanja pripomore h gradnji zaupanja znotraj njegove mreže, izboljšuje komunikacijski tok in ima pomembno spodbujevalno vlogo v odnosu med podjetnikovo mrežo in inovativnostjo podjetja.

V tretjem poglavju raziskujemo optimalno strukturo tima. Ker vedno več podjetij ustanovijo podjetniški timi, je pomembno odkriti dejavnike, ki vplivajo na njihovo uspešnost in inovativnost. Poleg številnih raziskav na področju sestave tima in inovativnosti ta študija črpa iz zanimive izkustvene teorije, ki sta jo razvila Kelley in Littman (2005) in ki time obravnava z vidika dizajnerskega razmišljanja, ter preveri njene prispevke in učinke na inovativnost tima. Za potrebe analize eksperimentalno-empirično raziskavo dopolnimo s kvantitativno analizo. Najprej izvedemo več poskusov na treh različnih mednarodnih vzorcih posameznikov (skupaj 34 timov) in posameznike v timu analiziramo z na novo razvitim instrumentom. Nato preizkusimo razmerje še z linearnim regresijskim modelom. Rezultati pokažejo, da so timi, ki vključujejo vloge omenjene teorije, bolj inovativni in da morajo biti za boljše sodelovanje, zadovoljstvo ekipe in hitrejši odziv vloge med člani razporejene enakomerno. Prav tako ugotovimo, da tim ne sme vsebovati več kot eno prevladujočo osebnost. Vsak inovativni tim naj bi zato obsegal vseh deset vlog: antropolog, preizkuševalec, navzkrižnik, premagovalec ovir, sodelovalec, direktor, arhitekt izkušenj, prostorski dizajner, pripovedovalec zgodb in skrbnik.

Ključne besede: dizajnersko razmišljanje, širina znanja, globina znanja, integrativno razmišljanje, eksperimentiranje, podjetniške mreže, inovativnost

IDENTIFYING THE KEY ELEMENTS OF DESIGN THINKING THAT FOSTER INNOVATIVE ACTIVITY

SUMMARY

Organizations nowadays are seeking ways to successfully implement creative ideas to enhance innovative activity, which ultimately determines their long-term survival and success. We use a design thinking perspective in order to determine mechanisms that positively impact firm innovation. This user-driven innovation strategy approach helps firms think differently and more creatively, reveal latent market needs, and improve overall user experience by embedding designers' views into problem solving. In order to contribute to a better understanding of the factors affecting innovation in small and medium-sized enterprises (SMEs), we investigate entrepreneurs' individual-level characteristics related to design thinking theory (knowledge depth and breadth, integrative thinking, proclivity to experimentation, etc.) and how they contribute to an organization's innovation. We also explore how to collaborate effectively. This dissertation represents one of the first attempts in scientific literature to draw from design thinking theory by determining innovative elements of an entrepreneur's and a firm's characteristics. In addition to introducing two conceptual models, we develop a scale for measuring integrative thinking.

In Chapter 1 we show that SMEs' innovation is determined by the knowledge and thinking of the entrepreneurs who run them. First, we examine how an entrepreneur's knowledge breadth interacts with the relationship between individual-level knowledge depth and an organization's innovation. Until now, these knowledge dimensions have been studied mostly at a firm level. We start by analysing the literature on individual knowledge and provide insights into its characteristics that have already been studied in different settings. In addition, we investigate entrepreneurs' integrative thinking ability in the innovation process and seek to delineate its key determinants. We continue with an analysis of the integrative thinking process and offer a thorough explanation of this phenomenon. We use interpretative phenomenological analysis (IPA) to attain an in-depth understanding of how entrepreneurs perceive these constructs and their behavior in firms. These findings support our arguments about the central role of knowledge in innovation and develop our understanding of the interplay of knowledge dimensions at an entrepreneurial level. We establish that an entrepreneur's knowledge breadth plays a significant role in enhancing the impact of the entrepreneur's knowledge depth on firm innovation. Our results also support our proposition that an entrepreneur's thinking skills are an important factor in innovative activity. Specifically, this study establishes that an entrepreneur's integrative thinking largely contributes to firm innovation and identifies the most prominent determinants of integrative thinking: fast decision-making, not striving for absolutes, holistic approach, openness to complex problems, an ability to identify all the invisible components of the

problem, a different perception of risk-taking, inclusion of others, and a future stance. In addition, these constructs are explored using a hierarchical regression analysis (Appendix E). We also develop a scale for measuring integrative thinking (Appendix D).

Chapter 2 focuses on the role of experimentation and an entrepreneur's social network in innovation. We begin by investigating experimentation's contributions to the product development process and the innovation process and present different modes of experimentation. To the best of our knowledge there previously have been only limited attempts at empirical verification of experimentation's impact on firm innovation; therefore we explore this relationship qualitatively with an IPA and test our hypotheses quantitatively on a large sample of 485 entrepreneurs using a hierarchical regression analysis. We determine that experimentation, especially through a trial-and-error process, enhances innovation and provides solid feedback on how to improve the problem-solution process. In particular, we show the important role of rapid prototyping in speeding innovative improvements of the product or service. Next, we examine how different aspects of an entrepreneur's social network affect innovation. Specifically, we argue that an entrepreneur's social network alone does not assure innovation activity of a firm. Our results suggest a strong correlation between knowledge breadth and the social network of an entrepreneur. Knowledge breadth seems to build trust within a social network, improves communication flow, and plays an important enhancing role in the relationship between an entrepreneur's social network and firm innovation.

In Chapter 3 we investigate the optimal structure of a team. Because more and more firms are started and founded by teams, the importance of determining the factors affecting team performance has been strongly suggested in entrepreneurial research. In addition to using previous research on the relationship between team structure and innovation, this study draws from an interesting experience-based theory advanced by Kelley and Littman (2005) which examines teams from a design thinking perspective, and tests its contributions to and effects on a team's innovation performance. We use experimental-empirical research complemented with a quantitative analysis. First, we conduct multiple experiments on three different international samples of individuals using a newly developed instrument to evaluate individuals in a team. We then test the relationship with a linear regression model. Our results suggest that teams that include roles proposed by Kelley and Littman are more innovative and that team roles should be allocated equally among members for enhanced collaboration, member satisfaction, and quick response. We also establish that in terms of attaining the highest level of innovativeness, a team should not possess more than one prevailing personality. Any team should include the following 10 team roles: anthropologist, experimenter, cross-pollinator, hurdler, collaborator, director, experience architect, set designer, storyteller, and caregiver.

Keywords: Design thinking, knowledge breadth, knowledge depth, integrative thinking, experimentation, social network, innovation

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INTRODUCTION

Background of the doctoral dissertation

Innovation is a fundamental driver of an organization's success and survival (Alegre & Chiva, 2008; Davis, 2010; Wheelwright & Clark, 1992). Therefore in order to enhance innovative activity in an organization a successful implementation of creative ideas is prerequisite (Myers & Marquis, 1969). With this in mind, organizations aim to introduce new products and services that are characterized by a high level of novelty and an excellent user experience. In particular, to sustain a competitive edge, firms try to tap specifically into those consumer needs that are not clearly expressed (Lynn et al., 1996; McDermott & O'Connor, 2002). It is necessary to think differently: more intuitively and more creatively.

Accordingly, organizations employ various methodologies to test new ideas with an aim to create innovative products and services. Recently, three major user-driven innovation strategies have gained increasing attention and have become increasingly efficient in new product development and fostering innovation: lean, agile, and design thinking. These strategies are used in the development processes of many innovative products and services currently on the market. In the following sections we examine them briefly and establish how they relate to each other. We use these findings to argue the foundation of this dissertation and explain why we choose design thinking – specifically, its characteristics – to be the focus of this study.

The beginnings of the lean strategy date back to the seventies, when principles for production-process optimization in automotive industry were developed by Toyota (Womack & Jones, 2003). In the following decades the lean concept has evolved and has now become a significant tool for building new products and fostering innovation in all industries. In 2008 Eric Ries introduced the "lean startup" methodology and expanded it to be suitable for individuals, teams, and organizations who seek to introduce new products into the market and make the process less risky (Ries, 2011). He argues that the most efficient innovation is the one that people actually need. The integral part of the lean process is thus understanding the customers – "building a continuous feedback loop with customers throughout the product development process" (Blank, 2006; Blank & Dorf, 2012). In sum, lean methodology has three important principles: (1) entrepreneurs accept the existence of untested hypotheses, (2) use of a customer development approach to test the hypotheses ("get out of the building") and (3) the use of agile development – iterative and incremental development of the product and creation of a minimum viable product to test on the market (Blank, 2013). It is crucial to test the assumptions early in order to minimize costs, waste, and time to market (Gehrich, 2012; Maurya, 2012; Trimi &

Berbegal-Mirabent, 2012). Accordingly, the process consists of three steps: (1) build, (2) measure, and (3) learn.

Agile methodology has gained increasing attention over the last 15 years, although its practices originate in 1990s. Agile describes principles for software development and is intended to emphasize maximizing value creation (Highsmith & Cockburn, 2001; Martin, 2003). The aim is to increase the efficacy of a team by reducing the cost of distributing information between team members, reducing the time between making a decision and feedback, and introducing flexibility and adaptability to unexpected events by following different rules rather than predetermined roadmaps (Cockburn & Highsmith, 2001; Lindberg et al., 2011).

Another method that has recently shown much potential in fostering better organizational innovation is design thinking (Davis, 2010). Design thinking is a user-driven innovation strategy approach developed in the late 1990s by the design and innovation consulting firm IDEO. Although some of its first mentions date back to Peter G. Rowe (1987), the methodology as we know it today was advanced by IDEO's founder David Kelley (Kelley & Littman, 2005) and its CEO Tim Brown (Brown & Katz, 2009). Design thinking serves as a tool to identify user needs, and it approaches problem-solving by stimulating a different way of thinking about problems and understanding complex situations (Schmiedgen, 2011; von Thienen et al., 2014). Moreover, it applies designers' principles to problem-solving with the aim of fostering innovation. Brown (2008) defines design thinking as a methodology that connects a vast range of innovation activities with a human-centered design approach. It is "a discipline that uses the designer's sensibility and methods to match people's need with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008, p. 85).

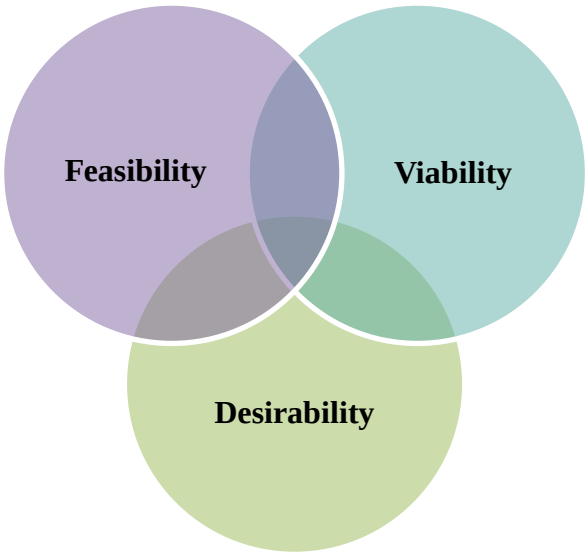
The goal of the approach is to improve a consumer's experience by developing a deep understanding of the consumer and the consumer's latent needs (Nussbaum, 2004). Martin (2009) and Leavy (2010) argue that constant searching for balance between intuition and analytics, between exploration and exploitation, between validity and reliability, supported by abductive reasoning that forms the core of the design thinking method, provides organizations with an inexhaustible, long-term business advantage. The importance of design integrated into business has been proposed by several authors (Lester et al., 1998; Liedtka, 2004; Liedtka, 2015; Senge, 1990; Simon, 1981). Mootee (2011), for example, argues that design thinking enables organizations to make better decisions based on identifying different strategic options in times of extreme uncertainty.

Design thinking is an open-ended, open-minded, iterative, chaotic, and nonlinear process that differs fundamentally from the milestone-based processes of traditional business

practice. Its nature ensures that there is no best way to move through the process in order to achieve successful results (Brown & Katz, 2009). Brown (2008) suggests taking it as a system of overlapping spaces (inspiration, ideation, implementation) rather than a line of orderly steps. Accordingly, various activities and characteristics form the continuum of innovation. Scheer et al (2012) describe it as a mindset and atmosphere supporting three core elements: flexible space, teamwork, and design process. In other words, design thinking supports an interdisciplinary approach to problem solving. It aims at producing solutions that consider the following three aspects in balance (Figure 1) (Brown & Katz, 2009, p. 18):

- technological feasibility (the solution is functionally possible),
- business viability (the solution shows commercial potential in terms of a sustainable business model), and
- social desirability (the solution is applicable and meets the real user needs).

Figure 1: Design thinking circles



Source: Brown and Katz, *Change by design*, 2009, p. 19

Despite several differences in methodologies, lean, agile, and design thinking share considerable similarities (Müller & Thoring, 2012; Petersen, 2010). The most prominent is that all help to create products for which there exists a market demand and to produce features that consumers want.

Lean methodology and design thinking share the same innovation focus by solving an actual problem for the user (Müller & Thoring, 2012). Both put the user in the center of the process and emphasize rapid iteration. The sooner one realizes that an idea is not working, the faster one can modify and retest it (Brown, 2005; Ries, 2011). In design thinking

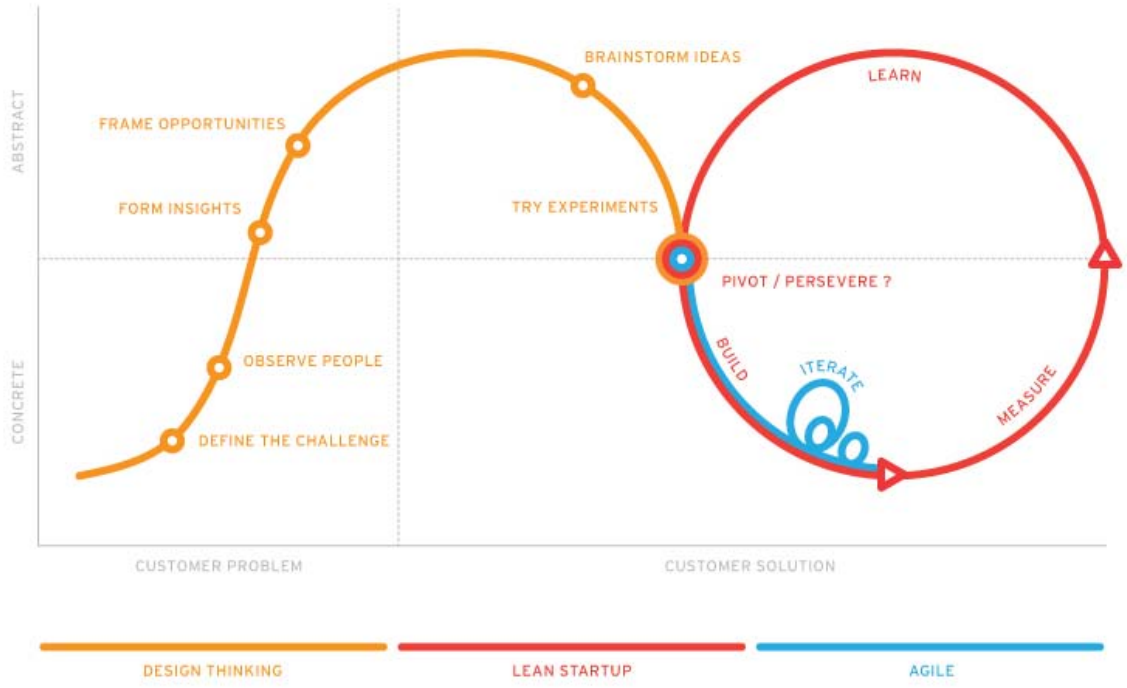
"iteration" usually starts after the testing, while in lean process pivoting can be employed earlier, after the first hypotheses testing. Moreover, they both use prototypes (rapid prototyping, minimum viable product) to gather user feedback in order to build a product users really need (Maurya, 2012; Schrage, 1999). However, there are several differences. Lean methodology mainly targets tech startups and uses an existing business idea (Rasmussen & Tanev, 2015), while design thinking aims at innovations in general and first needs to define an ambiguous problem (Brown, 2008). Furthermore, in design thinking the user problem is not predetermined, so it emphasizes the extensive use of ethnographic methods (Kelley & Littman, 2005), whereas the lean process starts with a founder's product vision, which can be modified later in the process (Müller & Thoring, 2012). Correspondingly, design thinking, in contrast to lean process, uses several ideation techniques, such as brainstorming, storytelling, shadowing, consumer journeys, and extreme user interviews (Nussbaum, 2004). Lastly, defining a business model is an important part of lean methodology (Osterwalder & Pigneur, 2010), whereas design thinking process ends before that – by creating a product or service.

Both design thinking and agile methodologies emphasize collaboration, individuals, user-centricity, iterative learning, and solid communication (Fowler & Highsmith, 2001; Miller, 2001). However, despite similarities, the practices do not overlap seamlessly. People practicing both strategies often disagree about how much time to spend for design thinking and when to start working on a solution, because design thinking is primarily grounded in determining the problem, understanding the user, and exploring different possibilities, whereas agile focuses on continuous incremental refinements (Lindberg et al., 2011). To delineate further, the understanding of the real problem in design thinking is parallel to the trial-and-error approach in agile. Similarly, lean and agile methodologies share the same goals, views, and principles. The main difference is that lean is used to build a marketable product, whereas agile is used in software development. Furthermore, a holistic view is unique to lean, whereas agile also defines processes, such as extreme programming and Scrum (Petersen, 2010). They also differ in terminology but mostly share the same meaning, although in a different context (Naylor et al., 1999).

Although these methodologies come with different names, they share similar features, attributes, and goals in the product development cycle. They complement each other in the process of innovation. However, the most distinctive difference is primarily which step of the innovation process they emphasize (Furr & Dyer, 2014). It is important to choose the right innovation method at the right time. Figure 2 shows how design thinking, lean, and agile intersect in terms of abstract/concreteness and problem/solution focus. The innovation process begins with an insight into the market needs, and continues by understanding the problem, finding the solution, and developing a business model. Basically, design thinking discovers the customers and their needs, lean discovers a

problem and efficiency, and agile discovers a solution (Blank, 2006; Brown, 2008; Furr & Dyer, 2014).

Figure 2: Intersection of design/lean/agile



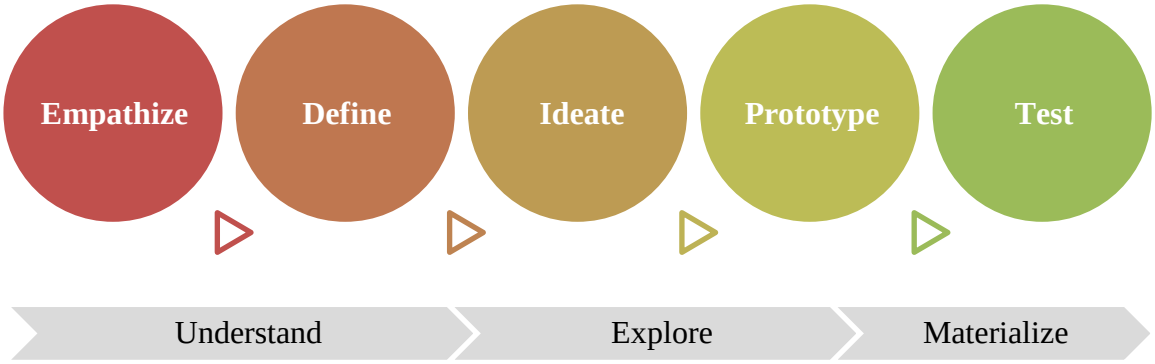
Source: *The intersection of design/lean/agile*, 2016

Design thinking is good for ideation. It adds the anthropological component to the innovation process to develop a deep holistic understanding of the problem (Müller & Thoring, 2012). On the other hand, lean and agile methodologies do not focus on user experience; the first is primarily used for testing propositions, whereas the latter emphasizes iterative discovery of requirements rather than problems. Design thinking focuses on identifying a problem that matters and discovering the users (e.g., Carlgren, 2013); lean is a business process focused on customer solutions that reveals whether the problem is worth solving and is able to be solved (e.g., Maurya, 2012); and agile is a technology process intended to provide insight into whether users benefit from the solution (e.g., Cockburn, 2006). In sum, design thinking methodology may provide inputs for lean and agile processes (Carlgren et al., 2016; Furr & Dyer, 2014; Lindberg et al., 2011).

Correspondingly, we further delineate the innovation process depicted in Figure 2 by tapping into the individual steps of the three innovation strategies. Design thinking is the first and the only methodology of these three to employ when trying to define the customer problem (Rauth et al., 2010). Therefore we start by explaining the process of design thinking depicted in Figure 3 and how it fits into the larger picture of innovation process (Figure 2). The first step, “Empathize”, matches the phases of observe and understand

(insights) within the process model and helps understand the user experience through empathic observation and interaction with the user. In the second step we synthesize the findings, frame opportunities, and define the problem. The result is the identification of a narrow problem statement. Next, a customer solution is provided by focusing on ideation to discover all the possible solutions using different brainstorming techniques. Prototyping (experimentation) is then used to transform ideas into tangible forms to gather feedback from users. This step includes a variety of methods ranging from quick and cheap artifacts (rapid prototyping) to computer simulations. The process ends with a test to refine prototypes, learn even more about users, and inspire further development (Ambrose & Harris, 2009; Brown & Katz, 2009; Carlgren, 2013; Plattner, 2010).

Figure 3: Design thinking process



Source: Plattner, *An introduction to design thinking process guide*, 2010

Next, the lean process focuses solely on customer solutions (Maurya, 2012). Unlike design thinking, the lean cycle is continuous and has no clear beginning or ending (Figure 2). The main principle is to meet the customers early in the development process to learn from them from beginning. It starts with a build step, where a prototype (minimum viable product) is made based on the idea or hypothesis. This prototype is then shown to customers and their feedback is measured. Information gathered through appropriate metrics allows for learning, which leads to confirmation or rejection of the hypothesis. During this process new ideas for modifications emerge, which then serve as inputs for subsequent cycles (pivot, persevere) (Ries, 2011). These methodologies overlap in certain sections of the process (Müller & Thoring, 2012): “build” (lean) resembles “prototype” (design thinking) and “measure” (lean) can be regarded as “test” (design thinking).

In addition, agile is optimized for creating software solutions and not for problem discovery (Cockburn, 2006). By exposing the solution to users one learns whether the solution works or not and gains limited insights into their problems as well. However, agile

supports short cycles (Figure 2). It focuses on conducting several iterations of the solution and through refinements creating a product or service (Abrahamsson et al., 2003).

All things considered, there exist different innovation strategies with different procedures. However, the common denominator of all is the mindset of the individuals who use each of them. Certain characteristics are emphasized that foster innovation as well as enhance the process of all mentioned methodologies. In this dissertation we argue that a deep understanding of the user is essential for the whole innovation process. Therefore our focus is primarily on design thinking, specifically the mindset and other attributes of individuals that derive from design thinking theory and as such also enhance implementation of other innovation strategies (e.g., lean and agile): human-centrism, mindfulness, empathy, experimentalism, action-orientation, inclination towards collaboration, integrative thinking, and optimism (Brown, 2008; Fraser, 2007; Zupan, 2015).

Design thinking is central to building innovation capability (Carlgren, 2013). A successful application of this methodology to the innovation process requires a special environment favorable to observation, fast learning, rapid prototyping, visualization of ideas, deep and holistic user understanding, open collaboration, cross-functional teams, unfocus groups, and wild ideas (Brown, 2005; Carlgren, 2013; T. Lockwood, 2009; Rauth et al., 2010). Existing literature suggests several characteristics and mindsets of design thinkers that are essential for a successful implementation of the process: T-shaped structure, deep insight, empathy, open-mindedness, risk taking, out-of-the-box and intuitive thinking, constant visualization, effective collaboration, optimism, rapid prototyping skills, human-centrism, user focus, abductive logic, perseverance, imagination, broad curiosity, integrative thinking, mindfulness, trust, and flexibility (Brown & Katz, 2009; Carlgren et al., 2016; Carr et al., 2010; Dunne & Martin, 2006; Hassi & Laakso, 2011; Holloway, 2009; Martin, 2009). In this study we focus on implementation of design thinking at an individual level and how individual key characteristics, deriving from design thinking theory, foster design-driven innovation and simultaneously lay the foundation for a successful design thinking process implementation. In addition, we investigate other elements of design thinking at an organizational level and test their contribution to organizational innovation.

Liedtka (2015) recognizes design thinking as an effective methodology for organizations to successfully face the innovation and growth challenges. It contributes to long-term firm innovation by enhancing resources, processes, culture, and mindset (Carlgren et al., 2014a, 2014b; Johansson-Sköldberg et al., 2013). Recently, the value of design thinking has also been recognized by several managers and entrepreneurs (Carlgren et al., 2016; Hassi & Laakso, 2011; Lockwood, 2010). Johansson and Woodila (2009; 2010) suggest that the expansion of design thinking to the management context is fuelled by design consultancies, who argue its usefulness in different industries and areas (Cooper et al., 2009; Kimbell, 2009). According to Schmiedgen (2011) and Mootee (2011), design thinking can

substantially enhance firm creativity and reduce development risks for new products and services. Indeed, its value has been recognized in IT development, which nowadays needs to focus primarily on user aspects of design problems in order to remain competitive (Lindberg et al., 2012). Design thinking also offers a beneficial methodology for interdisciplinary creative work (Lindberg et al., 2010). Because design thinking shows much potential in fostering innovation (Holloway, 2009; Leavy, 2010; Owen, 2006) and design principles can be easily applied to entrepreneurship (Dunne & Martin, 2006; Stolterman, 2008; Zupan, 2015), we suggest that its characteristics should be adopted by entrepreneurs in order to achieve better innovation performance (Brown & Katz, 2009; Mootee, 2013). Therefore the scope of our study is the investigation of design thinking principles at an entrepreneurial level.

Accordingly, this study investigates entrepreneurs and their ability to innovate according to design thinking principles. Specifically, we centre on their mindset and other attributes which help set a solid foundation for implementing design thinking in their firms. Because there exist several similarities in the mindsets of design thinkers and entrepreneurs, we can easily transfer design thinking characteristics to an entrepreneur (Zupan, 2015). First, they both need to identify the real user needs. Therefore empathy is of central importance for designers and entrepreneurs, because they need to imagine the world from multiple perspectives (Brown, 2008; Chiles et al., 2010). Second, they all need to think integratively and exhibit the ability to see all the relevant determinants of the problem (Martin, 2007b). Third, experimentation has been suggested as a significant part of new product development and innovation (Schrage, 1999; Vandevelde et al., 2001). Similarly, design thinkers emphasize the use of prototyping for providing possible solutions to attain better feedback from users (Nussbaum, 2004). Fourth, they both deal with uncertainty (Dym et al., 2006; Vesper, 1990). Fifth, they understand the beneficial role of teamwork in the innovation process (Hoegl & Gemuenden, 2001; Kelley & Littman, 2005). Finally, they need to exhibit an ability to recognize business opportunities and distinguish between useful and insignificant information (Shane, 2000; Stolterman, 2008). Based on these arguments we see that the use of design thinking principles and improving design thinking characteristics enables entrepreneurs to develop important entrepreneurial competencies (Izquierdo & Deschoolmeester, 2010; Zupan, 2015) and also enhance the innovativeness of product development (Lindberg et al., 2011).

The scope of research findings on design thinking has grown tremendously in the last few years for practitioner and scholarly audiences (e.g., Brown & Wyatt, 2015; Carlgren et al., 2014b; Liedtka, 2015; Plattner et al., 2011), which demonstrates the popularity of the topic and its effectiveness in improving organizational effectiveness. We add to this trend by exploring the role of individual-level characteristics with a design thinking background in firm innovation. Despite the increasing challenges in how large organizations can effectively develop these attributes in their employees' mindsets (Carlgren et al., 2014b;

Rauth et al., 2014), our main focus is SME entrepreneurs, who are seen as key players in economic growth and technological progress (Lin, 1998). Due to several potential liabilities of SME owner experience, such as limited knowledge, financial resources, and technological capabilities (Parker et al., 2009), the study of innovation in SMEs is very important. Although several studies have shown firm-specific drivers of innovation (e.g., Keizer et al., 2002; Lee et al., 2010; Terziovski, 2010), entrepreneurs have been shown to be central to SMEs' decision-making processes and vital drivers of innovation (Marcati et al., 2008). Therefore studying entrepreneurs' related attributes that cause differences in firm-level innovation is important (Baron & Tang, 2011). Nevertheless, our study offers implications that can also be used by larger organizations when introducing design thinking into their process.

This study focuses on attributes which originate from design thinking theory and examines their effect on innovation performance. We explore entrepreneur's knowledge in terms of depth and breadth and how these two perform in relation to innovation. Next, we discuss integrative thinking, identify its components, develop a measurement scale, and verify its contribution to innovation. Furthermore, we investigate an entrepreneur's social network from a perspective that views its role in innovation moderated closely related to knowledge breadth. Design thinking emphasizes experimentation as one of the main processes leading to innovation. Therefore we try to understand experimentation and different prototyping modes and how they influence the innovation activity. Finally, we integrate theoretical and practical evidence from a recent theory about team structure by Kelley and Littman (2005). We explain which team roles are crucial to include when trying to make a team more innovative and how they lead to a better innovation performance.

Research questions and goals addressed in this study

With this doctoral dissertation we aim to investigate in detail individual-level characteristics in relation to design thinking theory and how they contribute to innovation. The research intends to identify and verify those elements of design thinking that SMEs should stress in order to become more innovative and which would serve them in achieving and sustaining a competitive edge and, in particular, help them penetrate and become leaders in the global market. In particular, specific goals are related to:

- Analysis of the impact of individual-level entrepreneurial factors on firm innovation;
- Development of two conceptual models in the field of design thinking and innovation;
    - Verification of whether the T-shape concept (knowledge depth and knowledge breadth) can be transferred from the level of a firm to the

entrepreneurial level and still have a positive effect on innovation performance;
    - Verification of the existence of an enhancing role of knowledge breadth in the relationship between a social network and innovation;
    - Empirical verification, on a large sample, of the importance of experimentation for innovation;
    - A construct for the measuring of integrative thinking and empirical verification of the proposed positive influence of integrative thinking on innovation performance;
    - Verification of Kelley's (2005) proposed theory of an optimal team structure and examination of its contribution to innovation;
- Providing qualitative argumentation and support based on design thinking methodology for the constructs of the previous studies (T-shaped entrepreneurs: the moderating role of knowledge breadth on the relationship between knowledge depth and innovation; and the moderating role of knowledge breadth on the relationship between social network and innovation, experimentation, and integrative thinking);
- Research as a combination of qualitative research methods (experiments, interpretative phenomenological interviews) and quantitative research methods (conducted on a large sample of SMEs owners in Slovenia).

The following section delineates research questions that provide motivation for this doctoral dissertation.

The first chapter explores the phenomenon of knowledge in the context of entrepreneurs. As has been shown, knowledge provides the prerequisite foundation on which innovation can be built and which is essential to achieving a competitive edge (Liao et al., 2008; Nonaka et al., 2000). Scholars have shown that knowledge depth positively affects innovation activity and provides a competitive advantage (Bierly & Chakrabarti, 1996; Leonard-Barton, 1992; Prabhu et al., 2005). Interestingly, its effect is not self-evident. An "expert syndrome" caused by their usual negligence and blindness towards other domains outside their specialization inhibits experts' creativity (Dean, 1999; Osho, 2004). Therefore knowledge diversity has become essential in fostering creativity, innovation, and flexibility, and is associated with sustainable competitive advantage – focusing on one specific area of expertise and a lack of adaptive ability regarding advances in different fields might cause firms problems when handling different situations, resulting in the inhibition of innovation activity (e.g., Cohen & Levinthal, 1990; Leonard-Barton, 1992; Patel & Pavitt, 1997). With this in mind, a broader scope of knowledge enables a more complex and creative combination of related disciplines, which results in higher opportunity recognition (Casson, 1995; Kogut & Zander, 1992; Marvel & Lumpkin, 2007). In addition, design thinking proposes a new structure of the entrepreneur, a T-shaped

entrepreneur with deep knowledge within at least one domain and broad general knowledge, experiences, and empathy, which might be essential to better performance of the firm (Brown & Katz, 2009; Luigi & Kwaku, 2007; Martin, 2009; Prabhu et al., 2005). Therefore we expect that the more knowledge a person possesses in terms of breadth and depth separately, the more successful, creative, and innovative he or she will be (Bierly & Chakrabarti, 1996; Dewar & Dutton, 1986; Hansen & Oetinger, 2001). We try to examine that relationship with the following research questions:

Research Questions 1:
How does an entrepreneur's knowledge affect firm innovation?
How do knowledge breadth and knowledge depth influence each other?
How does the combination of knowledge breadth and knowledge depth impact firm innovation performance?

Furthermore, many principles of design thinking, especially at the entrepreneurial level, are encompassed in the concept of integrative thinking proposed by Martin (2007a, 2007b). Therefore this chapter also explores how an entrepreneur's thinking is associated with innovation. According to the literature, integrative thinking helps to produce great solutions and provides an effective way to solve complex problems (Karakas & Kavas, 2008, p. 8; Martin, 2007a, p. 62, 2007b, pp. 9, 16; Sternberg, 2005). Despite its indicated importance and need in modern business society, there is a lack of studies that empirically examine the important role integrative thinking has in the innovation process. Support for integrative thinking's positive influence on innovation is provided.

Research Questions 2:
What are the key determinants of an entrepreneur's thinking that enhance his or her problem-solving skills?
How does an integrative-thinking entrepreneur differ from other entrepreneurs?
How does an integrative-thinking entrepreneur affect firm innovation performance?

The second chapter examines the role of experimentation in a firm. Experimentation is a key component of design thinking (Brown, 2005, 2008; Brown & Katz, 2009; Brown & Wyatt, 2010). Experimentation is a method of problem solving which may significantly reduce costs and time needed in the innovation process (Hughes & Cosier, 2001; Sundukovskiy, 2009; Thomke, 1998a, 2001, 2003). It encompasses a variety of different modes. Recently, scholars (e.g., Schrage, 1999) have emphasized the important role of rapid prototyping for the purposes of a more effective innovation activity. Its contribution for effective product development and knowledge integration has been widely suggested (Hardgrave et al., 1999; Wouters & Roijmans, 2010). We review the impact of different modes of experimentation, specify its vital determinants, and test it on a large sample to determine the more innovative approaches.

Research Questions 3:
How does experimentation help entrepreneurs?
Which modes of experimentation have a profound impact on firm innovation performance?
What is the contribution of rapid prototyping to firm innovation performance?

The chapter continues by exploring the effect knowledge breadth has on the relationship between social networks and innovation. Social networks have been shown to facilitate innovation performance (e.g., Kaasa, 2009; Obstfeld, 2005); however, entrepreneurs should possess an ability to identify and exploit the knowledge needed in their firms (e.g., Cohen & Levinthal, 1989; Murovec & Prodan, 2009). A wide range of knowledge may facilitate such transfer, use, and integration of new knowledge across the range of entrepreneur's social network. (Henderson & Cockburn, 1994; Marvel & Lumpkin, 2007). Moreover, a person with a wider set of knowledge can share knowledge across organizations, transfer implicit knowledge more effectively, and easily connect their original problem to other disciplines, resulting in greater innovation performance (Brown, 2005; Brown & Katz, 2009; Hansen & Oetinger, 2001). We test this relationship on a large sample of SME entrepreneurs and explore the constructs qualitatively in detail.

Research Questions 4:
What factors determine the effective use of social networks in innovation activity?
How does knowledge breadth contribute to the relationship between social network and firm innovation performance?

The third chapter investigates how to compose and structure a team in order to facilitate innovativeness. The increasing number of ventures successfully founded by teams (e.g., Feeser & Willard, 1990) calls for a more detailed understanding of an effective and innovative team. Moreover, the literature recognizes the significant contribution of heterogeneous teams to idea development (Brown & Katz, 2009; Chasanidou et al., 2015; Hassi & Laakso, 2011). Therefore engaging functionally and hierarchically diverse individuals is prerequisite for a successful innovation process and sensemaking (Rauth & Nabergoj, 2016). Despite several validated theories on teams, such as by Belbin (2010), Parker (1990) and Holland (1997), we use a different approach grounded in design thinking theory. We use an interesting experience-based theory of building an optimal team advanced by Kelley (2005) and examine the proposed roles in detail. In addition, by using multiple experiments as a qualitative research method and a regression model as a quantitative research method, we attempt to verify its positive contribution to innovation.

Research Questions 5:
What are the key characteristics an innovative team should possess?
What roles does every team need in order to be most innovative?
What is the optimal form of a team?

Structure of the doctoral dissertation

This dissertation is structured in the form of three scientific articles, which follow the general introduction and conclude with summary remarks.

In Chapter 1 we investigate the interplay between an entrepreneur's knowledge depth, knowledge breadth, integrative thinking, and innovation. The constructs are examined following an interpretative phenomenological analysis (IPA). In Chapter 2 we develop a conceptual model to test the relationship between different types of experimentation and innovation. Furthermore, the role of an entrepreneur's social network is linked to knowledge breadth and their relationship is tested quantitatively on a large sample. Chapter 3 draws from an experience-based theory about innovative team structure by Kelley and Littman (2005). Using a combination of qualitative and quantitative research methods, we explain how to structure a team in order to improve innovation performance. The final chapter includes the summary of the study and offers overall implications and limitations. Finally, the dissertation ends with a comprehensive abstract in Slovene. In addition, we supplement the study by developing an integrative thinking measurement scale and verifying the conceptual model from Chapter 1 using a hierarchical regression analysis in Appendix E.

1 EXPLORING THE INTERPLAY OF AN ENTREPRENEUR'S THINKING, KNOWLEDGE, AND FIRM-LEVEL INNOVATION[1]

1.1 Introduction

The more extensive a man's knowledge of what has been done, the greater will be his power of knowing what to do.
Benjamin Disraeli
(1804–1881, British Prime Minister)

This quote by Benjamin Disraeli indicates the important role of knowledge, experiences, and accumulated skills in dealing with unknown situations. Its meaning can be easily reflected in entrepreneurship, where entrepreneurs tackle problems they have never experienced before with their own knowledge base and methods in order to provide an innovative solution. The impact of knowledge (Dakhli & De Clercq, 2004; Davidsson & Honig, 2003) and an entrepreneur's thinking (Baron, 1998; Krueger, 2007) on different entrepreneurship outcomes has been widely explored in prior literature. The significant impacts of these characteristics in entrepreneurship, such as creativity (Shalley & Gilson, 2004), firm performance (DeCarolis & Deeds, 1999), opportunity recognition (Ardichvili et al., 2003), and innovativeness (Marcati et al., 2008) have long been delineated. However, we still do not have a good understanding of how aspects of an entrepreneur's cognition interact in influencing firm-level innovation. Correspondingly, we are interested in an individual's narrative about innovation.

An individual's knowledge serves as a prerequisite base for discovering and exploiting opportunities (Gupta & Govindarajan, 2000; Wiklund & Shepherd, 2003) and represents a foundation on which innovation can be built (Nonaka et al., 2000). Authors such as Price et al. (2013) suggest a positive relationship between knowledge and innovation, and recognize knowledge as a vital part of innovation activity (Cohen & Levinthal, 1990; Martín-de-Castro et al., 2008). Scholars distinguish between different types of knowledge. Rather than studying a firm's accumulated knowledge, this research focuses particularly on knowledge at the individual level of an entrepreneur, specifically its breadth and depth, and the effect these domains have on firm innovation. The first refers to the range of different areas in which a firm has expertise, whereas the latter indicates the amount of within-field knowledge (Prabhu et al., 2005). Drawing from existing literature, our particular interest concerns exploration of individual as well as interactive effects of both dimensions – depth and breadth – on innovation.

[1] This chapter is has been accepted for publication in *Economic and Business Review* (EBR) in December 2016.

In addition to an entrepreneur's knowledge, we also aim to explore entrepreneurs' thinking patterns. Building on the proposition of F. Scott Fitzgerald (1945), who said "The test of a first-rate intelligence is the ability to hold two opposed ideas in mind at the same time and still retain the ability to function", we explore entrepreneurs' thinking patterns to discover components that lead to innovativeness. We base our research on a theory by Martin (2007b), who claims that successful entrepreneurs are competent integrative thinkers, and explore the contribution of such a thinking style to innovation. Martin defines integrative thinking as "the ability to face constructively the tension of opposing ideas and, instead of choosing one at the expense of the other, generate a creative resolution of the tension in the form of a new idea that contains elements of the opposing ideas but is superior to each" (Martin, 2007b, p. 15). According to Martin, integrative thinking is one of the capabilities that facilitates business success (2007b, p. 16). Moreover, this discipline of consideration and synthesis is a hallmark of a superior business and provides a built-in advantage over their competition. He argues the necessity of possessing this ability in every leader's mind to better confront complex problems and embrace the mess and ambiguity long enough to solve the problem (Sternberg, 2005).

Scholars have shown that integrative thinking enhances production of great ideas. Despite its indicated importance and need in modern business society, there is a lack of studies empirically examining the role of an entrepreneur's integrative thinking in a firm's innovation. This paper explores relevant components that characterize the thinking of an innovative entrepreneur, examines them in accordance with the theory of integrative thinking, and verifies their contribution to innovation.

We seek to verify empirically the importance of an entrepreneur's integrative thinking for innovation. The concept derives from observation, and we begin by exploring entrepreneur attributes that characterize innovativeness. By identifying the emerging themes that delineate thinking that fosters innovation, we reveal the resemblance to the theory of integrative thinking. In response to the limited studies in the field, we utilize qualitative research methods to develop a deeper understanding and rich descriptives of entrepreneurs' perceptions and behaviour in relation to firm-level innovation (Patton, 2002). A novel interpretative phenomenological analysis (IPA) is used to explore how entrepreneurs perceive different situations they are facing in the innovation process, how they make sense of the surrounding factors, and what meaning they attribute to underlying cognitive attributes (Smith et al., 1997).

In this study we focus on small and medium-sized enterprises (SMEs) entrepreneurs. We demonstrate that SMEs' innovation can be attributed largely to the knowledge and thinking of the entrepreneurs who run them, rather than being a cumulative effect of all employees. Generally speaking, SMEs provide an interesting field of research because they are essential to the economy (Drilhon & Estime, 1993; Lin, 1998) and have become a driving

force for technological progress, economic growth, and overall competitive development (Lin, 1998; Thornburg, 1993).

We begin by reviewing existing literature on individuals' knowledge, integrative thinking skills, and innovation to develop our research questions. We then continue by explaining our research methodology and synthesize results of the IPA analysis. We conclude by providing propositions, implications, limitations, and future research opportunities.

1.2 Literature review

1.2.1 Knowledge breadth and knowledge depth

This research focuses on two dimensions of personal knowledge: depth and breadth. In the literature, knowledge depth is described as the degree of expertise one possesses, whereas knowledge breadth refers to a broad understanding of other disciplines (Brown & Katz, 2009). To date, the knowledge dimensions of depth and breadth have been studied mostly at a firm level. Authors have looked at the subject from various perspectives. Marvel and Lumpkin (2007) proved the positive effect of experience depth on innovation radicalness. Similarly, Luigi and Kwaku (2007) conducted research in the field of market knowledge. Their results prove that market knowledge breadth has a direct, unmediated effect on product innovation performance, whereas market knowledge depth is only partially influential. A recent study by Carlo et al. (2012) examined a knowledge-based model of radical innovation in the field of IT. It shows an important role of knowledge depth and knowledge diversity of a firm in the level of radical innovation. However, these three studies were conducted at a firm level. Therefore more studies are needed to explore in detail the interplay between entrepreneur knowledge depth and breadth and the overall contribution of these domains to firm innovation.

Interestingly, the effect of knowledge depth is not self-evident. There is evidence of both negative and positive influences on innovation. Because knowledge nature is field specific, firms have different volumes of knowledge depth within a certain field (Prabhu et al., 2005). It is very likely that depth of knowledge affects innovation activity in a specific field in a positive direction. Prabhu et al. (2005) confirmed the assumption, showing that firms with a deeper knowledge are more innovative in terms of patent numbers. Similarly, other authors (Bierly & Chakrabarti, 1996; Leonard-Barton, 1992; Prabhu et al., 2005) suggest that firms, in order to gain competitive advantage and to innovate, must focus on specific knowledge domains (core competencies) and deepen that knowledge even further.

On the other hand, nowadays narrow specialization tends not to be sufficient – emphasizing one specific area of expertise and lacking the adaptive ability to advance in

different fields might cause firms problems handling different situations which require diversified knowledge, through the institutionalizing of core rigidities resulting in inhibition of innovation activity (Leonard-Barton, 1992, 1995). Specifically, experts typically possess many experiences and skills and much knowledge in their areas of expertise. Their focus becomes a specialized niche. Therefore they suffer from an "expert syndrome", which inhibits their creativity (Dean, 1999). The term describes the experts' usual negligence of other domains outside their specialization. The dangers of this limited focus are interestingly described by the philosopher Osho (2004): "All experts are blind. Expertise means you become blind to everything else. You know more and more about less and less, and then one day you arrive at the ultimate goal of knowing all about nothing. Then you are completely closed and not even a window is open. This is unintelligence. Intelligence is to be open to wind, rain, and sun, to be open at all."

Evidently, there exists the unconditional need for knowledge diversity and, consequently, knowledge breadth. Scholars (Bierly & Chakrabarti, 1996; Cohen & Levinthal, 1990; Simon, 1985) stress the importance of knowledge diversity for creativity and innovation, which also represents a basis for strategic advantage, and of the ability to integrate knowledge across different scientific knowledge bases outside and inside the firm's main scope, for better performance and innovation (Henderson & Cockburn, 1994; Pisano, 1994).

Furthermore, Madhavan and Grover (1998) claim that both knowledge depth and breadth are positively related to efficiency and effectiveness. Indeed, boosting knowledge breadth and depth in a complementary rather than a substitutive way might be crucial for a firm's success. Along with this assumption, Dewar and Dutton (1986) stress the importance of knowledge depth and diversity for innovation. So an entrepreneur must possess the highest level of both knowledge domains (Bierly & Chakrabarti, 1996). Prabhu et al. (2005) also suggest that breadth of knowledge increases the possibility for "happy accidents", which may originate as a result of concept application from one field across different disciplines. Likewise, van Wijk et al. (2012) indicate the necessity of balanced knowledge for enhanced innovation performance – knowledge depth is shown to contribute to exploitative and exploratory innovations, whereas knowledge breadth impacts solely exploratory innovations.

It is evident that companies that generate knowledge from a vast foundation are more productive (Henderson, 1994). Bierly and Chakrabarti (1996) emphasize the role of knowledge breadth, because such a knowledge base provides more options to transform related technologies in new, unexpected ways, which eventually increases the sustainability of competitive advantage (Reed & DeFillippi, 1990). Many researchers provide explanations of the positive role of the integration of different fields of expertise (Henderson & Cockburn, 1994), especially in technical industries. They mention that deep

expertise in one field and integration of a wide range of disciplines increases the competitive edge of a firm. In order to stay in the market within a certain discipline, firms have to broaden their areas of specialization. Prabhu et al. (2005) show that greater breadth of knowledge leads to increased innovation. Similarly, Cohen and Levinthal (1989) recommend a greater number of fields of knowledge in order for a firm to be more innovative.

Building on such theories as that human capital positively affects firm innovation (Becker, 1962; Dakhli & De Clercq, 2004; Popadiuk & Choo, 2006) and that depth of technical experience and education is positively related to innovation radicalness (Marvel & Lumpkin, 2007), we can assume also that entrepreneur knowledge – specifically, its breadth and depth – positively affects innovation performance of a firm. Deriving from the previous discussion, we can postulate that human capital in SMEs is largely represented by the entrepreneurs who run them, so their knowledge may have a positive effect on innovation. In other words, the knowledge set of an entrepreneur may provide a foundation on which a firm is able to innovate (Nonaka et al., 2000).

We build our research questions on the assumption of the prevailing role of entrepreneurs in the decision-making processes of SMEs (Lin, 1998; Torres & Julien, 2005). We use this role to create a parallel between the connection between firm-level knowledge and innovation and the connection between a manager's/entrepreneur's knowledge and firm innovation. The focus on the relationship between an entrepreneur's individual-level characteristics and firm-level innovation output is of particular importance in the context of SMEs, because it has been shown that entrepreneurs are vital drivers of firm innovation (Marcati et al., 2008). Amabile et al. (1996) suggest that innovation begins with creative ideas by individuals and teams within an organization. Whereas large firms are managed by professionals, SMEs usually are owned and run by founders (Lu & Beamish, 2006; Shuman & Seeger, 1986; Welsh & White, 1981). The latter are less comprehensive in their decision behaviour, and thus should possess more diversified knowledge (Smith et al., 1988), because their behaviour otherwise might have negative consequences for the enterprise's performance (Lu & Beamish, 2006). Moreover, firm performance, development, growth, and innovation are said to be a reflection of an entrepreneur's characteristics, actions, effectiveness, and behaviour (Baron, 2013; Covin & Slevin, 1991; Hmieleski et al., 2015; Lin, 1998; Liu et al., 1995). North and Smallbone (2000) show the central role of an entrepreneur in the initiation and development of innovation. In their study, an entrepreneur was often also the only person involved in the innovation process of a firm.

Building on prior literature, we define the scope of our research by posing the following questions:

How does an entrepreneur's knowledge affect firm innovation?
How do knowledge breadth and knowledge depth influence each other?
How does the combination of knowledge breadth and knowledge depth impact firm innovation performance?

1.2.2 Entrepreneurs' integrative thinking

Another important attribute successful entrepreneurs have been shown to exhibit is integrative thinking (Martin, 2007b). Integrative thinking illustrates a manner in which entrepreneurs solve problems. Effective use of such thinking brings their firms to a higher level of performance and innovation.

According to Martin (2007b) the process of integrative thinking consists of four steps. These stages do not differ tremendously from conventional business thinking; rather, it is the way in which integrative thinkers approach them that makes a difference. In determining salience, an integrative thinker, in contrast to a conventional thinker, searches for less obvious but potentially relevant factors. When analysing causality, not only linear relationships between variables are considered but also multidirectional and nonlinear relationships. A third step, employment of a holistic approach to the problem, is crucial. Resolution is later achieved by resolving tensions between opposing models.

In the following paragraphs we review the steps of the process in depth and examine their individual contributions to innovation. For the purposes of innovation it is crucial to determine real market needs, develop a deep understanding of the consumer, and then to comprehend all the fragments that compose a problem (Ambrose & Harris, 2009; Brown, 2005; Brown & Katz, 2009; Brown & Wyatt, 2010; Martin, 2007b; Nussbaum, 2004; Sakkab, 2007). Integrative thinkers exhibit an ability to see all the salient aspects of the problem and seek less obvious but relevant factors (Brown, 2008, p. 87; Martin, 2007a, p. 66, 2007b, p. 47). In other words, integrative thinkers are sensitive – they possess a capacity to uncover those conditions that are similar but still different (Martin & Austen, 1999). This advantage might have a parallel in an organizational construct of absorptive capacity. In order for firms to be innovative, they require an ability to recognize new and useful external information, assimilate it, and then use it for commercial purposes (Cohen & Levinthal, 1990). Such characteristics are suggested to have an important effect on innovation and overall performance, because more relevant information can be gathered externally and used appropriately in problem solving. The importance of recognizing valuable information has been suggested by several authors in relation to the search process for innovation (Fabrizio, 2009; Tsai, 2006), innovation capability (Liao et al.,

2009), product and process innovation (Murovec & Prodan, 2009), products and revenues (George et al., 2001), new product development (Stock et al., 2001), and learning and joint venture performance (Lane et al., 2001). Because our focus is on SMEs, where an entrepreneur's decisions usually also represent the firm's decisions (Carrier, 1994; Torres & Julien, 2005; Welsh & White, 1981), we postulate that the same features also apply to entrepreneurs.

Entrepreneurs further differ in mechanisms for analysing causality. To make a good decision later on, a proper analysis of the salient features and how they relate to each other must first be made. Conventionally, entrepreneurs seek an easy way out and are happy with simple linear relationships. On the other hand, integrative thinkers consider all relationships between variables, because they believe that better models exist around them that are not yet seen. For example, conventional entrepreneurs would think that "our competitors' price cutting is hurting our bottom line", whereas integrative thinkers would deduce that "our product introduction really upset our competitors. Now they're cutting prices in response, and our profitability is suffering" (Martin, 2007b, p. 42). This step is grounded in generative reasoning, which helps to provide a foundation for creative resolutions. Generative reasoning essentially seeks the best explanation in models that do not yet exist. To put it differently, it is the process of using abductive logic, which successfully operates with novel and interesting data and makes the best explanation of it (Ambrose & Harris, 2009, p. 43; Thomas Lockwood, 2009).

Deduction, a top-down approach, is the logic of what should be, where a conclusion is derived from a set of premises (Goel et al., 1997; Rips, 1994). On the other hand, induction is the logic of what is operative, drawing general rules from observation (Arthur, 1994; Goel et al., 1997; Martin, 2007b). Scholars (Peirce et al., 1974) argue that "neither deductive nor inductive logic satisfactorily explained how new models came into being". The first needs an established model on which one can establish reasoning, whereas the latter draws conclusions from repeated experiences. However, in order to be innovative, one needs a suitable logic to open one's mind. Therefore another reasoning style should be the adopted to help create the best model of novel data that does not fit any existing model (Martin, 2007b, p. 146).

In contrast to induction and deduction, abduction is the logic of what might be rather than what already is, which is appropriate for the purposes of integrating different ideas into a better solution. When solving difficult problems, integrative thinkers need to look at everything, because a potentially omitted part could lead them to solution. Abductive logic is a tool for discerning a pattern out of the mystery (Martin, 2007b, 2009, p. 74). Additionally, other scholars such as Kolko (2010) think of it as the "argument to the best explanation". He describes it as "the hypothesis that makes the most sense given observed

phenomenon or data and based on prior experience". In essence, abductive logic, unlike other reasoning tools, helps create new insights and knowledge.

According to Peirce et al. (1931-1966), abduction is a process of thinking from evidence to explanation without causing contradictions, and as such represents a step in scientific investigation (d'Avila Garcez et al., 2003; Kakas et al., 1998). After an observation of an unpredicted phenomenon is made, abduction is used to find answers, because it is perfect for managing incomplete information (Arrighi & Ferrario, 2008; Hintikka, 1998). Although it is not acknowledged as a method for validating scientific hypotheses, abduction proves useful in explaining a puzzling observation (Aliseda-Llera, 1997; Aliseda, 2003). Some scholars (e.g., Hanson, 1958; Peirce et al., 1931-1966) even claim that many discoveries have been made employing this method. For example, the reasoning Kepler is said to have used in explaining the universe was abductive. Abductive logic appears to have gained popularity in recent years mainly due to its potential for generating creative ideas. Nowadays, many businesses use it to as a good guess to design new business models in emerging and transforming industries, where innovative models are of vital importance for the success and survival of a firm (Dew, 2007).

In addition, an important feature of generative reasoning is also a trial-and-error concept, which is shown to shorten product development time (Thomke & Fujimoto, 1998), enhance product design (Thomke, 1998a), and foster innovation (Cannon & Edmondson, 2005; Thomke, 2003). In summary, abductive thinking, by generating new hypotheses and new outcomes, fosters creativity and innovation (Gonzalez & Haselager, 2005; Huston & Sakkab, 2006; Magnani, 2005; Martin, 2007b; Ross, 2010; Takeda et al., 2003).

After causal relationships between salient features have been established, a decision needs to be made. Entrepreneurs usually lose sight of a problem, which results in mediocre results. Integrative thinkers, on the other hand, do not break a problem into pieces and work on them separately. Rather, they keep the whole problem architecture in mind to see how different parts fit together and how decisions will affect one another. A third differentiation from conventional thinking is the use of a holistic approach.

Integrative thinkers create a holistic architecture in a search for creativity (Ambrose & Harris, 2009; Brown, 2008; Martin, 2007b, p. 82). They avoid conventional thinking by using segmented analyses, and by keeping the entire problem in mind while working on its parts they are able to examine the mutual effects of single parts (Brown & Katz, 2009; Martin, 2007a, pp. 65-67, 2007b, p. 43, 2009). Holistic thinking enhances understanding of the relationships between parts within the context of the system. This style creates the foundation for a greater innovativeness and innovation, because problem defragmenting is not optimal for solving tough problems (Fraser, 2009; Hassi & Laakso, 2011; Ward et al., 2009) – Martin (2007b, p. 79) argues that there exist only business decisions, not finance,

marketing, and other decisions. A problem must be seen as a whole, and segmented specialists (e.g., R&D, marketing, human resources) do not have much knowledge in other fields and therefore frequently reject decisions other than their own. Other divisions then have to try their best within limits. Many other scholars (Cooper & Edgett, 2008; Desbarats, 2005; Flynn et al., 2003; Loewe & Dominiquini, 2006; Matheson, 2006) agree that a holistic approach has become a new imperative for better innovation processes and therefore for achieving a competitive edge. For example, when designing a new and better product (e.g., a railcar), one needs to consider the entire experience users have with the product – that is, the ride (ticketing, waiting, boarding, riding, arriving, ...) (Martin, 2007b, p. 83).

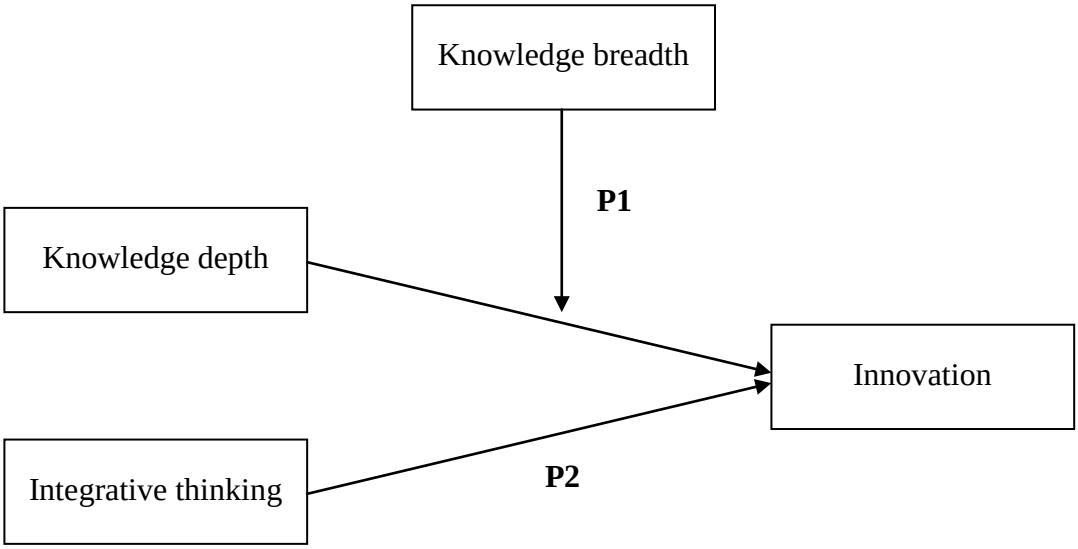
In achieving resolution, entrepreneurs too often accept unpleasant trade-offs and settle for the best alternative. The reason lies in their tendency to simplify, which causes ignorance of possible opportunities which emerge when examining problem features in the previous stages. By contrast, should there exist tensions between opposing ideas, integrative thinkers are prepared to solve them and generate innovative outcomes (Martin, 2007a). It is no problem for them to examine everything again at the end of the process and find a way to integrate all features in a nonconventional, superb, innovative outcome. Integrative thinkers are willing to hold tension in mind until they find the most optimal solution, which calls for openness to uncertainty and ambiguity rather than rushing to closure (Boland & Collopy, 2004; Cooper et al., 2009; Martin & Austen, 1999). They do not see challenges as binds and do not search for compromises; rather, they develop a creative strategy for coping with the unpleasant trade-offs and tensions (Hassi & Laakso, 2011).

Prior literature suggests that the steps that form the integrative thinking process have a positive effect on innovation individually. Building on prior knowledge suggesting a strong linkage of entrepreneur behaviour in fostering SMEs' innovation (Marcati et al., 2008), we expect that entrepreneur thinking enhances firm innovation. This study explores entrepreneur mindset, factors that determine how their thinking leads to innovation, determines how successful entrepreneurs act, and examines a possible linkage of these attributes with the characteristics of integrative thinking. The aim is to reveal prevailing factors of entrepreneur mindset that affect innovation and verify whether these factors actually characterize integrative thinkers, which are said to be the new imperative in business. To set the context of our research we pose the following questions:

What are the key determinants of an entrepreneur's thinking that enhance his or her problem-solving skills?
How does an integrative-thinking entrepreneur differ from other entrepreneurs?
How does an integrative-thinking entrepreneur affect firm innovation performance?

Figure 4 summarizes proposed relationships.

Figure 4: Summary of research questions and propositions – the interplay of knowledge, integrative thinking and innovation



1.3 Research design

This article develops a deep understanding of how an entrepreneur's knowledge dimensions and integrative thinking interact to impact firm innovation. Because there exists a paucity of studies that qualitatively examine entrepreneurs' stories about the mechanisms we study and their impact on innovation, the qualitative methodological approach was used to examine entrepreneurs' feelings, attitudes, and perceptions (Patton, 2002). Existing empirical studies suggest a positive independent effect of our investigating variables, but we do not yet know enough about their interplay and overall impact on firm innovation.

Interpretative phenomenological analysis (IPA) was found to be the most appropriate method for exploring the personal experiences and perceptions of entrepreneurs (Cope, 2011; Smith et al., 1997; Thompson et al., 1989). IPA attempts to explore real-life motives, largely leans on personal experience, and draws on individuals' perceptions, rather than producing an objective statement (Pietkiewicz & Smith, 2014). Using this method, we may be able to better understand relationships between knowledge breadth, knowledge depth, an entrepreneur's integrative thinking skills, and the overall effect of these factors on firm innovation. Our aim is thus to explore in detail our area of concern and identify essential components of entrepreneur knowledge and integrative thinking in relation to innovation which make them unique, rather than to test predetermined hypotheses.

The study draws on the indicative guidelines for IPA by Smith (2014; 1997). The process consists of several steps: (1) formulating research questions, (2) sampling, (3) data

collection, (4) analysis, and (5) writing up. The research questions were designed very broadly with an open inductive approach to understand how entrepreneurs experience our particular phenomena. No predetermined propositions were formed prior to our research. We used what we have learned from the research to later develop propositions based on the literature review.

1.3.1 Sampling

IPA aims to produce a detailed examination of phenomena, rather than to generate a generalizing theory. Nevertheless, the investigation may bring insights into universal mechanisms (Pietkiewicz & Smith, 2014). The method relies on the use of purposeful sampling within a fairly homogenous group, because it involves finding a group of information-rich participants who share significance and relevance for a particular research problem (Greening et al., 1996). Such participants provide an in-depth understanding of the studied phenomena (Patton, 2002). Purposeful sampling is constructed to serve our specific need to include entrepreneurs with similar demographic/economic-status profiles, closely related to experiences in innovation, in order to enable a profound examination of our research questions. In addition, snowball sampling was utilized by asking participants to suggest someone else in their network suitable for our research.

IPA studies use small sample sizes because a detailed analysis is time-consuming – the aim is not to generalize but to determine the in-depth perceptions of the participants (Smith, 2015). In theory, a sample of three is recommended because it allows adequate in-depth individual engagement and still showcases similarities and differences between individuals. A larger sample size could lead to overwhelmingly vast amounts of data being generated, which may inhibit production of a sufficiently incisive analysis. Therefore our sample consists of three Slovenian entrepreneurs whom we identified through our personal network.

1.3.2 Data collection

The primary methodology used in IPA research is phenomenological semi-structured interviewing. We followed IPA guidelines (Smith, 2015) to attain a first-hand description of investigated domains of the entrepreneurs' experiences. Such interviews allow enough flexibility to provide solid grounds for further detailed examination of unexpected directions and interesting areas that may arise. The interview protocol was loosely structured in advance and began with an opening question without hidden presumptions about the entrepreneurs' personal stories of determinants that can be attributed to their firm innovation, followed by key questions indicating the topics we wanted to discuss (Appendix B). Initial questions were modified to participants' responses by gentle probing (Smith, 2015). When respondents gave intangible answers, we used more-explicit yet still

sufficiently vague prompts to move to our addressing areas. Similarly, we strictly avoided evoking a notion of knowledge breadth, knowledge depth, and integrative thinking until the last part of the interview, when we tried to connect their stories with the mentioned mechanisms. We carefully recorded responses provided by participants and loosely funnelled them to the researched topics with minimal probing by asking them more-specific questions. Such questions included the role of their accumulated experiences, people around them, and their unconventional thinking in firm innovation. We recorded the interviews with the agreement of all three participants. The profiles are located in Table 1.

Table 1: Profiles of interviewed entrepreneurs

Name	***Profile***
Adam	Adam is a serial entrepreneur, manager, and, recently, a well-known Slovenian business angel with an interest in internet media, marketing, sales, and the automotive industry. He also lectures, consults, and writes for important Slovenian newspapers. He is a partner in many successful companies and has co-founded one of the biggest online stores in the region. Over more than 20 years he has created half a billion euros of business without any losses. His passion is predicting future trends and exploring the impact of new technologies. Recently he has started to mentor young entrepreneurs.
Ben	Ben is an entrepreneur with a diverse background in programming and philosophy, and can be best described as an evangelist of the regional start-up community. He is a co-founder and a general manager of the first start-up in Slovenia to acquire venture capital financing. His company raised almost 10 million euros' worth of investments. He is also a member of a Slovenian business angel fund. He has long lived and worked in New York and has become involved in different start-up stories as a supervisor. His experiences have been recognized by leading global accelerators.
David	David was on the board of directors at one the leading company for direct marketing and e-commerce in Central and Eastern Europe, with over 7000 employees and 300+ million customers, when he decided to leave his job four years ago. In charge of sales and IT, in his last year he had spent 298 days travelling for business. Ironically, after he quit, he went on a trip around the world for a year, which gave him incentive to start his own business. He founded his own start-up to create an imaginative centre where new ideas will arise. His first entrepreneurial story is a personalised natural cosmetics firm.

1.3.3 Data analysis

Smith (2015) suggests that IPA methodology is flexible, individual, and not prescriptive. Following a set of flexible guidelines, which can be adapted to specific purposes, we used a step-by-step approach to the analysis.

First we transcribed all three interviews, each of which lasted between 70 and 80 minutes. We read all three transcripts several times in order to become more familiar with the content and to identify potential new insights. In each stage of reading, we made additional notes and observations about the content, language, and context. The next stage involved

transforming these notes into emerging themes, concise phrases that captured the essential context of the notes. We continued with theme clustering by identifying the connections between emerging themes. These clusters then represented the superordinate themes, which fully capture the entrepreneurs' views of our topic.

Each transcript was searched individually for its own theme clusters without any presumptions. Following identification of convergence and divergence between participants' themes, a final table of superordinate themes was constructed for all three topics under investigation. In the process, certain themes were dropped because they did not fit well within the structure.

Three main superordinate themes emerged for entrepreneur knowledge and eight for integrative thinking. In what follows, we describe each theme and provide evidential interview extracts to support our interpretation and to present entrepreneurs' pertinent perspectives.

1.3.4 Findings

In the next sections, findings from the IPA analysis are described by categories. Because innovation is our main dependent variable, we initially aim to gain additional insight into how entrepreneurs perceive innovation and comprehend its meaning. Therefore, we start by providing a brief insight into innovation as it is understood by our entrepreneurs. We continue by demonstrating results for entrepreneur knowledge and conclude with findings regarding entrepreneur thinking. We started the interviews by discussing firm innovation. Although there exist several definitions of innovation in the literature, such as "the successful implementation of ideas within organizations" (Amabile et al., 1996) or "the generation, acceptance and implementation of new ideas, processes, products, or services" (Thompson, 1965), we aimed to understand how this term was understood, experienced, and conveyed by entrepreneurs themselves. Building on the findings of how our entrepreneurs see innovation, we can point out four superordinate themes that emerged: (1) openness, (2) entrepreneurs' characteristics, (3) company culture, and (4) performance.

First, our respondents relate a firm innovation and performance with a personal proclivity to openness, which has been suggested in the literature (Ciavarella et al., 2004; Dean, 1999; Slavec, 2014; Zhao et al., 2010). In order for a person to be innovative, David stresses that one "must be open, be acceptable to difference and seek new paths". He adds that out-of-the-box thinking and constant observation are prerequisites for an innovation activity. Such a person will "always investigate how to make things differently and follow world trends". Ben also argues that innovativeness is dependent on out-of-the-box thinking. Taking this concept to the firm level, he supplements his definition of innovation. In his opinion, an innovative firm "invents solutions during problem analysis without any

preliminary assumptions". Innovation is enhanced by "the processes that gravitate towards non-obvious solutions". In addition, Adam connects innovation with improvements a firm can offer to existing problems and obstacles: "Firm innovation is a firm's thinking about the future."

Our respondents emphasized that their personal characteristics largely reflect their firm's actions. These characteristics then affect firm performance and innovation (Marcati et al., 2008; North & Smallbone, 2000). In the words of Adam, "Every decision I make brings consequences to the firm. My characteristics have a great impact on business decisions I take and consequently on business decision my firm takes. The way I work and my approach will grant a totally different effect on a firm than somebody else's approach." In other words, the characteristics of a company that affect its performance and innovation largely can be attributed to entrepreneurs, because they impose all decisions. Ben argues, "The firm reflects decisions of all employees, especially of the lead entrepreneur, who is just more invested and creates more visible actions." Drawing on our respondents' insights we can suggest that an entrepreneur equates firm-level decisions to his own decision-making process.

A firm's culture and its intra-relations have been shown to be closely related to innovation (e.g., Hurley & Hult, 1998; Tellis et al., 2009; Terziovski, 2010). Adam argues that a "firm must develop a special system to support innovative people. And to enhance a firm's innovation, relaxed internal relations are a must." Correspondingly, David sees a firm's culture as an important driver of innovation. He emphasizes the importance of uniform acceptance of employees' ideas. He postulates that "entrepreneurial culture within a firm has a grave impact on innovation. There is no traditional hierarchy; everyone must trust each other and their ideas must be valued at the same level." Moreover, he attributes significance to empathy, which seems to be essential for innovation: "An entrepreneur must know how to listen to his employees. He must get into their shoes to understand and help them. Not just that, an entrepreneur must show a great interest in his employees, so they feel important. That means that a barrier between them becomes blurred." In his words, an entrepreneur must be an extrovert and accept different insights. This is how innovation is granted. Comparatively, Ben argues the importance of the whole ecosystem in attaining innovation: "The amount of innovation and execution will affect a firm's growth. It is very easy to only survive as a firm. However, many firms stay in their comfort zones and no extra breakthrough can be achieved. I think a firm needs to constantly grow, seek new solutions, and receive inputs of the whole ecosystem. Every start-up that succeeds is an achievement of the whole ecosystem."

Nonetheless, innovation seems not to be conditional for success (Lööf & Heshmati, 2006; Rosenbusch et al., 2011). They agree that in order for a firm to be safely successful, it does not have to be innovative. Ben says, "If a firm is satisfied with ordinary, no innovation is

needed. In my opinion, both innovative and expert problem solving are equally good." David adds, "Innovation is only partly linked to success." However, the innovation is necessary to make improvements and for overall progress. Adam says, "Without innovation there would be no future. And if you can be successful and innovative at the same time, that is something your firm should seek for."

1.3.4.1 Entrepreneur knowledge

Extensive knowledge in one field is said to be no longer sufficient. We expect that the more knowledge a person possesses in terms of breadth and depth separately, the more successful, creative, and innovative he/she can be; narrow specialists tend to neglect other points of view and thus are inflexible and hard to work with. On the other hand, if a person possesses only knowledge breadth, his/her skills are insufficient to be a part of strategic process. Therefore, Brown (2005; 2009) postulates that firms need to search for people with balanced knowledge depth and breadth to remain competitive. These two knowledge dimensions can be represented by a so-called T-shaped structure, where a vertical line depicts depth and a horizontal line depicts breadth. Such a balanced person possesses deep knowledge and deep analytical expert thinking skills in his/her field of specialization along with a broad understanding of other disciplines and broad empathy. In this case, depth represents a skill that allows making tangible contributions to the outcome, whereas breadth depicts the capacity and disposition for collaboration across disciplines. Such individuals are curious, open-minded, always eager to learn, and have experience in areas not necessarily directly needed for their jobs. This structure allows them to combine knowledge, i.e., to connect general knowledge, experiences, skills, and hobbies to a problem in the area of their expertise. It enables new perspectives on how to utilize the expert knowledge in many different aspects of life and thus makes entrepreneurs more creative and, ultimately, innovative (Brown & Katz, 2009).

Grant (1996) assumes that narrow-field knowledge itself is not sufficient by exploring mechanisms for effective specialist knowledge integration. He suggests that specialists do not need to know everything from other expertise domains, but communicating their knowledge to other specialists is of particular importance. For such operations, a common knowledge is crucial, because it enhances sharing different aspects of knowledge. Evidentially, there appears to be a solid relationship between an entrepreneur's knowledge and his/her innovativeness, which affects a firm's innovation (Jiao et al., 2014; Marcati et al., 2008). An entrepreneur's knowledge base may improve the likelihood of opportunity recognition and is positively related to innovation radicalness through generated breakthrough insights (Marvel & Lumpkin, 2007). In addition, knowledge breadth has been recognized as a catalyst for successful managerial innovation and innovation performance (Rodan & Galunic, 2004). In the following sections we review how entrepreneurs actually perceive knowledge in real-life situations.

Participants were asked to discuss all of the determinants that enhance and affect the innovation activity of the firm. They started very broadly and soon narrowed to their personal-level characteristics. The first topic that emerged was personal knowledge. The findings uncover three areas that characterize an entrepreneur's knowledge and its effect on innovation: (1) openness to experiences, (2) knowledge breadth and depth, and (3) learnability and curiosity. Table 2 systematically depicts results.

Entrepreneurial openness has gained a great deal of attention recently. Scholars such as Slavec (2014), Ciavarella et al. (2004), and Dean (1999) link it with innovation and performance. In terms of an entrepreneur's openness, all three participants highlighted travel, command of foreign languages, and personal hobbies. These three aspects are prerequisite to gaining new insights which enhance innovation. They enhance idea generation, improve the process of problem solving, and grant easier access to information. As participant David suggests, travelling serves as a foundation for spotting new ideas, enhanced communication, better self-confidence, and a greater understanding: "In this way you can see that the world is not a bogey, that others are not so much more capable than you, you get confidence and lose fear." Similarly, participant Ben argues that personal openness, hobbies and experiences gained through travelling are essential for innovativeness: "The breadth of life experiences significantly increases the likelihood that you will find the optimum solution for whatever is a concrete problem. And it is important to have a personal life just so that your brain remains soft and flexible." In his opinion an entrepreneur's brain is constantly on when faced with an ambitious challenge. It is not rare that one can find a solution to a problem when dealing with a completely different situation. Participant Adam, on the other hand, when discussing the innovation factors, puts significant emphasis on command of foreign languages: "You have to speak different languages to recognize the important actual trends and to acquire information easier."

The next theme that emerged during our data analysis is knowledge in terms of its depth and breadth. Knowledge depth creates a foundation on which innovation can be built (Prabhu et al., 2005). Specifically, depth of experiences contributes to innovation radicalness (Marvel & Lumpkin, 2007). David agrees: "Expertise in a certain area is central for strategic thinking and innovation." The vital role of knowledge depth is also summarized by Ben: "An entrepreneur needs a content to start innovating. You have to know it all to exploit opportunities and to find a gap in a certain area, which could be further optimized and turned into a prosperous business opportunity." Interestingly, Adam stresses the importance of different knowledge dimensions: "To keep your product fresh and competitive, you need to build on your existing expertise and dig deeper into technology, user experience, or even marketing. Similarly, when introducing new products, the knowledge depth in your field is still required; however, in order to construct something completely new, you need to expand your knowledge in various domains to produce something really unique." The need for both knowledge dimensions is best

described by David: “I need both knowledge depth and breadth. This is the only way that guarantees new perspectives on how my expertise can be creatively used.”

Knowledge in different domains for the purposes of greater innovativeness has been highlighted by several scholars (Bierly & Chakrabarti, 1996; Brown & Katz, 2009; Carlo et al., 2012). Participants highlight the important role of knowledge breadth in enhancing innovation, because combining different disciplines helps uncover innovative solutions. Adam sees knowledge breadth as an important generator of hype and curiosity to start something new and consequently fuel innovation: “You need a horizontal knowledge to be innovative. Not that I am a top expert in all domains, but at least I know which industries are prospective and what is to be expected from them.” Ben further outlines the important role of knowledge breadth in innovation: “Knowledge in a certain area may bring an innovative solution to the problem in a completely different area as you try to connect them together. The fact that I taught myself to program in a previous life has a significant impact on my ability to connect different disciplines with programming and search for creative solutions.” David adds, “Many times I remember Mr. Japec, who said that his cardiology profession helped him in designing innovative ships.”

All three respondents similarly specified knowledge breadth as the most important factor in achieving innovation. Knowledge breadth is vital to understanding what knowledge is missing and how to acquire it. “Breadth helps you to see your lacking skills. And then you go and get this knowledge yourself or find people who have this knowledge,” says David. Ben agrees: “I was surrounded by people from whom I could learn from the beginning. And I needed to teach myself how to proactively involve them in my business as consultants.” It is important to understand what one can and cannot do, what one knows and what one does not. As Adam says, “The decision who you will hire will affect the end product.” Therefore you need to know what you really want to achieve in that particular field in order to develop an innovative product you have in mind. Otherwise the end product may be something completely different from what you had expected. Adam says: “Should we come to an area where I presume someone knows more about it than me, I will be able to let go and participate only as a controller. For that you still have to know something in this field, in order to give the right instructions.”

Knowledge breadth is important for solving multi-faceted problems. Ben says that knowledge breadth enhances communication with employees and offers more-effective control over them to allow for a better and faster innovation process: “Knowledge breadth is important, as you never know what kind of problems you will encounter. It happens that I know how to talk with designers, although I have never worked in this field professionally. But my knowledge in this field helps me hire a better designer and to control his outcomes more effectively, since we speak a common language.”

Table 2: Insights from IPA analysis – knowledge

Emerging themes	Links to the literature	Illustrations from interviews
Openness to experiences		
Travelling and speaking foreign languages enhance entrepreneurs' openness, idea generation, communication skills, and self-confidence.		"You lose fear to communicate with the others." (David) "In this way you can see that the world is not a bogey, that others are not so much more capable than you, you get confidence and lose fear." (David) "There is something in an old proverb 'The more languages you know, the more of a person you are.' It shows not only the importance of knowledge, but also one's tendency to openness, willingness to learn new things. So you acknowledge there is more in the world than just your language." (David)
The breadth of everyday experiences and personal hobbies stimulate entrepreneurs' problem solving.	Ciavarella et al., 2004; Dean, 1999; Slavec, 2014; Zhao et al., 2010, Brown & Katz, 2009	"All I have learned was by trying things out. All I have now is an accumulation of recipes me and my team have come to." (Ben) "I think that innovativeness requires open brains. If you focus only on work, you sometimes cannot see the whole picture. You need a second life." (Ben) "I strictly believe that the breadth of life experiences significantly increases the likelihood that you will find the optimum solution for whatever it is a concrete problem. And it is important to have a personal life just so that your brain remains soft and flexible." (Ben) "When I am doing something else, for example, when I play with puzzles, my brain still processes something from work unconsciously. This particular thinking in that situation might cause a hint on how to tackle a certain problem at work." (Ben)
Travelling and meeting new people help you get new insights.		"If you travel and talk to different people, you certainly see the problem on a bigger picture. The more you go away from your safe environment, the more you will encounter completely new insights about particular thing. Then it gets interesting, when you start mixing these new insights with old ones." (Adam)
Command of foreign languages enhances entrepreneurs' opportunity recognition.		"There is so much knowledge stored in different languages. When you speak a different language and talk with the people, your world suddenly opens. You find out that they see things in a completely different way." (Adam) "You have to speak different languages to recognize the important actual trends and to acquire information easier." (Adam)
Knowledge breadth and depth		
Knowledge depth is a foundation for innovation		"Expertise in a certain area is central for strategic thinking and innovation." (David) "An entrepreneur needs a content to start innovating. You have to know it all to exploit opportunities and to find a gap in a certain area, which could be further optimized and turned into a prosperous business opportunity." (Ben) "To keep your product fresh and competitive, you need to build on your existing expertise to go deeper into technology, user experience or even marketing. Similarly, when introducing new products, the knowledge depth in your field is still required; however, in order to construct something completely new, you need to expand your knowledge in various domains to produce something really unique." (Adam)
Breadth of knowledge increases innovativeness, as one discipline helps identify innovative opportunities in others.	Bierly & Chakrabarti, 1996; Brown & Katz, 2009; Carlo et al., 2012; Madhavan & Grover, 1998; Hansen & Oetinger, 2001; Prabhu et al., 2005	"Many times I remember Mr. Japec, who said that his cardiology profession helped him in designing innovative ships." (David) "Breadth helps you to see your lacking skills. And then you go and get this knowledge yourself or find people, who have this knowledge." (David) "I need both knowledge depth and breadth. This is the only way that guarantees new perspectives on how my expertise can be creatively used in different areas." (David) "Knowledge in a certain area may bring an innovative solution to the problem in a completely different area as you try to connect them together. The fact that I taught myself to program in a previous life has a significant impact on my ability to connect different disciplines with programming and search for creative solutions." (Ben) "Knowledge breadth is important, as you never know what kind of problems you will encounter." (Ben)
Knowledge is an essential determinant of success and innovation.		"The knowledge is the only thing that doesn't make new problems, but helps you solve them." (David) "Knowledge is of vital importance for success and innovation. I am not only talking about formal education, but also about one's openness to adopt someone else's ideas of knowledge." (David)
Breadth of knowledge is important for understanding trends.		Not that I am a top expert in all domains, but at least I know, which industries are perspective and what is to be expected from them." (Adam)
Knowledge breadth enhances communication within a firm, and makes work more efficient and controlling easier.		"It happens that I know how to talk with designers, although I have never worked in this field professionally. But my knowledge in this field helps me hire a better designer and to control his outcomes more effectively, since we speak a common language." (Ben)

(table continues)

(continued)

One needs to be aware of what one does not know and know how to find/select those who do.		"I was surrounded by people from whom I could learn from the beginning. And I needed to teach myself how to proactively involve them in my business as consultants." (Ben) "The decision who you will hire will affect the end product. If Apple had different designers, iPhones would look completely different today." (Adam) "Should we come to an area where I presume someone knows more about it than me, I will be able to let go and participate only as a controller. For that you still have to know something in this field, in order to give the right instructions." (Adam) "Today, a manager must be aware that he doesn't know everything, that he knows barely something and must especially know how to choose people that know." (Adam) "You need to hire an excellent designer who knows today's trends. You need to select an excellent mathematician, programmers, and team. For that you need to know the basics of these work positions, so you know who will be the best for a certain position." (Adam)
Learnability and curiosity		
Continuous knowledge updates are a prerequisite for success and innovation.	Cope, 2005; Martin, 2007b; Mi Dahlgaard-Park & Dahlgaard, 2010	"Today you need to constantly upgrade your knowledge to stay competitive and to produce innovative products. Your attained knowledge is never enough." (David) "You build your innovative knowledge base with previous experiences, obedience, and mistakes along the way." (David) "The formal education will only tell that someone can overcome obstacles in his/her way. A programmer that graduated 10 years ago and has slept on his degree is totally useless for a business today." (David) "An entrepreneur needs more and more knowledge each year in order to stay competitive and produce innovative products." (Adam) "Expertise is important. However, you need a breadth in order to bring your expertise to a completely different level and produce innovative solutions. With knowledge breadth you connect different fields much easier." (Adam)
Curiosity and ability to learn improve problem solving.		"Curiosity is a must. You need to start solving problems not only because they need to be solved, but also because they are interesting. This is how you broaden your horizon." (Ben) "You have to know what and how to absorb and reuse when it matters the most – when searching for an innovative solution." (Ben)

The last theme that emerged is learnability, which is suggested to play a central role in innovation and performance (Cope, 2005; Martin, 2007b; Mi Dahlgaard-Park & Dahlgaard, 2010). In order to be innovative, one needs to constantly learn and nurture one's own curiosity. This is how one broadens and deepens his/her knowledge base, which serves as a foundation on which innovation can be built. Knowledge gained through regular education is never enough. Adam argues that an "entrepreneur needs more and more knowledge each year in order to stay competitive and produce innovative products". Ben adds that "curiosity is a must. You need to start solving problems not only because they need to be solved, but also because they are interesting. This is how you broaden your horizons." Furthermore, entrepreneurs need to learn how to listen to other people and to recognize things they don't know. Ben claims that "you have to know what and how to absorb and reuse when it matters the most – when searching for an innovative solution". David agrees: "You build your innovative knowledge base with previous experiences, obedience, and mistakes along the way."

This deep insight into the entrepreneurs' knowledge builds on the existing theories regarding its role by focusing on three major attributes that seem to be of great essence in practice. It indicates the highly important role knowledge has for entrepreneurs and for their firms. Despite the significance of an entrepreneur's expertise, interviews reveal that it is knowledge breadth that stimulates the problem-solving process and accounts for more-innovative solutions. A firm can be more innovative when an entrepreneur integrates different areas with their own expertise and identifies solutions that are not yet seen. In

addition, learnability, openness, and curiosity also are crucial because one's knowledge has to be constantly upgraded and expanded. So in order for a firm to be more innovative, its entrepreneur has to always strive for new experiences. In summary, these comments and themes are suggestive of the strong relationship that knowledge breadth has with knowledge depth and their joint enhanced impact on firm innovation. All things considered, we construct the following proposition:

P1: Breadth of an entrepreneur's knowledge, in terms of general knowledge, experiences, and skills, enhances the effect that the entrepreneur's deep knowledge has on firm innovation performance.

1.3.4.2 Entrepreneurs' integrative thinking

The literature describes integrative thinkers as entrepreneurs who do not rely on analytical processes and particularly refuse to accept trade-offs in the form of either/or choices. These entrepreneurs possess the ability to widen the scope of their approach and to see all of the salient aspects of a problem and try to find a way past them by favouring "both/and" thinking in order to create novel solutions (Brown, 2008, p. 87; Brown & Katz, 2009, p. 85). In contrast to Fitzgerald's definition (1945), which in fact creates the foundation for further development of the concept, the new understanding is much more generalized and not exclusive to geniuses (Chamberlin, 1931; Martin, 2007b). Even though there exist leaders who can strengthen their integrative capability through practice and exercise, great integrative thinkers are still rare, mostly due to the anxiety that it causes and to the fact that many leaders choose simplicity and clarity over complexity and ambiguity, which are considered to take much more time and effort (Martin, 2007a). The following paragraphs will serve as an insight into those thinking determinants which entrepreneurs find crucial for being innovative. As it turns out, all of the emerging factors characterize the integrative-thinking process.

The findings of our phenomenological interviewing indicate eight major themes grounded in personal decision-making, mindset and thinking processes that affect innovation of the firm (Table 3): (1) fast decision-making, (2) 80/20 rule, (3) holistic approach, (4) embracing complexity, (5) comprehensiveness, (6) risk perception, (7) inclusion of others, and (8) future stance.

The interviewees agree that fast decisions in problem solving are crucial for firm innovation. Similarly, the literature tries to understand how to make quality decisions quickly for better performance (Dane & Pratt, 2007; Eisenhardt, 1989; Perlow et al., 2002). It is better to start acting than to try to think of a perfect solution first. Such probing will allow for more-innovative solutions as one deals with the unknowns and puts the elements together in novel ways. David says, "When we opened new markets, we did not make any

substantial research of them, no Porter analysis and so on.… We just did it. If we had known all the indexes, then we would have opened half less markets. Sometimes you just need to try." Similarly, Adam agrees, "I make quick decisions and don't waste time with contemplating. As long as you picture your goal in your mind, it doesn't matter which option you will choose. The world will still be spinning and people won't mind." Likewise, it is better to make a mistake than to search for an ideal solution. According to David, "I think it is better to make a mistake on Monday, so you can fix it on Friday, than accept the right decision in two weeks." This is how one becomes involved in the market early enough to learn through mistakes and improve the solution over time.

The second theme to emerge was the 80/20 rule (Koch, 2011; Martin, 2007b). Although the theory of integrative thinking argues that it is worthwhile to put in an additional 80% of effort to reach a solution that is only 20% better, our respondents somewhat objected. All three respondents agreed that the value of time is priceless. "I think it is a waste of time to put 80% more effort in search for only 20% better outcome. I rather use this time to make another product" (David). Indeed, with more time one increases the number of problems one may solve. Ben says, "Today, 60% of the perfect solution can already be enough to be innovative." In his experience, "The problem must only be solved to the point where the next step, whether it is worth to dig in deeper, is confirmed." Correspondingly, one should not focus solely on one solution when one has to get to market as quickly as possible: "Someone else will surely come who will see a completely different story and make a better solution with far less effort than I would do" (Adam).

Holistic thinking is another important aspect in achieving innovation (Ambrose & Harris, 2009; Cooper & Edgett, 2008; Desbarats, 2005). In the participants' experiences, an individual cannot be innovative unless he/she approaches a problem in a rounded fashion. This is the only way in which partial aspects of the problem will not blur the higher meaning and divert the activities. David says, "You have to break a complex problem into pieces, otherwise you won't find the solution. But while working on each piece separately, you still have to think of the whole situation all the time. That enhances innovation for sure, otherwise you just get lost."

Furthermore, complexity evolves an entrepreneur's ability to think innovatively, identify more opportunities, and deal with problems creatively. Indeed, complexity seems important in business (Baggen et al., 2015; Hsieh et al., 2007). Problems are "supposed to be taken as personal challenges. This is how you build up the capacity to innovate," says Ben. Dealing with complex problems should not impose any stress. The search for a creative solution should be a great motivation for entrepreneurs. David says, "You can learn a lot and experience many unconventional solutions. Complex problems give many useful insights that can be used when searching for creative solutions of all the problems to come."

Table 3: Insights from IPA analysis – integrative thinking

Emerging themes	Links to the literature	Illustrations from interviews
Fast decision-making		
It is better to make a wrong decision than wait for a perfect solution.	Dane & Pratt, 2007; Eisenhardt, 1989; Perlow et al., 2002	"It t is better to make a mistake on Monday, so you can fix it on Friday, than accept the right decision in two weeks." (David) "When we opened new markets, we did not make any substantial research of them, no Porter analysis and so on... We just did it. If we had known all the indexes, then we would have opened half less markets. Sometimes you just need to try." (David) "I will tell you the story my grandmother told me and which affected my perception of the world: Two birds are standing in the middle of a country road. Suddenly, a cow passes them and right at the moment, when she is above them, she takes a poo. The birds go completely crazy and yell at her for quite some time, all covered in mud, while cow is moving away. Their screams are so loud, a cat soon hears that. The cat approaches and sees two loud birds that cannot move. She helps them out of the mud and soon after they clean themselves, eats them. Therefore, I have learnt two important things from this tale: Not everyone, who pushes you in trouble is your enemy, and not everyone who saves you is your friend. And when you are in trouble, keep your mouth shut and try to get out of it as fast and as quietly as you can." (David)
Fast decisions in entrepreneurship are necessary as long as you keep the goal in mind.		"An entrepreneur must be aware that it is him who makes decisions." (Adam) "You need to be quick, concise, and able to follow your goal. Don't walk left or right, because you will get nowhere." (Adam) "I make quick decisions and don't waste time with contemplating. As long as you picture your goal in your mind, it doesn't matter which option you will choose. The world will still be spinning and people won't mind." (Adam) "The speed of analysis is what makes you or breaks you. It is paramount for innovation and competitive edge." (Adam)
80/20 rule		
Make a decision only as good as necessary as quickly as possible.	Koch, 2011; Martin, 2007b	"It is a waste of time to put 80% more effort in search for only 20% better outcome. I rather use this time to make a new product." (David) "Today, 60% of the perfect solution can already be enough to be innovative. Because if you lay a good foundation and direction, you will have enough time to come to 100% with a help of customer feedback." (Ben) "The problem must only be solved to the point where the next step, whether it is worth to dig in deeper, is confirmed." (Ben) "The less the better. Because you can increase the amount of things you can try. And the amount of things you can try and time you need for them result in an equation, which tells you whether you are going to succeed or not." (Ben) "Someone else will surely come who will see a completely different story and make a better solution with far less effort than I would do." (Adam)
Holistic approach		
Entrepreneurs should keep the whole problem in mind while working on its individual parts.	Ambrose & Harris, 2009; Cooper & Edgett, 2008; Desbarats, 2005; Hassi & Laakso, 2011	"You have to break a complex problem into pieces or you won't find the solution. But while working on each piece separately, you still have to think of the whole situation at all times. That enhances innovation for sure, otherwise you just get lost." (David) "I always break complex problems into pieces. When I work on them separately, sometimes I consciously think on the whole problems. However, sometimes the individual piece is so tricky that I can focus solely on it and then count on my little brain to inform me if a certain decision is in contradiction with the whole picture." (Ben)
Embracing complexity		
Dealing with complex problems helps develop entrepreneur's problem-solving skills.	Baggen et al., 2015; Boland & Collopy, 2004; Cooper et al., 2009; Hsieh et al., 2007	"You can learn a lot and experience many unconventional solutions. Complex problems give many useful insights that can be used when searching for creative solutions of all the problems to come." (David) "Complex problems are supposed to be taken as personal challenges. This is how you build up the capacity to innovate." (Ben)
Complex problems as a proof of entrepreneur's ability.		"I believe there exists a certain metastructure in your brain which affects your ability to do well with the complexity. So I like a tough challenge every one and then just because I believe it affects my personal growth." (Ben) "I like solving complex problems also to prove myself I can." (Ben) "I will never say that a problem is too hard to crack. I can only decide that it is not worth working on any further." (Ben)

(table continues)

(continued)

Comprehensiveness		
In problem solving it is necessary to analyse all the constituent pieces in order to arrive at a superior solution.		"I have many experiences, which helps me find the components that may seem hidden. I use these components to make a better decision and ultimately build a better product." (David) "When I deal with the problem, I try to analyse all the facts and analyse the best way out." (David)
To be innovative, an entrepreneur should expand the problem, see the structure from different perspectives, and focus where needed the most.	Ambrose & Harris, 2009; Brown, 2008; Drews, 2009; Hassi & Laakso, 2011; Martin, 2007a	"You need to expand the problem space to let you see the structure. You try to identify what affects the solution. Then you start focusing on individual parts and search for a way out." (Ben) "I have an irrational passion for comprehensiveness and will always search for all determinants of the problem." (Ben) "First you need to understand the whole story, gather ideas from your co-workers, without any prior established presumption that would inhibit the detection of new facts. Then you connect all the dots and start experimenting. Usually this results in an innovative solution." (Ben) "When I face a certain problem, I try to look at it from different perspectives to find something that is missing and identify all crucial components that may lead to different solutions and are usually overlooked. I also include insights from different people. Then I try to connect these findings in a new, innovative way. This is how firm innovation works." (Adam) "I always start discussing the problem very broadly. So how the problem arose, why, what the others think, how it affects others, try to see it from different perspectives." (Adam)
Risk perception		
Innovative entrepreneurs have a different perception of risk.	Hyrsky & Tuunanen, 1999; March & Shapira, 1987; Palich & Bagby, 1995	"To find an innovative solution, you do need to go out of the box and have courage into diving into less known areas. Only thus you dare to try new things and grow your creativity and innovativeness by mixing them with accumulated experiences. However, I don't perceive such act as an act of risk-taking." (David) "I understand risk-taking at an intellectual level. However, it doesn't affect my decisions." (Ben) "With a great intuition, the risk diminishes." (Ben) "If you know things well enough, there is no risk involved." (Adam)
Inclusion of others		
The main drive of innovative entrepreneurs is **a** desire to share knowledge.	Byrne et al., 2009; De Jong & Den Hartog, 2007	"Passion must exist, unless you won't find satisfactory and innovative solutions." (David) "What drives me the most is help other entrepreneurs being successful. I use my experiences to mentor others. This makes me better at my job." (Ben)
Entrepreneurs should know when to include others in problem solving.		"It is difficult to admit you were wrong and others were right, but as soon as you realize that this is the way to a greater innovativeness of a firm, you are on the right path." (David) "You always need to know when is the time to leave things to someone else." (David) "I search for solutions in discussions with others." (Ben)
Entrepreneurs should pay attention to their employees to generate innovative solutions.		"Entrepreneurs need to have an ear for their employees, friends, and others. Listening to their stories and their insights might give them completely different view of a certain matter. And then you just need to integrate everything in an innovative solution." (Adam)
Future stance		
In order to be innovative, one needs to constantly think about the future.	Drews, 2009; Hassi & Laakso, 2011; Martin, 2007b; Yadav et al., 2007	"To be more innovative, you need to always be in the future with your mind. You need to think how your current solution will affect the future and how you can help build it. You try to do unthinkable, yet necessary in order to be more innovative. You try to predict the future by imagining your product in it and see how well it fits." (Adam) "I see the world as full of challenges. Everyone wants to live better, and I want to be a part of the future." (David) "I always keep my personal vision of the world in 10 years in mind, when searching for answers." (Adam)

Our respondents strongly emphasized an integrative approach to any problem solving (Ambrose & Harris, 2009; Brown, 2008; Martin, 2007a). They see it as a path to identifying features of a problem others may miss, and in this way to build an innovative solution. All three entrepreneurs have in common a capacity to search for all the salient data available. That is to say that innovative entrepreneurs have this predisposition. David confirms, "I have many experiences, which help me find the components that may seem

hidden. I use these components to make a better decision and ultimately build a better product." When facing a problem, entrepreneurs should first closely examine all its parts from near and far to find something that may be essential for a more-innovative solution and then connect these findings in a non-conventional, non-linear way in order to achieve a greater innovativeness. Adam says, "When I face a certain problem, I try to look at it from different perspectives to find something that is missing and identify all crucial components that may lead to different solutions that are usually overlooked. I also include insights from different people. Then I try to connect these findings in a new, innovative way. This is how firm innovation works." Similarly, Ben says, "First you need to understand the whole story, gather ideas from your co-workers, without any prior established presumption that would inhibit the detection of new facts. Then you connect all the dots and start experimenting. Usually this results in an innovative solution." In addition, in order to get innovative results, Ben mentions the need for "a fast and comprehensive analysis", which in his opinion is extremely rare.

Another important aspect that adds to a more innovative entrepreneur's thinking process is risk perception (Hyrsky & Tuunanen, 1999; March & Shapira, 1987; Palich & Bagby, 1995). Innovative entrepreneurs are supposed to perceive risk in a different way. According to the participants, there is no such thing as risk and it does not affect their decision-making process. Adam argues, "If you know things well enough, there is no risk involved." Ben adds, "With a great intuition, the risk diminishes." However, they agree that courage is a must and should not be mistaken for risk-taking. David explains, "To find an innovative solution, you do need to go out of the box and have courage into diving into less known areas. Only thus you dare to try new things and grow your creativity and innovativeness by mixing them with accumulated experiences. However, I don't perceive such act as an act of risk-taking."

Entrepreneurs need to have passion for their work. Otherwise, as David states, "they won't find satisfactory and innovative solutions". They need to include other people in their thinking process and search for challenges in discussions with others (Byrne et al., 2009; De Jong & Den Hartog, 2007). That is how a firm can be more innovative as different views are merged together into a solution. According to the interviewees, not many entrepreneurs are open to other people's opinions. That is a true virtue and a distinctive competence. Adam argues, "Entrepreneurs need to have an ear for their employees, friends, and others. Listening to their stories and their insights might give them a completely different view of a certain matter. And then you just need to integrate everything in an innovative solution." In David's words, it is sometimes "difficult to admit you were wrong and others were right, but as soon as you realize that this is the way to a greater innovativeness of a firm, you are on the right path". Moreover, the communication should go in both directions. An innovative and successful entrepreneur will have a passion for sharing his knowledge and for mentoring others. According to Ben, that is one of "the

main drivers of entrepreneurship". In other words, giving back to employees gives you more confidence and better recognition. This is how employees will have no fear sharing ideas with an entrepreneur, which "will result in better firm innovation".

A salient topic that emerged is an ultimate orientation towards the future. Greater attention to the future leads to a more effective uncovering of new technologies and an enhanced innovativeness (Drews, 2009; Hassi & Laakso, 2011; Martin, 2007b; Yadav et al., 2007). The world has to be seen as full of challenges and changes for the better. This competence is best described by Adam: "To be more innovative, you need to always be in the future with your mind. You need to think how your current solution will affect the future and how you can help build it. You try to do unthinkable, yet necessary in order to be more innovative. You try to predict the future by imagining your product in it and see how well it fits."

Phenomenological interviews offered us deep insight into entrepreneurs' thinking processes. We identified several themes that characterize problem-solving skills important for innovation. These emerging themes also echo important practices of integrative thinking as described by Martin (2007a): consideration of more salient features, multidirectional consideration of causality, visualisation of the whole problem, and refusal to accept unpleasant trade-offs. Because the process has not been investigated thoroughly in the literature, we wanted to gain a close understanding of how an entrepreneur's thinking skills provide more creative and innovative solutions. It turns out that an entrepreneur's thinking is central to problem solving. Different methods and skills of an entrepreneur might result in completely different solutions. In our participants' opinions, these are the characteristics that will grant a higher innovativeness to entrepreneurs and, consequently, better performance and innovativeness of their firms.

We found that the essential characteristics of an entrepreneur's thinking process that enhance problem solving and innovation are also the ones that differentiate an integrative thinker from a conventional thinker: the ability to accept fast decisions, not striving for absolutes, the ability to develop an integrative approach to a problem and keep it in mind while searching for solutions, openness to complex problems, the ability to identify all the invisible components of the problem, constant use of others' opinions, and a different perception of risk-taking and future stance. All these characteristics, according to our observations and our participants' opinions, have a strong impact on their personal innovativeness as well as on overall firm innovation. Consequently, we assert the following proposition:

P2: By using integrative thinking in problem solving, entrepreneurs improve creativity and enhance firm innovation performance.

1.4 Discussion and implications

This research was intended to improve our understanding of the underlying factors of entrepreneurs' cognitive attributes, to explore how these attributes are related to each other, and to reveal the prevailing personal factors that have a strong effect on firm-level innovation. We used qualitative research methods to understand the feelings, emotions, perceptions, and personality characteristics of entrepreneurs. Specifically, we utilized IPA to explore entrepreneurs' personal experiences about their knowledge and thinking and drew on the individuals' own perceptions. The findings expand the existing view of entrepreneurs' cognitive assets (e.g., Dakhli & De Clercq, 2004; Martin, 2007b; Marvel & Lumpkin, 2007) in relation to innovation in order to emphasize a strong link between entrepreneurs and firm-level output.

While supporting the vital role of entrepreneurs in firm innovation (Marcati et al., 2008), this research supplements the existing theories on knowledge (e.g., Zhou & Li, 2012) and thinking (Martin, 2007a) by suggesting the importance of knowledge breadth for innovation processes. Building on the prior research on human capital (Fuentes et al., 2010) a diversity of experiences acquired by entrepreneurs has been shown to play a vital role in opportunity recognition and firm innovation. These experiences develop an entrepreneur's knowledge breadth, which allows for new perspectives on how to use his/her expertise in different ways. Combining different areas of knowledge makes entrepreneurs more creative and innovative.

Furthermore, innovation is largely dependent on the thinking processes of entrepreneurs. Evidently, in order to achieve innovation and to be better at it, certain thinking patterns emerged which all could be linked to integrative thinking theory (Martin, 2007a). These themes facilitate the innovativeness of an entrepreneur and positively affect overall firm innovation: fast decisions, non-perfectionism, holistic approach, inclination towards complexity, comprehensiveness, collaboration, and future stance.

Our research contributes to the areas of entrepreneurs' characteristics and behaviour and the innovation of SMEs. In sum, our findings correspond to observations in the literature that suggest firm performance and innovation are a reflection of entrepreneur characteristics and behaviours (Baron, 2013; Hmieleski et al., 2015). We provide clearer evidence of the impact entrepreneurs have on their firms by connecting their activities to firm-level outcomes. We analyse and identify the most relevant personal characteristics that contribute to firm-level innovation. This study is among the first to examine knowledge depth and breadth at an entrepreneurial level. So far, the literature encompasses studies of knowledge dimensions mostly at a firm level (e.g., Marvel & Lumpkin, 2007). Using IPA methodology and bridging entrepreneurs' decisions with their SMEs' decisions, we seek to understand entrepreneurs' knowledge dimensions, the mutual interaction of

these dimensions, and how they help SMEs to be more innovative. Our findings support previous arguments about the importance of knowledge in innovation (e.g., Farace & Mazzotta, 2015) and complement the understanding of the interplay between its dimensions at the personal level of the entrepreneur. In addition, our results emphasize an important enhancing role that is played by knowledge breadth in terms of general knowledge, experiences, and skills in the relationship between entrepreneur expertise and firm innovation.

Similarly, entrepreneurs' thinking skills that contribute to innovation are explored in detail and linked to the theory of integrative thinking proposed by Martin (2007b). It seems that there exists a certain mindset – attributes of entrepreneurs' thinking processes – that facilitates entrepreneurs' success as well as innovation. In the first stage of this innovative process, the entrepreneur has the capacity to spot less obvious but relevant and salient features of the problem. In the next step, he/she seeks to explore multidirectional and nonlinear relationships between different parts of the problem. In the third step, the entrepreneur creates the relationship model depicting variables from previous steps by using a holistic approach. Finally, the entrepreneur generates an innovative outcome by embracing complexity, considering all parts of the problem, and resolving tensions among opposing ideas.

We have several practical implications for entrepreneurs to facilitate innovation in SMEs. First, the study highlights that entrepreneurs in SMEs have a vital role in fostering innovation, because they often play the central decisive role. Based on the interviews, entrepreneur characteristics have a strong impact on firm-level outcomes. Therefore, in order for a firm to perform better or be more innovative, entrepreneurs themselves are a key element of change. Next, our interviews illustrate that entrepreneurs should constantly expand their horizons with travelling, learning foreign languages, and hobbies, because these are prerequisites for easier information acquisition, which can be used in innovation activity. An entrepreneur's openness therefore enhances the innovative idea-generation process and helps gain new insights into the problem area. An innovative entrepreneur should be curious and eager to learn in order to stay competitive and produce innovative solutions. Furthermore, knowledge breadth has been suggested as the vital and most important dimension of knowledge, which entrepreneurs tend to neglect. Entrepreneurs' knowledge breadth increases personal innovativeness and ability to execute and control several activities effectively. Indeed, knowledge breadth is an essential factor in firm innovation because it facilitates an interdisciplinary approach in finding creative solutions. On the other hand, it also reveals gaps in an entrepreneur's knowledge. It helps in human-resource–based decisions, because it grants the capacity to select the right employees for a certain activity and promotes more-effective controlling and monitoring. In addition, entrepreneurs should constantly deepen their expertise to enhance exploitative innovation and identify opportunities in their domains.

Similarly, an entrepreneur's thinking has been shown to largely influence his/her innovativeness and enhance firm innovation. All the themes that emerged in this analysis are strongly connected to the concept of integrative thinking, which is said to enhance a person's innovativeness and ultimately lead to better firm innovation. Evidently, in order to achieve better innovation outputs, an entrepreneur has to possess an ability to make quick decisions. It is better not to invest all the time in searching for a perfect solution to a problem, because this allows more time for experimentation. Moreover, entrepreneurs who utilize integrative thinking have a capability to identify certain components of the problem that many others many not see, which allows them to connect ideas in a way that will boost firm-level innovation. Correspondingly, entrepreneurs who want their firms to be more innovative consider other people's opinions, because these might offer them novel tools to understand different insights and merge them in an innovative solution. Finally, it is important to think about the future. Mentally transferring current problems and possible solutions to the future helps entrepreneurs spot the missing link and identify the right direction, and ultimately leads to more-innovative outcomes for a firm.

In addition, these findings imply recommendations for educational practice. To produce people with 21st century competencies that are capable of complex problem-solving, entrepreneurship courses should include design thinking in their curricula. Students should internalize curiosity, empathy, and the power of knowledge. Courses should train their reasoning skills, develop their integrative thinking skills, provide insights into how to integrate knowledge from different disciplines, and offer them international exchange programs. It is essential to introduce entrepreneurship courses to all study programs, which would allow technical students once they go into business to understand their potential users and their needs.

1.5 Limitations and future research

There are several limitations to this study. We use qualitative research methods, which typically raise concerns such as subjectivity, sampling, validity, reliability, and statistical generalization (Carr, 1994; Neergaard & Ulhři, 2007; Stritar & Drnovšek, 2015). In general, with the use of qualitative research our findings cannot be extended to wider populations with the same degree of certainty that quantitative analyses can be (Atieno, 2009). In addition, the generalization is also affected due to the small number of cases used in the study. However, the aim of IPA is to gain rich descriptions of the studied phenomenon, identify its essential components, and explore individuals' perceived insights into different situations, rather than making more-general claims (Pietkiewicz & Smith, 2014). Furthermore, use of small sample sizes and purposeful sampling to find a fairly homogenous sample are suggested in order to attain theoretical generalizability (Smith et al., 1997). Without sufficient experiences in the field of innovation, it would be much more

difficult to determine the components that facilitate innovation at an entrepreneurial level. Therefore the individuals analysed in the research were selected on the basis of their own success stories. Such a method would normally lead to a sample selection bias (Heckman, 1977), but the aim of this study is to gain rich insights by understanding a sense of the participants' experience and to compose propositions for further research. Hence future research should focus on additional examination and verification of entrepreneurs' cognitive aspects and their effect on firm innovation. To make results statistically significant, quantitative research methods can be used to test propositions on a large sample without the interference of the researcher's presence that can affect subjects' responses.

Second, IPA suggests using open-ended questions without any hidden presumptions in order for an interview to go into novel areas. As the interview schedule is only suggestive, there is an issue of attained objectivity. Furthermore, probes are allowed to guide a participant and investigation into a certain area of interest. Different techniques may have been used for each individual participant in order to achieve this. In addition, prompts followed from participants' answers may unintentionally affect their subsequent answers. There is a need to conduct such research on a larger scale and to use as uniform an interview schedule as possible.

Third, learning from experience may result in the issue of hindsight bias, which affects individuals' inability to recall their experiences and circumstances accurately (Cassar & Craig, 2009; Henriksen & Kaplan, 2003). This simplification of past events describes the tendency for people to overestimate the likelihood of past event occurrences and see them as more predictable (Arkes et al., 1988; Bukszar & Connolly, 1988; Roese & Olson, 1996), and is suggested to be strongly linked to entrepreneurs' recollections of their entrepreneurial experiences (Cassar & Craig, 2009). Therefore in our analysis we may have overlooked some of the more complex determinants of knowledge and thinking effect on innovation. Further research should be undertaken with a focus on factors of entrepreneur knowledge and thinking which may be affected by hindsight bias.

Fourth, this study does not address an interplay between knowledge dimensions, integrative thinking, and innovation in full detail. There exists a question of their reciprocal effect, as well as the strength of their individual effect on innovation. Further studies are needed to identify components that are more essential for innovation than others. To understand this, a measure of integrative thinking and personal knowledge should be constructed. Because integrative thinking is a fresh concept, deriving from experience and observation, the measure would allow for its verification on a large sample of entrepreneurs and explore its significant contribution. Moreover, existing measures of knowledge are based on prior work experience (years in business) and education (education level). In our opinion, these measures do not represent personal knowledge

correctly. Rather, a measure should be constructed that would allow the capture of personal level of knowledge according to different fields of expertise.

2 THE INTERACTION OF AN ENTREPRENEUR'S SOCIAL NETWORK, KNOWLEDGE BREADTH, EXPERIMENTATION, AND INNOVATION

2.1 Introduction

Organizational innovation is central to economic growth and instrumental to a firm's competitiveness and long-term success (Marvel & Lumpkin, 2007). Simultaneously, growing attention is being paid to small and medium-sized enterprises (SMEs), which are perceived as the catalysts of technological progress (Zeng et al., 2010). In this role SMEs require novel ways of achieving a greater innovation capacity to compensate for their vulnerability in the rapidly changing business environment (Hoffman et al., 1998). Prior literature reveals a substantial body of research on mechanisms determining effective innovation in SMEs (e.g., Çakar & Ertürk, 2010; Lasagni, 2012; Raymond & St-Pierre, 2010; Rhee et al., 2010). Nevertheless, we still do not know enough about what factors are key to a successful implementation of innovation in firms (Bharadwaj & Menon, 2000; Bullinger et al., 2004; Rothwell, 1992).

This study complements a recent focus on determinants of innovation at an individual level (e.g., Huang et al., 2012). Given an entrepreneur's importance in fostering economic development (Wong et al., 2005) and crucial role in managing innovation (Drucker, 2014) in SMEs (Marcati et al., 2008), we explore how an entrepreneur's proclivity towards experimentation coupled with the impact of his/her social network relates to firm innovation performance.

Recently, several authors have emphasized the role of users in analysing innovation dynamics. For example, in searching for tools to enhance organizational innovation, there has been a rise of research in fields such as co-creation (Ramaswamy, 2010; Vargo et al., 2008), open innovation (Chesbrough, 2006), and design thinking (Liedtka, 2015; Müller & Thoring, 2012). This approach uses a designer's sensibility to meet people's needs in a technologically feasible and strategically viable way (Brown & Katz, 2009). A successful design thinking process requires a special environment favorable to observation, visualization, open collaboration, and deep user understanding (T. Lockwood, 2009). An important practice in design thinking is experimentation, which allows for continuous verification of new ideas and a successful exploitation of knowledge generated through social networks.

Experimentation is defined as a way of problem solving and plays a significant role in reducing the cost and time of innovation (Sundukovskiy, 2009; Thomke, 1998a, 2003). Despite its long-standing presence in everyday life – it has often been considered to be a

catalyst for scientific discoveries (e.g., Galileo, Egyptians etc.) – a core concept was introduced much later by Simon (Bohn & Lapre, 2011; Newell & Simon, 1972). Experimentation is certainly an important part of organizational innovation culture (Brown & Katz, 2009; Thomke, 2003). Although the concept in relation to innovation has been studied at the level of case studies (Thomke, 1998a; Thomke, Hippel et al., 1998), existing literature lacks empirical verification of the significant role that experimentation may play in the innovation process. This study explores different modes of experimentation and their contributions to organizational innovation.

At the heart of experimentation is "trial and error", and as such, experimentation is closely related to the concept of learning from failure, which has become a hallmark of innovative companies (Edmondson, 2011; Leonard-Barton, 1995; Sommer & Loch, 2004). In order to learn from failures, this philosophy must be strongly embedded in an entrepreneur's mind, because people normally tend to acknowledge a sense of failure with difficulty (Cannon & Edmondson, 2005). On the other hand, it has been suggested that social networks provide support in case of shortfalls and increase the probability of survival and growth of new businesses (Brüderl & Preisendörfer, 1998). Entrepreneurs need support from others in order to adopt experimentation, as well as to get information from their social network about the failures they have made and to learn about future opportunities.

Social capital is considered to be an important factor of innovation (Akçomak & ter Weel, 2009; Dakhli & De Clercq, 2004; Fountain, 1998; Landry et al., 2002). Despite numerous definitions of social capital found in the literature (Coleman & Coleman, 1994; Nahapiet & Ghoshal, 1998; Putnam, 1995) suggesting its various dimensions, such as network breadth, strength of ties, and embedded trust, this study focuses merely on the determinants of successful exploitation of an entrepreneur's social network and its impact on innovation. This dimension demarcates the use of personal relationships in order to obtain information, knowledge, and resources (Birley, 1985; Hakansson & Snehota, 2006; Ming-Huei & Ming-Chao, 2008; Tsai & Ghoshal, 1998). It provides support and access to diversified knowledge and thus serves as a complementary source to existing competencies of an entrepreneur (Aldrich & Zimmer, 1986; Hansen, 1995; Teece, 1986).

Interestingly, drawing from current literature we find very little evidence that social networks alone accelerate the innovation performance of a firm. We argue that social networks provide only a resource base, but in order for this base to impact innovation it must be effectively exploited. We postulate that entrepreneurs with a broader knowledge base might benefit more from their social networks in terms of knowledge acquisition, increased opportunity recognition, and collaboration. In its essence, networking may shorten the path to obtaining diversified knowledge (Greve & Salaff, 2003). Therefore this paper explores the interplay of knowledge breadth and social networks in innovation.

This study makes the following contributions: First, we explore the role of experimentation in innovation to determine its more important modes that impact innovation performance. We determine which mode – whether traditional or rapid prototyping – is salient to innovation. Second, we examine how different aspects of social networks affect innovation performance. In our assumption, the social network of an entrepreneur determines the level of firm innovation; however, knowledge breadth may be an essential factor in enhancing this impact. To our knowledge, this connection has not yet been explored in detail. We verify it with an interpretative phenomenological analysis (IPA), complemented by a quantitative analysis in a large sample. The results of this study improve our understanding of the role of experimentation in fostering innovation and how social network and knowledge breadth interact.

We begin the study by reviewing existing literature on social networks in connection with knowledge and on experimentation in relation to innovation to develop research hypotheses. We proceed with a description of the research methodology, insights of IPA analysis, a summary of quantitative research results, and discussion. We conclude with this study's limitations and future research opportunities.

2.2 Literature review

2.2.1. The role of experimentation in organizations

Thomke (1995) was one of the first to define experimentation as learning by trying things out and encompassing a range of modes, such as rapid prototyping in the beginning of the innovation process, modeling, and high-tech detailed computer simulation, conducted in order to test ideas within organizations. In this study we use the term "experimentation" and "prototyping" as hypernyms of all different techniques (modes) of prototyping, where a prototype is defined as any physical representation of an idea ranging from simple drawings to high-end production versions (Ingale, 2016). Our aim is to investigate the contribution of different modes of experimentation to innovation. Specifically, drawing from design thinking theory, we make a distinction between rapid prototyping and other modes of prototyping. Therefore we group all other techniques and name them with the term "traditional prototyping" for greater clarity.

According to the literature, experimentation improves the new product development process (Ingale, 2016; Kahn et al., 2006; Sundukovskiy, 2009; Wheelwright & Clark, 1992), ameliorates identification of new product concepts (Tidd & Bodley, 2002), helps in verification and refining the idea (Ingale, 2016), positively correlates with performance (West & Iansiti, 2003) and is fundamental to the innovation process in a firm (Bowen et al., 1994; Thomke, 2003; Tidd & Bodley, 2002). Scholars argue that experimentation

significantly contributes to product improvement and innovation performance (Brown & Katz, 2009; Sundukovskiy, 2009; Thomke, 1995) and strikes the optimal balance between innovation and risk (Alberts & Hayes, 2005).

In addition, a higher number of experiments proves to be central for a better innovation outcome (Brown & Katz, 2009; Gofman, 2009; Schrage, 1999). Working models used as an essential part of experimentation enable more-effective communication between stakeholders and offer more-powerful explanations via solution visualization and successful idea evolving (Ingale, 2016). Visualization of concepts and ideas essentially contributes to common understanding (Carr et al., 2010; Hassi & Laakso, 2011; Ward et al., 2009) as ideas are shared more easily and new features arise that are not attainable only from verbal communication (Junginger, 2007; Sato et al., 2010). Brown and Katz (2009), on the other hand, emphasize the paradoxical feature of experimentation. According to them, models slow us down to speed us up, because we can avoid expensive mistakes – in particular, sticking with weak ideas. Prototypes in the early process are thus intended to accumulate useful feedback and therefore require only a reasonable amount of time and effort (Brown, 2008). Moreover, there seems to exist a reverse relationship between the finalization of a prototype and visualization benefit in the beginning of the process of new product development.

Experimentation is closely related to the trial-and-error process. Kelley et al. (2001) suggest that firms should fail often in order to succeed sooner. The importance of this process, particularly early-stage failures, is also expressed by other authors (e.g., Thomke & Fujimoto, 1998; Wouters & Roijmans, 2010). Late modifications or even problems discovered when a concept is moving towards completion can prove very costly and time consuming. Because the product has to loop back to early stages of development, serious consequences for the project economics may arise. Similarly, Thomke and Bell (2001) criticize firms that tend to lower costs by delaying prototype creation in the process of product development. In other words, entrepreneurs who underestimate the importance of prototyping may unintentionally inhibit effective product development (Wheelwright & Clark, 1992). Furthermore, Thomke and Bell (2001) suggest that firms need to realize the benefits of early information, although these benefits usually are not measured in contrast to testing expenses. They allow more reliable assessment of an idea and thus reduce uncertainty.

Similarly, due to fast-changing markets and competition, today's process of developing new products requires new, faster, and more flexible approaches. Therefore the use of experimentation lies at the foundation of this activity (Takeuchi & Nonaka, 1986). Also, relevant information obtained through experimentation proves to be a prerequisite when the product development process is unclear (Davila, 2000; Pisano, 1994). Piller and Walcher (2006) argue for the transfer of internal R&D capabilities to users by trial-and-

error experimentation in order to access information, which results in a greater user innovation performance.

All things considered, the value of prototyping is seen in the way it simplifies analysis of the concept by examining the variety of aspects of reality that have an effect on the experiment (Thomke, Von Hippel et al., 1998). The importance of experimentation is also indicated by Clark and Fujimoto (1991), who see its role as a facilitator in the new product development process. However, more than just its direct impact on innovation is suggested (Schrage, 1999; Thomke, 2001, 2003; Wouters & Roijmans, 2010) – there is evidence of some indirect effects on innovation performance as well. Bacon et al. (1994) suggest that prototypes enhance intra-team and intra-firm communication, and facilitate feedback from key users. According to them, poor communication results in poor recognition of the problems in early stages of product development. On the other hand, experimentation enables collaboration, which facilitates innovation (Brown & Wyatt, 2010; Martin, 2009; Nussbaum, 2004). Similarly, Hughes and Cosier (2001) see the vital function of prototyping for expanding innovative culture through enhanced collaboration and customer involvement.

Clearly, experimentation improves the learning rate (Lapré et al., 2000; Thomke, 1998b). Scholars such as Alegre and Chiva (2008) and Bohn and Lapre (2011) emphasize the central role of experimentation in facilitating organizational learning capability, which in fact enhances innovation performance. It serves as a good predictor for changes to the product and therefore helps accumulate knowledge in a firm. Likewise, prototyping induces knowledge integration, which is seen as a crucial organizational strength and has a positive effect on new product development (D'Adderio, 2001; Roller et al., 2004) and innovation (Nohria & Gulati, 1996). Furthermore, Eisenhardt and Tabrizi (1995) and Thomke (1995) speak in favour of several design iterations and testing in order to accelerate the product development process in novel environments. Specifically, such an experimentation enhances experiential knowledge accumulation and positively affects opportunity recognition (West & Iansiti, 2003).

Furthermore, rapid prototyping as a unique mode of experimentation has gained much attention in design thinking literature (e.g., Neeley et al., 2013; Plattner et al., 2011), indicating its importance for achieving a competitive edge (Brown, 2008; Nussbaum, 2004). It is a process of generating cheap, no-frills, quickly constructed, and easy-to-modify prototypes. A closer look at Thomke's experimentation process reveals that rapid prototyping can be a fast and effective way of building the experimental apparatus and shortening the phase of running experiments, whereas computer simulation proves best in running experiments and the final analysis (Thomke, 1998a). In sum, rapid prototyping has been shown to improve business model innovation (Rayna & Striukova, 2016) and can increase the rate and amount of learning from each iteration cycle (Tidd & Bodley, 2002).

Overall, this mode of experimentation is suggested to have the ability to shorten and improve the product development process (Martínez Sánchez & Pérez Pérez, 2003; Pham & Dimov, 2001) and enhance innovation (Cole, 2002; Thomke, 2003). Schrage (2000) adds that rapid prototyping is the cornerstone of the innovative enterprise.

Drawing from the literature we propose the following hypotheses:

H1: Rapid prototyping positively impacts firm innovation performance.
H2: Traditional prototyping positively impacts firm innovation performance.

2.2.2 Entrepreneur's social network and knowledge breadth

In reviewing social network literature we find that the literature encompasses a vast array of studies in relation to innovation outcomes in organizations. Prior researchers, for example, suggest that networks full of structural holes provide solid information about new opportunities (e.g., Burt, 1995; Gargiulo & Benassi, 2000). Furthermore, the literature discusses a mediating role of network centrality between individual attributes and innovation roles (Ibarra, 1993), the importance of collaborative networks in novel product innovation (Nieto & Santamaría, 2007), a positive relationship between cooperation networks and innovation performance (Zeng et al., 2010), the significant effect that network links and structure have on innovation diffusion (Abrahamson & Rosenkopf, 1997), and different effects of network types on innovation (Hadjimanolis, 1999; Julien et al., 2004; Whittington et al., 2009). Indeed, previous research has shown that a social network is an intangible asset that facilitates innovation performance and is an important predictor of people's involvement in innovation (Abrahamson & Rosenkopf, 1997; Ahlin et al., 2014; Kaasa, 2009; Obstfeld, 2005). Moreover, social interaction ties were shown to have a significant effect on product innovation (Tsai & Ghoshal, 1998).

In other words, the literature highlights the important enhancing role of social networks in SMEs' innovation performance (Landry et al., 2002). However, authors have paid little attention to thoroughly examining which mechanisms effectively facilitate this relationship (Ahlin et al., 2014). Indeed, although it has been established that networking is beneficial (Havnes & Senneseth, 2001), there is a particular interest in understanding the relationship between entrepreneurs' use of networks and firm innovation performance (e.g., Watson, 2007). Furthermore, few firms are able to innovate alone; for such an activity they need interaction with an external environment (Kaasa, 2007; Tether, 2002). An entrepreneur's social network speeds information exchange, lowers costs of information search, and plays a crucial role in establishing a new business (Kaasa, 2007). The network structure itself provides access to valuable information (Burt, 2009), skills, technologies, competencies, and opportunities (Mancinelli & Mazzanti, 2009; Mazzanti & Mancinelli, 2007) and sets a foundation on which new combinations of technologies and knowledge can be created

(Mors, 2010; Whittington et al., 2009). Furthermore, social capital theory suggests that connection between people creates a network, which serves as a source for support and resources and results in more-effective problem solving (Burt, 2009; Coleman, 1988; Hongseok et al., 2004).

However, the relationship between a social network and innovation is not self-evident. Cohen and Levinthal (1990) argue that mere exposure to external knowledge is not sufficient. Firms cannot benefit only from the density and breadth of social networks, and the strength of ties that individuals have cannot alone explain variations in innovative capabilities (Tortoriello & Krackhardt, 2010). In order to facilitate innovation, firms must be able to identify and exploit such knowledge (Murovec & Prodan, 2009; Stock et al., 2001; Tsai, 2006; Vinding, 2006). Therefore acquiring knowledge through external collaboration and the ability to interact within a network have become important factors in promoting the innovative capability that explains the success of innovation (Harmaakorpi et al., 2003; Kaminski et al., 2008). Because SMEs' behaviour is largely represented by their owners' decisions (Marcati et al., 2008), the owners must know where to search for information, what information they are after, and whom to contact and when. Moreover, they need to understand the information given and know how to use it. Understanding of the information received and awareness of the information's existence may be improved by the scope of knowledge an entrepreneur possesses. Therefore this study explores how entrepreneurs' knowledge breadth contributes to a more-effective firm innovation.

The importance of the knowledge breadth an entrepreneur possesses in terms of experiences and skills has been strongly suggested in the prior literature. Such a personality can share knowledge across organizations and transfer implicit knowledge more effectively, resulting in greater innovation performance (Hansen & Oetinger, 2001). Moreover, scholars have expressed the importance of knowledge breadth for the purposes of more-effective collaboration (Brown & Katz, 2009; Hansen & Oetinger, 2001; Martin, 2010). Knowledge breadth may facilitate the ability to integrate knowledge across different fields (Henderson & Cockburn, 1994; Leonard-Barton, 1992; Pisano, 1994; Reed & DeFillippi, 1990). It is evident that an individual with greater knowledge breadth can acquire external knowledge, use it for the purposes of the firm, and communicate it to other firms more easily. Whereas social networks provide access to business opportunities (Aldrich & Zimmer, 1986; Elfring & Hulsink, 2003; Sozen & Sagsan, 2009; Whittington et al., 2009), it is knowledge breadth in terms of variety that impacts opportunity recognition (Casson, 1995; Marvel & Lumpkin, 2007). Therefore a person with knowledge in several domains might absorb information from different fields of expertise and integrate it creatively in his primary domain, which may result in producing outstanding outcomes. Furthermore, an entrepreneur with greater knowledge breadth may identify more rapidly the right person in his network with whom to discuss certain matters, as he/she builds trust with several common themes (e.g., Chung-Jen, 2004; Huang, 2009). Also, he/she may

approach new contacts more confidently when starting a conversation in the topic of a contact's field of expertise. Knowledge breadth thus may increase the possibility of an effective conversation between two individuals. For this reason, background diversity in terms of skills and experiences is crucial for the process of communication and innovation – it allows the creation of new associations and linkages (Simon, 1985).

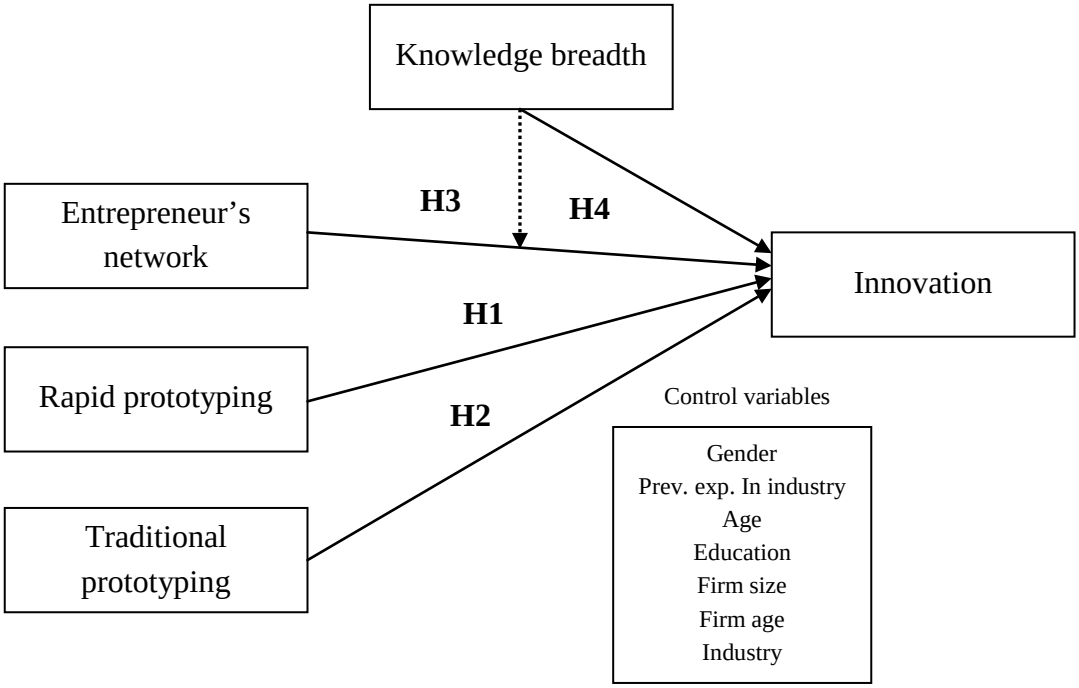
In particular, rich diversity of knowledge helps individuals make novel associations and connections, and therefore facilitates the innovation process (Cohen & Levinthal, 1990; Hilgard & Bower, 1966; Nieto & Santamaría, 2007). Correspondingly, scholars argue that the process of information assimilation is determined by the richness of the prior knowledge structure, including past experiences and skills (Ahanotu, 1998; Daghfous, 2004; Nonaka & Takeuchi, 1995; Zahra & George, 2002). Familiarity in different domains creates a better ability to recognize the importance of external information available through an entrepreneur's social network, to enhance knowledge exploitation, and to facilitate understanding by creating a wider base of different perspectives (Cohen & Levinthal, 1990; Lindsay & Norman, 1977). This enables more creative associations and linkages and utilization of new information provided by one's social network that may have never been considered before (Vinding, 2006). Therefore a common stock of knowledge shared between a source and a recipient allows for more-effective assessment, idea sharing, and integration of each other's domain-specific knowledge (Carlile, 2004; Kogut & Zander, 1992). Scholars further elaborate that possession of different knowledge domains increases the ability to transfer and convey complex ideas within a heterogeneous group (Reagans & McEvily, 2003) and that individuals must possess diverse knowledge, even if they do not need it regularly, because it enables an easier interpretation of and engagement with the knowledge of others (Swan et al., 1999; Weick, 1990). To summarize, diversity of information is a necessary factor to prompt innovation (Hargadon, 2002), because the lack of common understanding and shared meanings raises obstacles to knowledge integration (Bechky, 2003; Dougherty, 1992; Tushman, 1977). Lane and Lubatkin (1998) illustrate this assumption: "A chemistry scholar has to acquire some understanding of basic biological sciences in order to appreciate advances in biotechnology." In other words, diversified knowledge facilitates assimilation and use of new knowledge gathered through a social network, because there will exist more chances that the two fields are related to one another (Gray, 2006).

We therefore argue that a higher level of an entrepreneur's knowledge breadth will result in more effective exploitation of the knowledge provided by his social network. We offer the following hypotheses:

H3: An entrepreneur's personal network positively impacts firm innovation performance.
H4: In addition to experimentation, an entrepreneur's personal network and knowledge breadth combined positively affect firm innovation performance.

The proposed relationships and hypotheses are depicted in Figure 5.

Figure 5: The conceptual model of an entrepreneur's network, knowledge, experimentation and innovation



2.3 Research design and methodology

This study combines qualitative and quantitative research techniques. First, we use IPA in order to gain in-depth insight into the concepts of social network and experimentation in relation to innovation as comprehended by entrepreneurs, to better explore their perceptions and feelings, and to provide experience-based support of the proposed hypotheses (Smith, 2015). This method allows us to understand the nature of relationships between social network and innovation and between experimentation and innovation, which provides grounds for further quantitative research. The qualitative part of the study follows guidelines for IPA by Pietkiewicz and Smith (2014); quantitative analysis (hierarchical regression) was used to provide additional support for our hypotheses.

2.3.1 Sampling

We began with semi-structured interviews of three Slovenian entrepreneurs using IPA analysis. Adam is a serial entrepreneur, manager, and business angel with more than 20 years experience, who co-founded one of the biggest online stores in the region. Ben is an entrepreneur and business angel in his early 30s with a diverse background (programming,

philosophy), whose startup received an investment of almost 10 million euros. David spent 20 years on the board of directors of one of the leading e-commerce companies in Central and Eastern Europe, with more than 7000 employees. Recently he founded his own start-up. As Smith (2015) argues, IPA studies use small sample sizes, and three participants are recommended to acquire an adequate insight into their experiences. We used a purposeful sampling method.

The sample used in the quantitative analysis of the study consists of SME business owners in Slovenia randomly selected from the Business Directory of the Republic of Slovenia (PIRS). In order to acquire industry-specific insights, we focused on the following four industries: (1) manufacturing, (2) retail trade, (3) computer programming, and (4) research and experimental development in natural sciences and engineering. To produce high-quality information, Dillman's (2007) tailored design method was utilized in constructing the questionnaire and its distribution. The suggestions of four sequential stages from Dillman (2007) were used as a basis for pre-testing: (1) expert review, (2) expert interviews, (3) observation and sample interviews, and (4) a final check. We interviewed one assistant professor and entrepreneur; one professor, investor, and entrepreneur; three successful entrepreneurs; and three top management representatives. Interviewees were from different sectors: manufacturing, food production, information and communication technology, and the textile industry (See Appendix A). In addition, prior to that we discussed the questionnaire in a small focus group with participants of diverse backgrounds (Kitzinger, 1995; Krueger & Casey, 2015; Morgan, 1996). This group included four entrepreneurs, one doctoral student, two SMEs employees, and an assistant professor from Slovenia. The questionnaire was first prepared in English, then translated to Slovenian in order to conduct the interviews; the responses were then translated into English (Brislin, 1970; Craig & Douglas, 2000; Hambleton, 1993).

We first implemented a pilot study of a sample of 25 entrepreneurs to gather initial feedback on the questionnaire. Based on these insights several modifications were made to improve the clarity of the questionnaire. The survey was conducted online via email. It was sent to all firms which had their contacts published online. Although online surveys tend to achieve lower response rates than paper-based surveys, we utilized several practices to enhance our response rate (Dillman, 2007; Nulty, 2008). A notification was sent to all recipients, with a cover letter including a thank you note for those who had already responded or a kind invitation to respond for all non-respondents. In addition, two weeks later the final contact was initiated towards the non-responding recipients, who were again asked to fill in the questionnaire. We also offered to send the final report to all interested respondents as an incentive.

We used an online questionnaire distribution program, which allowed us to track all the responses and see how many emails and consequently how many surveys actually reached

the target participants. Of the 13,830 surveys mailed, 2,436 e-mails were viewed and opened and 485 questionnaires completed in a one-month process of collecting the data, which yields a 19.9% completion rate. This response rate was higher than those obtained by similar studies in Slovenia (e.g., Jeraj & Marič, 2013) and abroad (e.g., Ensley et al., 2006). The average age of firms was 13 years, with 7 people employed and revenue of €330,000. Entrepreneurs were on average 44 years old; 68% were males and 32% were females. They had an average of 18 years of experience in the industry and their average level of education was a bachelor's degree.

The usable responses yielded a low percentage of missing data (less than 1.5%) with no particular pattern, therefore the missing data were considered missing at random (Hair, 2010). We used two imputation techniques: where less than 50% values were missing, within-case mean imputation was used; for other cases, item mean imputation was implemented.

2.3.2 Measures and validity

For the purposes of qualitative analysis, innovation and personal social network were measured using validated survey instruments. In addition, a measure for experimentation reflects a number of occurrences/iterations of different experimentation modes. The knowledge was assessed by methodology adapted from Sullivan and Marvel (2011).

2.3.2.1 Independent variables

To measure entrepreneurs' social network size we used three items adapted from Greve (1995) and Renzulli (2000), which were used in research by Prodan and Drnovsek (2010). The first reflects the average hours per week the entrepreneur spends maintaining contacts with people with whom he/she discusses business. The second captures the average hours per week the entrepreneur spends developing new contacts with people with whom he/she may discuss business. The third item indicates the total number of people with whom the entrepreneur has discussed business in the previous week.

The definition of experimentation used in this paper includes different modes. A prototype can be as simple as a mockup of reports or screens, or as complete as software that actually does some processing. As our focus was to find out only which techniques entrepreneurs use in the innovation process but also how often each is used, a simple question was posed. Respondents were asked to estimate how often on average they use experimentation in developing a new product before the product launch. The question was adapted from Thomke's research (1995). Modes of experimentation were divided into several categories, ranging from fast prototyping to computer simulation and modeling. We used a 5-item Likert scale ranging from "never" to "always".

In contrast to previously adopted measures of knowledge in an organization, such as previous formal education (years of post-secondary education) and industry-related work experience (the total number of years in the industry) used as major factors reflecting personal knowledge in the research of existing knowledge by Smith et al. (2005), we wanted to gain deeper insight into this cognitive area of investigation (Borgatti & Carboni, 2007). Rather than using existing measures based on educational and firm-related instruments, we adopted a simple scale methodology from the entrepreneur business-related knowledge set scale by Sullivan and Marvel (2011), expanding it to all knowledge fields to capture entrepreneurs' perceptions of their overall knowledge. Respondents were simply given a list of all knowledge fields, from which they selected the fields of knowledge which they possess and have experience in. The number of different knowledge fields represents the respondent's knowledge breadth. Furthermore, they evaluated the knowledge fields in terms of their expertise, skills, and experiences on a 7-item Likert scale. Numbers closer to seven reflect a more comprehensive knowledge within a certain field. The highest-rated expertise was used to measure knowledge depth. The list of knowledge fields was adapted from The International Standard Classification of Education (ISCED) (Organisation for Economic & Development, 1999), an instrument designed by UNESCO suitable for presenting educational statistics internationally. The number of selected knowledge fields reflects a respondent's knowledge breadth and the level of expertise within all selected fields represents a respondent's knowledge depth. The list of variables is located in Appendix C.

2.3.2.2 Dependent variables

Respondents rated their innovation performance in comparison to that of their main competitors in the industry in the last three years. To encompass product innovation, a scale developed by Yang et al. (2009) was used. It captures the level of novelty of new products/services a firm has introduced to the market, the number of new products that are first-to-market, and the speed of new product development. In addition we included items for measuring process innovation suggested by Jiménez-Jiménez and Sanz-Valle (2011): number of process changes new to the firm, introduction of first-to-market processes, and the reaction to competition's new processes. Both scales were then combined into a single factor on the basis of an exploratory factor analysis.

2.3.2.3 Control variables

In the questionnaire, the following control variables were included to exclude third variable effects: firm age and size, industry type, an entrepreneur's gender and age, an entrepreneur's experience in industry, and his/her level of education. We assigned "0" for male and "1" for female. Firm age was calculated as the total number of years since its

founding, and firm size was based on the total number of employees. An entrepreneur's experience was measured as the total number of years working in the industry. An entrepreneur's level of education also was determined.

2.3.3 Data analyses

We first examined the possible response bias between early and late responses (Armstrong & Overton, 1977). We found no significant differences in collected data with regard to firm size, firm age, and number of employees.

Before starting an investigation of the model, a measurement model needs to meet the criteria for validity and reliability (Fornell & Larcker, 1981, p. 45). We used Cronbach's alpha to determine construct reliability. All constructs surpass the acceptable limit of 0.60, which is widely accepted in exploratory research (Hair, 2010, p. 125). Innovation yields a Cronbach's alpha of 0.911, social network yields 0.65, and experimentation yields 0.751.

Content and construct validity were assessed using exploratory and confirmatory factor analysis (Floyd & Widaman, 1995). Content analysis was performed with SPSS 16.0 using the Maximum Likelihood extraction method and Direct Oblimin rotation; for the construct validity analysis we used AMOS. One factor was extracted with eigenvalues greater than 1.0. based on the indication by a scree plot. The analysis yields a KMO of 0.881 and a significant Bartlett's test of sphericity (Hair, 2010).

Next, the model was tested for potential multicollinearity problems. After examining correlation coefficients we found out that none were above the 0.80 level, which is suggested by Hair (2010). VIF values for variables were all between 1.011 and 1.071, which is below the suggested cut-off value of 10 (Belsley, 1991).

To examine the impact of experimentation, social network, and knowledge breadth on innovation, we used a hierarchical regression analysis using SPSS. Such an approach allows us to build successive linear regression models by entering more predictors cumulatively each time and test if the new model fits better than previous ones. Thus we can verify whether the variable interaction allows for a more-significant contribution over the main model (Cohen et al., 2003, p. 158). The first model examined the effect experimentation has on innovation. In particular, we explore the effect that rapid prototyping and traditional prototyping have on firm innovation. The second model added social network, and the third also included knowledge breadth. Regression models yield variance inflation factors (VIF) within a suggested tolerance. They ranged from 1.018 to 1.058, which is far below the limit (Hair, 2010). Therefore we conclude that multicollinearity was not detected.

2.4. Results

We begin by reporting results from exploratory qualitative analysis using IPA and then continue by providing an overview of statistical findings.

2.4.1 Findings from interpretative phenomenological analysis

2.4.1.1 Experimentation

The participants were asked to talk about the product development process from the very beginning to the point of launching the product. After content analysing their responses we found four emerging themes that characterize the experimentation phase: (1) trial and error, (2) innovation enhancement, (3) improved feedback, and (4) rapid prototyping. Detailed insights from IPA analysis are located in Table 4.

Experimentation is mandatory when searching for unknown answers. It is a prerequisite for innovative solutions when dealing with new, unforeseeable, and complex situations (Sommer & Loch, 2004; Thomke, 1998a). All three participants first indicated trial and error to be an essential part of experimentation and innovation. David emphasizes, “They say that smart people learn from other people’s mistakes and are stupid on their own. However, if you are building something new, something innovative, that the world has not seen before, it is very difficult to master it fluently. Not without errors on the way. All you need to do is to repeat the exercise and ultimately you will come to a solution.” In other words, the ability to learn from failure has proved to be a vital characteristic of an innovative entrepreneur. Ben argues, “There is no other way than adopting trial and error. I mean, you can try to describe what you want to do to someone who has already done it, and then he tells you how he has done it. However, this also is categorized as learning from someone else’s failure.” In the same manner, Adam adds, “The ever-unknown path down the road leading to innovation is cramped with obstacles. Experimentation helps you find the right way towards the end of it.” Drawing on their arguments, experimentation presents a conceptual map that helps entrepreneurs find the optimal and the right way to the desired outcome, even when one happens to be in the middle of darkness and searching for a light at the end of the tunnel. That means that the road towards the light will involve much stumbling and tripping. One just needs to stand up again, remember, what brought one down, and use this experience when continuing towards the goal.

As part of the trial-and-error concept, the interviewees further emphasize the need for a rapid product development process. This has become urgent in beating the competition, which need a longer development time (e.g., Atuahene-Gima & Li, 2004; Tyagi et al., 2015; Zhao et al., 2014). The need to test the ideas as soon as they arise has become vital

in achieving a competitive advantage. In this way one can gather enough information to decide whether it is worth going forward or whether to abandon the idea. Ben explains, “Whenever an idea comes to mind, we begin by group discussion. Soon after that, we try to let it out and make it tangible. This is the only way to test its potential. To me it is no problem if a programmer wastes two days playing with a certain technology. In my eyes, this is the only way that leads to innovation.” Of course, mistakes along the way are a part of the innovation process. One can gain new insights from each repetition and learn much more than from only discussing the possible strengths and weaknesses. Accordingly, David argues that it is “better to make a mistake on Monday, so you can fix it on Friday, than accepting the right decision in two weeks”.

Moving on to the second theme, experimentation leads to better innovation and provides higher quality solutions, as discussed in the existing literature (Sundukovskiy, 2009; Thomke, 2003). Prototypes represent the necessary visuals on which one builds further actions in the development process. Adam explains, “You get a working model of your idea and then you enhance it by making another prototype. And you repeat this process until you are satisfied with the result.” Similarly, David argues that “experimentation is the only way to the final solution”. To summarize this idea, prototyping should be a vital part of the product development process if one hopes to find innovative solutions. This is how one can solve “unsolvable” problems. With each iteration, new insight into the potential product is gathered. David adds, “Only by prototyping we now have come to a solution of the problem that was too complex one year ago.”

The importance of experimentation for a higher innovativeness was emphasized by the other two interviewees. They argue for the necessity of an abundance of prototypes, which in their opinion results in better firm innovation performance and helps identify the true needs of the market. Adam elaborates, “The more prototypes we use, the better product we will make. They will help us avoid many possible errors at product launch, which you initially cannot foresee. And they will help us be more successful and innovative as a company.” Indeed, prototypes may completely alter the initial idea, but in most cases they will help identify those components which make the product unique and answer the market needs. “When you look back, a year or two, you see that everything has changed. All these minor improvements result in a completely different user experience and a different business model, you have also changed the way you work,” says Adam. Furthermore, according to Ben, “Experimentation is the only way to innovation. Prototyping creates an innovative user experience. When you deal with the unknowns, it will guide you through mess and complexity to ultimately reach a better product for customers. This is the way to make your firm more innovative and to identify the real needs of the market, such that not even people know they need.”

Table 4: Insights from IPA analysis – experimentation

Emerging themes	Links to the literature	Illustrations from interviews
Trial and error		
Trial and error is the only way	Sommer & Loch, 2004; Thomke, 1998a	"They say that smart people learn from other people's mistakes and stupid on their own. However, if you are building something new, something innovative, that the world has not seen before, it is very difficult to master it fluently. Not without errors on the way. All you need to do is to repeat the exercise and ultimately you will come to a solution." (David) "There is no other way than adopting trial and error. I mean, you can try to describe what you want to do to someone who has already done it, and then he tells you. However, this also is categorized as learning from someone else's failure." (Ben) "The ever-unknown path down the road leading to innovation is cramped with obstacles. Experimentation helps you find the right way towards the end of it." (Adam)
Accelerates the development process	Atuahene-Gima & Li, 2004; Tyagi et al., 2015; Zhao et al., 2014	"Whenever an idea comes to mind, we begin by group discussion. Soon after that, we try to let it out and make it tangible. This is the only way to test its potential. To me it is no problem if a programmer wastes two days playing with a certain technology. In my eyes, this is the only way that leads to innovation." (Ben) "It is better to make a mistake on Monday, so you can fix it on Friday, than accepting the right decision in two weeks." (David)
Innovation enhancement		
Prototypes enhance innovation performance and create better products	Liedtka, 2015; Sundukovskiy, 2009; Thomke, 2003; Ingale, 2016	"You get a working model of your idea and then you enhance it by making another prototype. And you repeat this process until you are satisfied with the result." (Adam) "Experimentation is the only way to the final solution." (David) "Only by prototyping we now have come to a better solution of the problem that was too complex one year ago." (David) "The more prototypes we use the better product we will make. They will help us avoid many possible errors at product launch, which you initially cannot foresee. And they will help us be more successful and innovative as a company." (Adam) "When you look back, a year or two, you see that everything has changed. All these minor improvements result in a completely different user experience and a different business model, you have also changed the way you work." (Adam) "The use of prototyping enhances innovation performance." (Adam) "Experimentation is the only way to innovation. Prototyping creates an innovative user experience. When you deal with the unknowns, it will guide you through mess and complexity to ultimately reach better product for customers. This is the way to make your firm more innovative and to identify the real needs of the market, such that not even people know they need." (Ben)
Improved feedback		
Prototypes enable easier transfer of a concept when gathering a feedback	Brown & Katz, 2009; Junginger, 2007; Sato et al., 2010; Serrat, 2010; Ward et al., 2009	"We use prototypes to get impressions and ideas from our friends, employees, and potential customers. You get a valuable feedback on the functionalities, easiness of use and design you would never get when just presenting the idea only verbally." (David) "I use prototypes for better communication. I can easily transfer the concept to the others by an e-visualization and thus receive rich return information about the potential product or service. I can simulate how a certain thing would work and then it gets much more evident, whether such a thing would bring any good or not. We create stories based on the prototypes." (Ben)
Rapid prototyping		
Rapid prototyping improves innovation performance	Lopez & Wright, 2002; Schrage, 1999; Brown, 2008	"Get to the market as soon as possible, test the idea, and you get to see what to improve." (David) "Don't get deep into conceptualization; if you have an idea, try to make it tangible quickly. The rapid realization of idea is much better than discussing it. Then you observe reactions and make another prototype. It turns out that it is no use for deep analyses at the beginning, as it would require too much time." (Adam) "With several experiments in the beginning of a product development process I test my hypothesis for a certain idea. Moving quickly from idea to design enables bug fixing on a real product, which is far better than theorizing problems that may happen or may not." (David) "There is no other way than rapid prototyping. When I get the idea, I try to draw it immediately or construct it out of paper or any other accessory from my office. Then I already see some imperfections. I make another prototype and discuss it with employees. I see more imperfections or maybe it sparks some completely different ideas. This is how a firm can get more innovative." (Ben)

(table continues)

(continued)

Testing the idea in the market as soon as possible	Olsen, 2015; Rasmussen & Tanev, 2015	"We try to put the idea on the market as soon as possible; that is called minimal viable product. It is still a prototype, but working. It is simple, which allows users to creatively think of any possible improvements. If we launched a finalized, optimal product without prior testing, then a lot of money and effort could be in vain, as it would be too expensive to alter it according to their wishes." (Adam) "If we gather enough positive feedback and see that there exists an interest, we move to the next level, otherwise we just abandon the idea." (Adam) "We set the budget for every idea that has been accepted within the firm and then test it. If it works, we go for it." (David) "If we had wanted to launch a perfect TV, then we would have waited for 50 years and we wouldn't have produced black and white televisions. But they did. They manufactured a TV that was barely watchable and over the years, new models emerged and the product has gone through many phases to be designed in such a way that answers users' needs completely. These are constant improvements based on the feedback from the market. This is experimentation leading to innovation." (Adam)

The discussion reveals the third theme that delineates experimentation. The use of prototyping facilitates the transfer of the concept – i.e., it provides better user feedback (e.g., Brown & Katz, 2009; Serrat, 2010). One can present an idea in a tangible way to gather rich information for further enhancements of the products. When one can actually see the idea, it is much easier to think about what one would change, what is good, and what might be a complete conceptual misdirection. David says, "We use prototypes to get impressions and ideas from our friends, employees, and potential customers. You get a valuable feedback on the functionalities, easiness of use and design you would never get when just presenting the idea only verbally." The importance of prototypes for gathering feedback by creating a plastic representation of the idea was also recognized by Ben. "I use prototypes for better communication. I can easily transfer the concept to the others by an e-visualization and thus receive rich return information about the potential product or service. I can simulate how a certain thing would work and then it gets much more evident, whether such a thing would bring any good or not. We create stories based on the prototypes."

Finally, the last theme that emerged from the interviews was the urgency for rapid prototyping. It has been suggested by different scholars that rapid prototyping is central to the innovation process and a facilitator for achieving a competitive edge over the competition (e.g., Lopez & Wright, 2002; Schrage, 1999). Our interviewees spoke in favor of this experimentation mode in innovation process. "Don't get deep into conceptualization; if you have an idea, try to make it tangible quickly. The rapid realization of idea is much better than discussing it. Then you observe reactions and make another prototype. It turns out that it is no use for deep analyses at the beginning, as it would require too much time" (Adam). Such a procedure allows for more creative fixes that in the end lead to better innovation. Accordingly, Ben argues, "There is no other way that rapid prototyping. When I get the idea, I try to draw it immediately or construct it out of paper or any other accessory from my office. Then I already see some imperfections. I make another prototype and discuss it with employees. I see more imperfections or maybe it sparks some completely different ideas. This is how a firm can get more innovative." Similarly, David explains, "With experiments in the beginning of a product development

process I test my hypothesis for a certain idea. Moving quickly from idea to design enables bug fixing on a real product, which is far better than theorizing problems that may happen or may not."

Indeed, technological progress and innovation have their foundations in experimentation. Today's products are simply the results of everlasting prototyping. As Adam says, "If we had wanted to launch a perfect TV, then we would have waited for 50 years and we wouldn't have produced black and white televisions. But they did. They manufactured a TV that was barely watchable and over the years, new models emerged and the product has gone through many phases to be designed in such a way that answers users' needs completely. These are constant improvements based on the feedback from the market. This is experimentation leading to innovation." With the arguments above we identify the important role rapid prototyping has in innovation. It represents a tool for speeding up innovative improvements of the products on the basis of the constant feedback each iteration produces, because people do not always know what they want in a product until they see it and feel it. Rapid prototyping translates product and service ideas into tangible workable forms by creating the idea one can see, test, touch, smell, and taste. This then allows capturing the real feel of the prototype and provides information regarding customers' needs, desires, manufacturability, design, and packaging.

In addition to favoring rapid prototyping, the entrepreneurs further support a rapid idea-development cycle resulting in rapid user feedback (e.g., Olsen, 2015; Rasmussen & Tanev, 2015). Adam argues, "We try to put the idea on the market as soon as possible; that is called minimum viable product. It is still a prototype, but working. It is simple, which allows users to creatively think of any possible improvements. If we launched a finalized, optimal product without prior testing, then a lot of money and effort could be in vain, as it would be too expensive to alter it according to their wishes." He emphasizes that the process serves as a decision-making tool: "If we gather enough positive feedback and see that there exists an interest, we move to the next level, otherwise we just abandon the idea." Similarly, David explains, "We set the budget for every idea that has been accepted within the firm and then test it. If it works, we go for it." According to the entrepreneurs in our study, a rapid idea-development cycle is very important for a great product, which can only be produced over several iterations. Therefore the idea must be tested as soon as possible with potential customers to gain the feedback of potential end users and to present an innovative solution. With innovative products, people usually are not aware of what they want because some things are difficult to imagine when they do not exist yet. If people are asked about a certain creative solution to a problem, they would immediately say that they would buy it. However, the reality shows that that is not the case. One needs to involve potential end users in the development process from the beginning to include features they really need and that are easy to use. With this in mind, entrepreneurs should put the concept out in its early stage and then observe the reactions from the market. If one

constantly fixes the concept and upgrades it according to the feedback, one ultimately will come to a more-innovative solution.

We gained deeper insight into the entrepreneurs' perceptions of experimentation. Our aim was to enhance our understanding of the experimentation process conducted by entrepreneurs and how they relate it to innovation. Four themes emerged from the interviews, and it is clear that experimentation is vital for all firms. Its structural part, trial and error, is central to the innovation process. It is the only way to a successful outcome when constructing something that does not exist yet, because one does not know the right path. With that in mind, experimentation leads to better, more-innovative solutions, because the density of prototype iteration unlocks creativity. It also allows a firm to see what the market really needs by receiving better feedback from end users and making it easier to transfer concepts. Moreover, the participants indicate the important role of rapid prototyping. According to them, such a mode of experimentation provides better information for the direction of product development while it is still in process. Visual representation of the concept, especially in the initial stages of new product development, spurs creativity and provides innovative enhancements to the product.

2.4.1.2 Entrepreneurs' social networks

In the interviews, social networks were emphasized as a vital driver of performance and innovativeness. When investigating deeper, four superordinate areas emerged that constitute an entrepreneur's use of a social network: (1) knowledge as a foundation for networking, (2) trust through knowledge, (3) communication, and (4) mutual benefit. The first three themes are all strongly connected to knowledge breadth. Detailed results are reported in Table 5.

All three participants considered the social network of an entrepreneur to be essential to innovation, which supports the literature suggestions (e.g., Agapitova, 2003; Landry et al., 2002). As an illustration, Adam always recognizes the vital role of social networks: "Today, you can do nothing alone. It is very important who you meet and who you have in your social network to find the right people in the right time." Additionally, all three participants find international networks to be an absolutely necessary factor in business: "Think internationally, get as many valuable contacts from all over the world as possible. But to do that, you have to possess a wide spectrum of conversational topics so you have more chances approaching different people" (Ben). "Knowing people from different countries and cultures absolutely changes how one deals with a problem" (Adam). "You can use your contact's insights from a certain country when trying to penetrate that very country with your product. But you have to know that person very good, which means you need to be interested in his experiences and hobbies, or even share similar experiences and hobbies" (David).

Table 5: Insights from IPA analysis – social networks

Emerging themes	Links to the literature	Illustrations from interviews
Knowledge as a foundation		
Knowledge breadth improves networking and helps you acquire essential contacts from all over the world. Together they enhance innovation.	Carlile, 2004; Nieto & Santamaría, 2007	"Today, you can do nothing alone. It is very important who you meet and who you have in your social network to find the right people in the right time." (Adam) "Think internationally, get as many valuable contacts from all over the world as possible. But to do that, you have to possess a wide spectrum of conversational topics so you have more chances approaching different people." (Ben) "Knowing people from different countries and cultures absolutely changes how one deals with a problem. These people may give you a completely different insight and new knowledge." (Adam) "Having an international social network is central to my business. You can use your contact's insight from a certain country when trying to penetrate that very country with your product. But you have to know that person very good, which means you need to be interested in his experiences and hobbies, or even share similar experiences and hobbies." (David) "If I have to choose one thing that helped me in effective networking, I would say that was my accumulated knowledge in different areas." (Adam) "If you connect your social network with your knowledge breadth, your company will be more innovative and more successful. I cannot imagine it otherwise." (Ben) "You have to remember where all the people in your network are and then do something about it." (Ben) "If I have to choose only one thing my broad knowledge helped me with, I would say networking." (Ben) "Knowledge breadth helps you a lot when employing new people. First, you determine easier if their skills are any good, then you guide them easier through the first steps in their new position and finally, it helps you control an employee, since you know how good their solution is and how long did they take to achieve it." (Ben) "A greater knowledge breadth means that you find a common theme for conversation with a new contact easier." (Ben) "Knowledge gives you a foundation in the process of searching the right people. To understand how someone can help you, you need to know something in that specific field, otherwise you cannot be sure, and how your network can help you and what to get from a certain friend or acquaintance." (David)
Trust through knowledge		
Knowledge breadth builds trust and improves problem-solving.	Chatenier et al., 2010; Huang, 2009	"Because I have tried many different things in my life, everything from art to programming and lecturing, that gave me a great advantage when I was trying to approach and connect with new interesting people anywhere in the planet. This amount of different experiences gives me cues for a completely different, much less mechanical way of making new contacts. Also such an obscure thing as studying philosophy helped, because every other person has both professional and personal side. And very quickly I find bridges to the personal matter and then the business gets easier. I think the trust is built right away." (Ben) "It helps if you know something from your contact's personal interest. This is how you focus on more interesting areas, get closer to this contact and then funnel the conversation to the matter of your interest more naturally over the time." (David) "I used to be a hacker and many entrepreneurs used to be too. When making a contact with someone sharing the same past gives us a lot of enthusiasm to creatively, innovatively discuss the new possibilities and technologies in this field." (Ben) "A greater knowledge breadth means that you find a common theme for conversation with a new contact easier." (Ben) "Knowledge is important when approaching new people." (Adam) "Knowing your contact's expertise helps searching for disruptive and innovative solutions." (Ben)
Communication		
With knowledge breadth one can better understand other people.	Andersen & Drejer, 2009; Simon, 1985; Tong et al., 2014	"If you know nothing about a person's field of expertise, then you cannot do anything with him, cannot make a proper discussion. You do not even know why you need this person in your network. It's a total waste of time." (Adam) "Empathy correlated with lots of general knowledge will help you understand your opponent's views and ease the communication." (David) "I am always using giving forward approach. I try to understand my contact's situation, what is his industry, his problem space, and I ask him about these things first. I don't question myself what I will have of this conversation. Rather I try to figure out how to invest in him as much as I can." (Ben) "If you only call when you need something, you soon will have a dead contact. Therefore you need to nourish your relationship with casual communication. And for that you need to have a lot in common with the other person, so you do not run out of topics to discuss." (Ben)

(table continues)

(continued)

Mutual benefit		
Networking is a long-term building process.	Bhagavatula et al., 2008; Crossley et al., 2015	"If you are not prepared to help someone you want help from, then in the long term this network will be invalid." (David) "You can't drain the contact immediately with everything you need to know, you need to build long-term relationships." (David) "You need to understand that your network is comprised of many innovative people, which means that they will always provoke you to find better solutions to already existing problems. They will give you patronizing lecturing about anything in a good way that will then give you an incentive to show them you know better." (Ben) "Network is an investment you need to care for." (Ben) "You need to learn how to listen to other people." (Ben)

However, a social network on its own does not have any value if one does not know how to use it and does not wish to use it. "To build a good network, all you need is a personal determination" (Adam). Having said that, our participants first emphasized an entrepreneur's knowledge as a driver and a prerequisite for the effective use of personal networks. Ben argues, "If I have to choose one thing that helped me in effective networking, I would say that was my accumulated knowledge in different areas." Furthermore, he indicates a positive joint effect that social networks have on innovation: "If you connect your social network with your knowledge breadth, your company will be more innovative and more successful. I cannot imagine it otherwise" (Ben). These findings reinforce arguments by various scholars that possessing different knowledge domains results in a more effective exploitation of one's social network (e.g., Carlile, 2004; Nieto & Santamaría, 2007).

Moreover, knowledge breadth also boosts one's familiarity with his/her network, which aligns with the prior literature (e.g., Brown & Katz, 2009; Swan et al., 1999). To understand what certain contacts have to offer, one needs to have basic knowledge in that certain area to understand what one is after. Ben argues, "You have to remember where all the people in your network are and then do something about it." David adds, "Knowledge gives you a foundation in the process of searching the right people. To understand how someone can help you, you need to know something in that specific field, otherwise you cannot be sure, and how your network can help you and what to get from a certain friend or acquaintance." This also can be translated into the area of employment, because it allows one to appropriately address potential employees and see whether they fit in the plan. Knowledge in a certain field will let one recognize the real experts in a particular area and guide them through activities.

The second theme revealed in the conversations was building trust through knowledge. Trust is a very important factor when one is trying to build or exploit a network (e.g., Chatenier et al., 2010; Huang, 2009). People need to trust each other and trust that there is no hidden agenda in order to be willing to help each other. And trust can be most easily built with knowledge breadth. As Ben puts it, "Because I have tried many different things in my life, everything from art to programming and lecturing, that gave me a great

advantage when I was trying to approach and connect with new interesting people anywhere in the planet. This amount of different experiences gives me cues for a completely different, much less mechanical way of making new contacts. Also such an obscure thing as studying philosophy helped, because every other person has both professional and personal side. And very quickly I find bridges to the personal matter and then the business gets easier. I think the trust is built right away." Indeed, knowledge in different areas helps one to get closer to a contact, to start a casual conversation, to remove potential barriers, and to build a special connection with the potential contact. David adds, "It helps if you know something from your contact's personal interest. This is how you focus on the more interesting areas, get closer to this contact and then funnel the conversation to the matter of your interest more naturally over the time." If one has any knowledge in the other person's area of expertise, that also boosts innovativeness, because this common interest can lead to a search for disruptive ideas in the other person's problem space that can be connected with one's own. "I used to be a hacker and many entrepreneurs used to be too. When making a contact with someone sharing the same past gives us a lot of enthusiasm to creatively, innovatively discuss the new possibilities and technologies in this field" (Ben).

The third emerging theme found in social networks was effective communication through knowledge, which is suggested by several authors (e.g., Andersen & Drejer, 2009; Simon, 1985; Tong et al., 2014). To use a network efficiently, one needs to use knowledge to build proper communication. General knowledge is then used to understand each other and to create innovative solutions through the conversation. Adam argues, "If you know nothing about a person's field of expertise, then you cannot do anything with him, cannot make a proper discussion. You do not even know why you need this person in your network. It's a total waste of time." It is important to realize that one must empathize with the new contact and know how to understand his/her perspective. David says, "Empathy correlated with lots of general knowledge will help you understand your opponent's views and ease the communication." Furthermore, one needs to understand the contact's situation and what he does, and be able to make him feel important, in order to have something to discuss and to make an overture to one's own conversation. Ben says, "I am always using a giving-forward approach. I try to understand my contact's situation, what is his industry, his problem space, and I ask him about these things first. I don't question myself what I will have of this conversation. Rather, I try to figure out how to invest in him as much as I can."

In addition, a network is not to be exploited inappropriately. Many common interests are required, and consequently, knowledge. "If you only call when you need something, you soon will have a dead contact. Therefore you need to nourish your relationship with casual communication. And for that you need to have a lot in common with the other person, so you do not run out of topics to discuss" (Ben).

The last theme found in our analysis is mutual benefit, which has been found essential in developing a social network (e.g., Bhagavatula et al., 2008; Crossley et al., 2015). All three participants claim that a network is only effective if it is balanced, so there is something in it for everyone. David claims, "If you are not prepared to help someone you want help from, then in the long term this network will be invalid." A network is an investment and one must build it for the future. David continues, "You can't drain the contact immediately with everything you need to know, you need to build long-term relationships." An important part of such relationship is the stimulation to be more innovative one receives from the network. "You need to understand that your network is comprised of many innovative people, which means that they will always provoke you to find better solutions to already existing problems. They will give you patronizing lecturing about anything in a good way that will then give you an incentive to show them you know better" (Ben). To put it differently, a network will make one more innovative and one will make one's network more innovative in return.

The interviews indicate new insights regarding the understanding of an entrepreneur's social network. There seems to be a relationship between an entrepreneur's social network and knowledge. With higher knowledge breadth, an entrepreneur can approach new contacts more easily, breaking the initial barrier with common discussion themes and building trust with a new contact. Moreover, an entrepreneur can detect the information that he/she really needs in other industries more rapidly. Communication is enhanced if an entrepreneur speaks the same language as a potential contact. With broad knowledge an entrepreneur can exploit his/her network better and connect different areas in order for the firm to be more innovative.

2.4.2. Regression analysis results

We used a hierarchical regression to test influences of variables individually and in combination with other variables to see whether the successive models fit better than previous ones. We followed procedures by Cohen et al. (2003). In the first step, control variables were entered; in the second step, rapid prototyping was added; in the third step, traditional prototyping was added; in the fourth step, the social network was included; and the last step added knowledge breadth. The descriptive statistics and correlations are presented in Table 6.

The results of the hierarchical analysis are shown in Table 7. The base model first analysed the impact of the control variables. Results show that only previous experience in the industry and firm age has a significant positive effect on innovation. An entrepreneur's gender, age, education level, firm size, or industry, have no significant effect on innovation in the base and subsequent models.

Table 6: Descriptive statistics and inter-correlation matrix

	Mean	S.D.	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)
1) Innovation	4.53	1.02	1.00											
2) Rapid prototyping	10.25	7.11	.28**	1.00										
3) Traditional prototyping	6.52	5.31	.19**	.21**	1.00									
4) Social network	8.84	8.56	.17**	.07	.06	1.00								
5)Knowledge breadth	4.3	1.44	.14**	-.06	-.01	.08	1.00							
6) Experience in industry	18.09	10.06	-.03	.08	.08	.01	-.09	1.00						
7) Firm size	7.29	30.65	.07	-.08	-.04	.02	.06	.03	1.00					
8) Industry	2.57	1.22	-.07	-.10	.15*	.00	-.03	.26**	-.04	1.00				
9) Education level	4.24	1.19	.15**	.12	.06	-.03	.13**	-0.21	.09	-.13**	1.00			
10) Gender	0.68	0.47	.03	.12	.16*	-.05	.05	.22**	.06	.15**	.01	1.00		
11) Age	44.47	10.69	-.05	-.03	.04	-.02	-.10*	.70**	.06	.19**	-.08	.15**	1.00	
12) Firm age	13.43	11.72	-.08	-.06	-.02	.03	-.04	.32**	.24**	.23**	-.09	.08	.33**	1.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

We continued by entering rapid prototyping in Model II. The result shows that rapid prototyping is positively related to innovation. In particular, the beta coefficient is positive and significant ($\beta = 0.261$, $p < 0.001$). This provides full support to Hypothesis 1. The coefficient of determination amounted to 0.091, meaning that 9.1% of the total variance in innovation is explained by this regression model.

Model III incorporated rapid prototyping and traditional prototyping. The overall coefficient of determination rises to 0.155. Rapid prototyping still significantly affects innovation ($\beta = 0.193$, $p < 0.01$), as does traditional prototyping ($\beta = 0.274$, $p < 0.001$). This provides full support to Hypothesis 2.

In Model IV we added social network. R^2 increases to 0.185 and the effects of rapid prototyping ($\beta = 0.190$, $p < 0.01$) and traditional prototyping ($\beta = 0.249$, $p < 0.001$) still significantly influence innovation. Social network yields a coefficient of determination of 0.180 at the $p < 0.01$ significance level. Therefore, Hypothesis 3 is fully supported.

Finally, the last model encompassed rapid and traditional prototyping, social network, and knowledge breadth. The model contributed to an increase in the coefficient of determination, explaining 23.1% of the total variance in innovation, which leaves the rest (76.9%) as variability of the model data. The effect of the previous constructs is positive at

different significance levels (rapid prototyping: $\beta = 0.212$, $p < 0.001$; traditional prototyping: $\beta = 0.251$, $p < 0.001$); social network: $\beta = 0.159$, $p < 0.05$). In addition, knowledge breadth yields a positive significant coefficient of 0.235 ($p < 0.001$). In other words, the combined effect of experimentation, social network, and knowledge breadth is positive and significant and explains more of the variance than does Model IV. Hypothesis 4 is supported.

Table 7: Results of hierarchical regression

Variable / model	Model I	Model II	Model III	Model IV	Model V
Innovation					
Control variables					
Gender	-0.07	-0.10	-0.14	-0.09	-0.09
Prev. exp in industry	0.30 **	0.25 *	0.26 *	0.24 *	0.22 *
Age	-0.20	-0.18	-0.17	-0.18	-0.16
Level of education	0.03	0.01	-0.01	0.00	-0.03
Firm size	0.10	0.13	0.13	0.13	0.11
Firm age	-0.22 *	-0.19 *	-0.20 *	-0.18 *	-0.15
Industry	0.04	0.07	0.01	0.00	-0.01
Independent variables					
Rapid prototyping		0.26 ***	0.19 **	0.19 **	0.21 ***
Traditional prototyping			0.27 ***	0.25 ***	0.25 ***
Social network				0.18 **	0.16 *
Knowledge breadth					0.23 ***
Model					
Ajd R^2	0.03	0.09	0.16	0.18	0.23
R^2	0.07	0.14	0.20	0.23	0.28
R^2 change		0.06	0.06	0.03	0.05

** p < 0.05, ** p < 0.01, ** p < 0.001*

2.5 Discussion and implications

This study adds to the nascent research incentives in the field of entrepreneurial stance and innovation. Because innovation has been suggested to play a central role facilitating a firm's competitiveness (Marvel & Lumpkin, 2007), a deeper understanding of variables supporting it is essential. Therefore we explore how experimentation, in particular rapid and traditional prototyping modes, are related to innovation. Moreover, we postulate that the effect of social network on innovation performance may be enhanced by an entrepreneur's knowledge breadth. In sum, our findings support propositions in the literature which see firm performance and innovation as a reflection of entrepreneurs'

characteristics and behaviour (Baron, 2013; Hmieleski et al., 2015). A combination of qualitative and quantitative research methods was used in the study.

In the following section we highlight main contributions of this study. To our knowledge, this study is among the first to investigate experimentation qualitatively and to test its impact on innovation quantitatively on a large sample. With IPA methodology we gain a deeper understanding of the underlying factors that build experimentation and how it affects innovation. We reveal the positive impact of all prototyping modes on innovation performance and additionally contribute by delineating the central role of rapid prototyping. We test this proposition with hierarchical regression and provide support to the hypothesis that its role in innovation is indeed significant. Furthermore, we explore the construct of entrepreneurs' social networks and find knowledge breadth to be an important facilitator of the social network's relationship with innovation. Knowledge breadth is also shown to have an essential influence in building and preserving personal social networks. Moreover, greater knowledge breadth will improve the process of new contact acquisition, because trust is built faster and communication is smoother. It will also facilitate new idea generation by combining different fields of interest. We test this proposition quantitatively and confirm the positive joint effect of social network and knowledge breadth on firm innovation performance.

With this study we find that social network and experimentation are indeed related. A social network provides support when errors are made and may direct the experimentation process by providing information of others' experiences. We suggest a possible connection in our last model, where we see that both rapid and traditional prototyping as well as social network and knowledge breadth achieve the highest coefficient of determination.

We also discover several implications for entrepreneurs in fostering the innovation performance of their SMEs. We find entrepreneurs being in favour of experimentation to be an essential part of innovation and new product development. Prototyping allows for clearer concept transfer to the market and better feedback. Usually people do not know what they want, especially if it is something that does not exist yet. Prototyping enables more-effective communication. By using prototypes entrepreneurs may determine hidden needs, because they will use people's feedback on features to enhance the product in order to reach an innovative solution. We find that rapid prototyping plays an important role in achieving innovation. It is also the best way to test any idea, because visual representation stimulates people's imagination. Entrepreneurs should aim at launching a minimum viable product rather than conceptualizing and searching for an optimal solution. The more finalized a prototype is, the less creative people will be when assessing it. They will have difficulties seeing what it lacks and discovering potential improvements. In addition, it is less socially desirable to criticize a polished prototype. Therefore, in order to learn the most about the existing idea and to inspire new innovative ideas, early prototypes should

not be complex. With responses received from end users, development can proceed in the right direction by constantly upgrading features. Therefore prototyping seems important when aiming to create more innovative outcomes, especially in the early stages of new product development. Findings from empirical analysis support the important role of experimentation in the innovation process. In addition, our model indicates that rapid prototyping is a more-innovative mode than traditional prototyping.

Above all, design thinking emphasizes that for the purposes of experimentation, material from daily life (e.g., boxes, glue, paper, packaging, cloths, wood) can be used with imagination, along with computer programming and other techniques (laser cutting, electromagnetic forming, 3D printing, laser bending). Taking advantage of the first helps in reducing the costs and provides instant feedback, whereas the latter is more precise and suitable for the later stages of a product development, where details come into play (Nussbaum, 2004; Onuh & Yusuf, 1999). Nevertheless, experimentation provides a base for further innovative adjustments and should take into account consumer orientation in addition to technical performance features (Hardgrave et al., 1999; Hughes & Cosier, 2001; Thomke, 1998a). Accordingly, entrepreneurship courses should be designed in such a way that would emphasize the important role of experimentation. Students should internalize the culture of prototyping and learning from failure in order to be more innovative as young entrepreneurs.

Furthermore, many authors suggest a positive effect of an entrepreneur's social network on innovation (e.g., Chen & Wang, 2008), but these relationships so far have been supported only at a firm level. This study offers new insight into the potential effects that an entrepreneur's social network has on innovation. A strong relationship between social network and an entrepreneur's knowledge has been highlighted. Knowledge breadth may facilitate the process of making new contacts because it helps build trust faster by targeting the contact's interests with a grounded discussion and problem solving. This is how creative combinations of different topics may result in innovative solutions. Knowledge also allows for a better investment in a contact because a long-term relationship can be built more easily with trust. In addition, an entrepreneur with greater knowledge breadth may understand others much better, and this helps to identify and distinguish important clues from insignificant topics. As the findings indicate, knowledge breadth facilitates the relationship between an entrepreneur's social network and innovation. Finally, an entrepreneur's social network represents an incentive and provocation to do things better and develop more-innovative solutions.

It is important that educational communities recognize the significance of expanding students' knowledge and growing their personal networks in order to be productive in the workplace once they graduate. Entrepreneurship courses should therefore help students

gain capabilities to grow personal networks and help them understand the importance of broad knowledge base.

2.6 Limitations and future research

We acknowledge several limitations to this study, which may present opportunities for future research. First, in our qualitative research we are aware that prompts used by the interviewer may unintentionally lead participants in the desired direction to give answers to support research questions. We tried to eliminate these issues by combining this method with a quantitative research methodology to extend our findings to a larger population (Atieno, 2009; Creswell & Clark, 2007). Despite this, new studies should be conducted on a larger scale incorporating IPA methodology. Second, the qualitative part may be a subject to hindsight bias (Cassar & Craig, 2009), which affects one's recollection of the past. Due to simplification of past events, analysis may have omitted some important factors concerning experimentation and social network. Third, measures in the quantitative study are self-reported, which threatens its validity (Donaldson & Grant-Vallone, 2002) because self-reported measures are usually biased towards more confident participants (Lasagni, 2012). Such data are also a subject to socially desirable responses, where participants try to present a favourable image of themselves (Johnson et al., 2002; Van de Mortel, 2008). Fourth, the estimation of the model is based on a sample of SME owners in only one country and few industries (manufacturing, retail trade, computer programming, and research and experimental development in natural sciences and engineering). In addition, the selection of entrepreneurs, who are supposedly full or partial business owners of SMEs, may hinder generalization across other types of organizations, such as large enterprises. Future research may include cross-national comparisons and extension to other industries as well. Fifth, in this study we did not address other possible moderators or mediators in relationships between social networks and innovation or between experimentation and innovation. Further studies are needed to examine the relationships more carefully to explore possible constructs. Sixth, this study is limited to a specific point in time, which inhibits causation. Future research can profit from longitudinal empirical research.

3 EFFECTS OF TEAM STRUCTURE ON INNOVATION PERFORMANCE: AN EMPIRICAL STUDY[2]

3.1 Introduction

Increasing global competition and the ever-increasing requirements for flexibility and adaptability to the unexpected conditions and changes have advanced the salience of how teams are structured in the effective production of innovative goods and services (Guzzo & Dickson, 1996; Kozlowski & Ilgen, 2006). Consequently, significant attention has been paid to better understanding which determinants make teams work effectively. In several studies in the field of business, management, and psychology scholars have tried to discover the factors that affect team performance (Kozlowski & Bell, 2003). For instance, group cohesion (Mullen & Copper, 1994), emotional displays (Van Kleef et al., 2009), collective goals (O'Leary-Kelly, Martocchio, & Frink, 1994), and member satisfaction (Feng, Yongjuan, & Erping, 2009) were all shown to be significant predictors of team performance and innovation.

Similarly, more and more ventures are successfully founded by teams (Feeser & Willard, 1990). An increasing number of success stories from the "start-up" world have emphasized the importance of teamwork in the field of entrepreneurship (e.g., Chan, 2009) and broader management research (e.g., Guzzo & Dickson, 1996). In addition, multidisciplinary collaboration has been suggested as central to complex problem solving, idea development, and innovative solutions (Chasanidou et al., 2015; Gloppen, 2009; Hassi & Laakso, 2011; Rauth & Nabergoj, 2016). Although existing literature has largely contributed to our knowledge about determinants of team performance (e.g., Banker et al., 1996; Stewart & Barrick, 2000), there are several remaining unanswered questions. For instance, although existing studies highlight many differences across teams' innovative performance and underscore the importance of considering composition of team roles in the study, less attention has been paid to understanding how the composition of team roles impacts innovative performance. In particular, factors affecting teams' performance, creative excellence, and innovativeness are still poorly examined (Bygrave & Timmons, 1992; Henneke & Luthje, 2007).

Furthermore, evidence shows that team heterogeneity is crucial for product innovativeness (Henneke & Luthje, 2007), team learning (Clarysse & Moray, 2004), and firm performance (West, 2007), but little is known so far about processes that lead to successful team formation (Chandler & Lyon, 2011; Forbes et al., 2006). Taken altogether, research in determinants of team innovation performance has been growing over the past few years,

[2] This chapter was published as Prebil and Drnovšek (2013) and was presented as a working paper at the NCSB 2012 Conference.

with team structure being emphasized as one of the main reasons for variability in innovation performance of teams (e.g., Cohen & Bailey, 1997; DeCusatis, 2008). In particular, individual characteristics and attributes of team members influencing the allocation of tasks and authority have been attributed a crucial role in team performance (O'Neill & Allen, 2011; Peeters et al., 2006) and team innovation (Bell, 2007).

In examination of the impact of team role structure, Belbin's model of team roles has so far gained much research attention. According to Belbin, team roles are defined as a pattern of six factors: personality, mental ability, current values and motivation, field constraints, experience, and role learning. Although Belbin (2010) did not show how much of the variance of a specific role is explained by individual factors, he argued that all roles should acquire a balanced representation in a team (Aritzeta et al., 2007). However, not all studies could verify the Belbin roles' contribution to innovation and performance (e.g., Anderson & Spleap, 2004; Rushmer, 1996). Meanwhile, other role theories and guidelines, such as by Benne and Sheats (1948), Katz and Kahn (1978), Graen and Scandura (1987), Parker (1990), Davis, Millburn, Murphy, and Woodhouse (1992), Spencer and Pruss (1992), and Holland (1997) have gained only limited attention in practice. Those findings are particularly interesting because some of the mentioned models have overlapping roles, whereas some of them are unique to a particular researcher (Senior, 1997).

Many have tried to determine a perfect formula that would allow forming the most-innovative teams (Belbin, 1981, 2010; Parker, 1990), but none of the guidelines can be generalized across a variety of circumstances. The lack of solid theoretical foundations for studying the impact of team role composition on innovation performance represents a significant gap in literature and demands attention in order to enable more systematic future research. Although certain theories have already been validated and well noted, in this research we study team roles from a different angle. Our research is grounded in design thinking theory, which has become increasingly popular in innovation activities in firms, with the specific goal of testing team structures that allow better implementation of design thinking in firms. The basic mechanism of design thinking is to use the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity (Brown, 2008). In addition, drawing from design thinking logic, Kelley and Littman (2005) argued that team members' diversity, skills, abilities, responsibilities, and personalities affect team innovation performance. Their findings are built upon their own fieldwork experiences in working with different teams in very different contexts. Although the ideas that Kelley and Littman are advancing in their theorizing are very appealing, they have yet not been validated in a structured manner. Therefore, the main purpose of this study is to test and verify, using a large sample, their empirical theory on 10 innovative roles and its connection to innovation performance in a team. In order to do so we use a combination of experimental and quantitative research methods in the contexts of different teams.

Our specific contribution is conceptual and empirical. First, we develop theoretical logics and propositions explaining why a team structure that includes key team roles leads to better innovative performance of teams. Second, we test our proposition using experimental techniques. Third, while most of the existing research on teams has focused on the micro-level, to explore individual member contribution to innovation performance; the leadership style of teams (e.g., Oldham & Cummings, 1996); or the macro-level, to explore effects of organizational design, industry specific attributes, prior ties, and demographic homogeneity on teams' performance (e.g., Eisenhardt & Tabrizi, 1995); to our best knowledge not many studies have focused on the team level. According to Klein and Kozlowski (2000), examining determinants of organizational effectiveness from the team level of research allows better understanding of intra-team interactions and behaviour as well as its external influences (Glynn et al., 2010). This study therefore investigates the innovation performance of teams depending on members' interactions and personalities. By identifying and validating characteristics of innovative team structure to which entrepreneurs should pay specific attention, we provide practical implications that can help firms enhance their competitiveness.

3.2 Literature review and hypothesis

Teamwork facilitates firm innovation because diversity, skills, and knowledge breadth of team members' contributions are more than a simple sum of individuals' contributions (Burpitt & Bigoness, 1997; Jehn et al., 1999). Innovation often has seeds in the mind of a creative individual, but requires the whole team to analyse and develop (Tang, 1998). The experience-based theory of team structure effectiveness developed by Kelley and Littman (2005) argued that any team should include 10 different team roles from three major domains: (1) learning (the anthropologist, the experimenter, and the cross-pollinator); (2) organizing (the hurdler, the collaborator, and the director); and (3) building (the experience architect, the set designer, the storyteller, and the caregiver). Kelley and Littman's proposition does not necessarily denote 10 different persons each denominated with a single role: The roles should be understood as 10 attributes, which can be distributed among any number of team members – a member may possess more than one role. For each of the roles, its characteristics and task responsibilities are linked to the positive effect they have on innovation and performance that lead to a higher innovation performance. Drawing from the fact that teamwork depends upon individual contributions, and that each of the characteristics and responsibilities has an individual influence on innovation, we expect that a team will be more innovative and effective with members covering each of the roles explained hereinafter (Barrick et al., 1998; Stewart & Barrick, 2000; Tjosvold et al., 2009). Below we summarize the key roles identified in the Kelley and Littman's (2005) framework and integrate them into the innovation performance literature. We emphasize specific key characteristics of each role and link it to existing studies that relate a specific characteristic with innovation performance.

The learning roles are crucial for the firm's performance, because knowledge provides a basis for a competitive edge and fosters innovation (e.g., Cohen & Levinthal, 1990; Grant, 1996). Learning roles, which include the anthropologist, the experimenter, and the cross-pollinator, are in charge of expanding knowledge by constantly gathering new information.

The Anthropologist

The anthropologist's task is to observe the market and develop a deep understanding of the latent needs of society and the way people interact with products. He/she tries to see all the important details, particularly of the problem-solving action. The most prominent characteristics of this role are open-mindedness, intuition, and empathy (Kelley & Littman, 2005, pp. 15-40). In prior research, these three characteristics have been significantly related to innovation performance. The first, open-mindedness, indicates the degree to which people are open-minded and like novelty (McCrae & Costa, 1987). Moreover, it refers to the willingness to tolerate different opinions and consider new unfamiliar ideas (Flynn, 2005; LePine, 2003), which traits which facilitate good understanding of members and lead to a better team innovation performance (Homan et al., 2008). Furthermore, open-mindedness was shown to positively impact an individual's creativity, imagination, and innovativeness (e.g., Baer & Oldham, 2006; Jacoby, 1967). The second, intuition, evolves from experiences and accumulated knowledge, and is most often used in an environment that lacks information (Harper, 1988; Kardes, 2006). Furthermore, intuition proves useful in strategic decisions (Khatri & Ng, 2000) and can foster creativity and individual innovation performance (Sadler-Smith & Shefy, 2004; Tesolin, 2007). The third, empathy, helps branch out into other skills and integrate them with their deep knowledge, as long as they experience the problem from multiple perspectives to fully understand the latent needs. By combining different insights it allows for creativity and higher innovation performance (e.g., Martin, 2009; McDonagh & Thomas, 2010).

The Experimenter

The experimenter's task is to make ideas tangible to give a shape to a new concept. He/she embraces failures at early stages to avoid big mistakes later in the process and thus saves money and makes the thinking process more fun, therefore making the work more pleasant. The most prominent characteristics of this role are ability to experiment, risk-taking, and learning from failures. A person's ability to experiment is crucial for the team's performance and new product development, because prototypes (from experimentation) enable more powerful explanation via solution visualization and successful idea evolving (e.g., West & Iansiti, 2003; Wouters & Roijmans, 2010). Second, risk-taking involves taking bold actions and is also an important factor that positively affects creativity in terms of idea boldness (Baucus et al., 2008), firm performance (Antoncic, 2003), and team innovation performance (particularly radical innovation, due to a higher level of complexity and uncertainty) (Cabrales et al., 2008; Rhee et al., 2010). Moreover,

experimentation and trial-and-error learning improve the development process and foster creativity and organizational innovation performance (Cannon & Edmondson, 2005; Thomke, 2003).

The Cross-Pollinator

The cross-pollinator's role is to provide knowledge breadth to the team. This team role facilitates combining knowledge – i.e., connecting general knowledge, experiences, skills, and hobbies to the problem in the area of expertise. It enables bringing to the team new perspectives on how to utilize expert knowledge in many different aspects of life (Brown & Katz, 2009; Kelley & Littman, 2005, pp. 67-90). The variety of knowledge and skills of this role enhances opportunity recognition (Kogut & Zander, 1992), new product development (Leonard-Barton, 1995), creativity, and firm innovation (Sakkab, 2007). Finally, it was demonstrated that curiosity has a positive effect on creativity and innovation performance (e.g., Fleming, 2004; Sakkab, 2007).

The set of roles that concentrate on organizing are salient for moving ideas forward in organizations. Organizing is essential to teams because it provides a path to follow in order to connect and integrate all the members into a team by setting goals and motivating other team members. These roles also manage team resources such as time, effort, and financial resources (Kelley & Littman, 2005).

The Hurdler

The hurdler is the entrepreneur of the team, persistent, optimistic, and determined, with great problem-solving skills. He/she follows the path to the goal he/she believes in and successfully overcomes obstacles that emerge along the way. In the past, persistence has been positively related to innovation, because it helps to complete a variety of tasks over time no matter what (Wong et al., 2009). Optimistic individuals are also more effective problem-solvers (Peterson et al., 1998) because they are more open to new knowledge and experimentation (Levinthal & March, 1993), more open to new challenges (Seligman & Nathan, 1998), pay more attention to information (Aspinwall et al., 2001), and are more likely react to problems (Geers et al., 2003), which results in a higher problem recognition (Papenhausen, 2004) and individual innovation performance (Gary, 2003).

The Collaborator

The role of the collaborator is to take care of the team, to assign roles to team members depending on the problem set and the skills needed, and to inspire the team with confidence (Kelley & Littman, 2005, pp. 113-140). He/she brings people together to get things done and ties the group together in challenging times. In the literature, collaboration has been recognized as an essential part of fostering innovation performance through idea generation (Barczak et al., 2010; Brown & Katz, 2009), creativity (Alves et al., 2007), speeding up the product development process (Brown & Eisenhardt, 1995; Schippers et al.,

2010), and better predicting environmental changes (Ambrose & Harris, 2009; Hansen & Oetinger, 2001). The collaborator's main goal is to ensure that the team is used to its full potential in attaining innovation performance.

The Director

Among the organizing roles, the director is the operative manager of the team. He/she needs to find talented individuals, compose a team, and direct the team towards a goal. The director helps to spark creativity and instils the team with inspiration, motivation, and empowerment (Kelley & Littman, 2005, pp. 141-164). Empowerment is important for the creation of trust (Brunetto & Farr Wharton, 2007), autonomy, power in decision-making (Spreitzer et al., 1997), proactiveness, open communication, and shared vision and common goals (Ahmed, 1998), which have all been shown to lead to enhanced performance and organizational innovation performance (e.g., Jung et al., 2003).

The building roles integrate information gathered by the learning roles with the empowerment of the organizing personas into a combination that allows and fosters innovation.

The Experience Architect

This role creates unique consumer experiences to connect at a deeper level with the consumer's latent needs and satisfy market needs. By having the capability to transform a product or service into an extraordinary experience (Kelley & Littman, 2005, pp. 165-192), the role fosters innovation performance. Indeed, design literature suggests that focusing on the functional performance of products is not sufficient; innovating firms need to consider a product's emotional satisfaction and market latent needs as well (Leavy, 2010; Li et al., 2007). Many contemporary business success stories relate to new experiences (Martin, 2007a, 2009); companies such as Apple, P&G, Four Seasons, Red Hat, and Cirque de Soleil brought to the market what people had not even known they need or want.

The Set Designer

The set designer has the capability to transform ordinary work environments into a powerful tool that stimulates creativity and fosters innovation by affecting participants' behaviour. The work environment has been determined to be an important factor in stimulating an individual's creativity, affecting creative performance and innovation as a result (Oldham & Cummings, 1996). The work environment is salient to individuals' creativity and innovation performance (Amabile et al., 1996).

The Storyteller

The storyteller builds morale and environmental awareness by fostering the transmission of values, emotions, and objectives through fascinating stories. Stories have a greater power of persuasion than facts or reports and are also the channel through which knowledge,

norms, and values are exchanged and shared in the pursuit of emotional connection (e.g., Boyce, 1996). They enhance trust and commitment through greater understanding, provide new perspectives on the problem, and are a source of inspiration and simulation. The storyteller enforces new ways of considering market needs, which normally results in an improved product, consumer experience, and innovation performance (Beckman & Barry, 2009; Heath & Heath, 2007). He/she also has a specifically instrumental role when the team pursues radical innovation (Beckman & Barry, 2009; Sole & Wilson, 1999).

The Caregiver

The caregiver is a customer-focused role with strong empathy to promote and further enhance the consumer experience. His/her customer focus and empathy enable him/her to promote and further enhance the consumer experience by making people feel like they are the only customers in the world and that a certain product or a service is specially designed for them (Kelley & Littman, 2005, pp. 215-240). The caregiver is able to step into the customer's shoes (Ambrose & Harris, 2009), which results in much greater innovation performance as many new ideas are exposed (e.g., Li et al., 2007; Wylant, 2008).

Above we showed how each of the roles advanced by Kelley and Littman (2005) is related to innovation performance by itself. Given that, we argue that including all of the roles discussed above in a team should also be significantly related to innovation performance (Barrick et al., 1998; Stewart & Barrick, 2000; Tjosvold et al., 2009). This leads us to propose:

Hypothesis A: A team structure that includes the roles proposed by Kelley and Littman (2005) will lead to better innovation performance than a team structure that includes a random combination of individuals.

In this case, "a role" is considered to be an attribute of a team structure and is not necessarily linked to one team member only. Moreover, each member of a team can fulfil more than just one role.

3.3 Research design

3.3.1 Research strategy, measures, and data analysis

In order to test our hypothesis a combination of qualitative and quantitative research methods was used (Bryman, 2006; Tashakkori, 2006). Given the nascency of this research field, the qualitative methodological approach was found appropriate to explore the motives, feelings, values, attitudes, and perceptions that underlie and influence the behaviour of individuals in a team (Merriam, 1998; Patton, 2002). Based on qualitative

theory, experiments were used to gain better insight into the phenomenon within its real-life context (Denzin & Lincoln, 1994; Patton, 2002; Yin, 2009) and to understand underlying emotions and cognitions within a team (e.g., Sørensen et al., 2010). Quantitative research (linear regression) was used to provide additional support to the relationship between the presence of team roles and organizational innovation.

Given the longitudinal nature of this research, multiple experiments were used as a qualitative research tool to consider different cases for replication. Indicative guidelines by Yin (2009) and Patton (2002) were followed regarding how to perform experiments to have a control over actual behavioural events and simultaneously focus on contemporary events (Denzin & Lincoln, 1994). However, recommendations regarding qualitative research design are somewhat loose, which leaves a lot of room for a researcher's subjective interpretation. In what follows, the research design that was used for the purposes of this research is explained.

Because Kelley and Littman's theory comes from the authors' long-term observations of how teams function, an experiment was designed in similar settings to those within which the original findings emerged. In such settings team members work together for a longer period of time and therefore know each other's advantages, weaknesses, and interactions better. The experimental phase started with an observation of teams of international students and teams of technical students. Additionally, a deeper understanding of the same phenomenon in the short run was desired. Therefore a one-day experiment was also conducted.

Three different samples were involved in the experiment. They were selected in a way that allowed long- and short-term observation as well as international participation. The duration of observed sample and each experiment varied, because the intention was to gain a deeper understanding of the effect of different team structures (different roles) and intra-team interactions on innovation in different time frames, which were distinctive from individual tasks. All participants performed in teams and were given a problem set to solve. During the task their roles were assessed and compared to those proposed be Kelley and Littman, and their solution was reviewed by a group of independent experts.

The first sample was composed of 13 teams of international students enrolled in the entrepreneurship course at the local university. They were observed working on two different projects during a six-month time frame to determine how team roles interact over the long-term and how individuals coming from different cultures and countries operate. Teams were observed once a week during workshops to allocate different roles that appeared during the process and their variable interactions. The second sample included 11 teams of engineering major students enrolled at the local university. They were observed once a week during workshops while working on a single project during a four-month time

frame. The third sample consisted of 10 teams of randomly selected individuals, aged between 20 and 58, with diverse backgrounds. They were observed during a one-day experimental study to gain an insight into the roles' interactions when performing quick tasks.

During the process, team interactions were carefully monitored and recorded to gain an in-depth insight into team dynamics and to identify member team roles. To obtain more detailed information and to simplify the research process, a structured questionnaire was developed on the basis of our observation (Appendix F). Our survey instrument included questions about team members and was tested on a group of post-graduate students at the local university prior to being used in the experiment. The questionnaire proved to be an adequate substitute for observation because the answers of the existing roles were similar to what we observed, and it was then used to calculate the independent variable: team role score. For the purposes of this research the name "Kelley's index" was suggested to designate team role score.

After a task completion, each team member was asked to evaluate his/her team members. In terms of structure and organization, the left side of the questionnaire held descriptions of each of the 10 roles, whereas the right side contained a table to fill out. Each member of the team had one minute to read the characteristics of a certain role (e.g., the anthropologist). Afterward, more information on a specific role was provided by interrogator in order to prevent misunderstanding. Next, the team members had one minute to evaluate the mentioned role within the sample of their members, including themselves, and attribute it to any individual. They repeated the process outlined above for each of the 10 roles. Each member of the team was able to select a maximum of two people who in his/her opinion possessed the mentioned characteristics, and rated them on a scale from 1 (the characteristics are poorly expressed) to 5 (the mentioned characteristics can be completely related to the person). If no such characteristics existed in the team, the respondent was requested to leave it blank. The independent variable, Kelley's index, was measured through questions. Individual scores were then used to calculate the team role score with only the role scores of members receiving at least 50% of the total votes being considered. The index was calculated as the sum of the individual shares (the number of ratings compared to the maximum number of ratings a person could get) and measured the number of expressed roles in a team (out of 10).

The dependent variable (the team's innovation performance) was assessed by independent experts' opinion. Three experts individually evaluated each teams' projects in terms of innovation performance on a scale 0–100%. For the purposes of the study the average rating of innovation performance for each team was calculated. It is again important to emphasize that not all roles existed in each team and that team members could be associated with multiple roles.

3.3.2 Sampling

Sample 1 was composed of international students of entrepreneurship, aged between 19 and 24. They were requested to finish two projects (Cases 1 and 2), each during a five-week time frame. For Case 1, the problem involved designing a new cafeteria on the school's patio. They were assigned to six different teams, consisting of five to six members each, and were given five weeks to finish the project. Throughout the execution of the project, the teams were regularly monitored and each member needed to fill out the questionnaire on teamwork. Team innovation performance was also assessed at that point by three experts. Case 2 was conducted on the same group of students, but with different team compositions. Students were requested to form teams volitionally. There were seven teams in this case, each consisting of four to five members. They were given three similar problem sets to choose from and were allowed five weeks to finish their projects. Throughout the execution of the project the teams were regularly monitored and each member needed to fill out the questionnaire on teamwork. Team innovation performance was also assessed at that point by three experts.

Sample 2 included two groups of students (Cases 3 and 4) majoring in engineering, aged between 18 and 25 years, who were requested to finish two projects within a time frame of three months. Students were asked to finish two business projects of their own. Based on design thinking principles, they had to develop their own ideas and then present them in a business plan format. Throughout the execution of the projects, the teams were regularly monitored and each member needed to fill out the questionnaire on teamwork. Their presentations, along with the business plans, were rated by independent experts who also evaluated each team's project innovation performance.

Sample 3 included 25 randomly selected individuals, aged 20 to 58, who formed five teams for the first two creative problem sets, and were later assigned to different teams for the next two problem sets. The duration of the tasks was between 8 and 45 minutes. For Case 5, the five teams were formed volitionally and were given a "warm-up" task of constructing an instrument for eating any kind of food when on a hike or in the mountains. They had 45 minutes to finish their task. Afterwards they were requested to evaluate each other by filling out the questionnaire. Three experts assessed team innovation performance. For Case 6, teams were formed based on the results from the questionnaire in Case 5. Individual scores of the roles they possessed enabled the formation of the following five teams: Team 1 included participants who had developed several strong personal team roles in the first problem set; Teams 2 and 3 consisted of individuals who had not significantly expressed any of the roles in a team; and Teams 4 and 5 were composed of individuals who had expressed a maximum of two roles, and, as a combination of members, covered all 10 necessary roles. These teams were given two problem sets. The first was a short, impulsive one, and the second was similar to the previous experiment. Two different tasks

that required different completion times were selected to gain insight into the effect of stress and restraints. As the teams remained the same during both tasks, the role score index was evaluated with one questionnaire for both tasks after the second task was finished. Furthermore, innovation performance was calculated as an average of both problem set scores. In the first problem, teams were given a short team-building exercise. The first task included construction of a floating boat within eight minutes. If the team completed the task, it was given the opportunity to race with its boat by blowing into it in a small pool. The teams' innovation performance was rated accordingly to exercise rules. The second problem required designing an innovative solution to existing camera bags (with specimen). At the end of 45 minutes, team members evaluated their partners with a questionnaire. The team role score was then calculated as the sum of both individual scores, and experts rated the innovation performance of the solution.

3.4 Results

The qualitative research results (observation and interviews) provided evidence to support our hypothesis that the number of roles influences a team's innovation performance. Teams that had more roles demonstrated higher innovation performance in their solutions. In addition, as the sample was of sufficient size, a linear regression analysis was used to assess the effect of the roles on innovation performance. The hypothesis was tested using a linear regression model of standardized coefficients. The following regression coefficient was obtained:

$$\text{Innovation performance} = 0.68 \times \text{Kelley's index}$$

which denotes that innovation performance is predicted to increase by 0.68 when Kelley's index increases by one. "Kelley's index" in the regression model is the overall team role score (the number of the roles that were formed in a team) that was calculated from questionnaire data. The significance level of the coefficient was 0.000 (t = 5.518). The coefficient of determination (R^2) was 0.46, indicating that 46% of the total variance in innovation performance was explained by this linear regression model, which left the rest of the variance (54%) as variability of the data from the model. Unquestionably, the argumentation above provides sufficient reasoning to confirm our hypothesis, because Kelley's index measured the number of expressed roles in a team. Accordingly, teams of members covering a larger portion of the roles proposed by Kelley and Littman are more innovative than teams that encompass a random combination of members.

The results are presented in Table 8. In what follows, the results of the executed experiments are discussed in detail, based on our monitoring of the teams. Case 1 supported the idea that teams that achieve a better Kelley's index are more innovative. The top three teams according to innovation performance rank were also the top three

teams based on Kelley's index rank. The team that achieved the highest Kelley's index scored the second-best result in innovation performance, and the team that placed first on the innovation performance scale scored the second-highest Kelley's index. Teams 6 and 2 attained third and fourth place, respectively, according to their Kelley's indexes and the achieved the same respective ranks in innovation performance. In addition, Teams 3 and 5, whose solutions to the problems were the least innovative, scored the lowest Kelley's indexes. Case 2 included seven teams. The results of this experiment further support the hypothesis. Teams that ranked in the upper half of Kelley's index results achieved better cumulative innovation performance ranks compared with the lower half of ranked teams.

Table 8: Standardized values ranks

Case	Team	Kelley's index	Innovation performance	Kelley's index rank	Innovation performance rank	Standardized Kelley's index rank*	Standardized innovation performance rank*
Case 1	Team 1	5.10	91.0	2	1	-0.80178	**-1.33631**
	Team 4	6.45	89.3	1	2	-1.33631	**-0.80178**
	Team 6	4.35	83.3	3	3	-0.26726	**-0.26726**
	Team 2	3.96	82.3	4	4	0.26726	**0.26726**
	Team 3	1.32	70.0	6	5	1.33631	**0.80178**
	Team 5	3.20	64.3	5	6	0.80178	**1.33631**
Case 2	Team 4	5.16	95.0	4	1	0	**-1.22559**
	Team 3	8.55	94.2	1	2	-1.38873	**-0.77406**
	Team 7	3.96	89.2	5	2	0.46291	**-0.77406**
	Team 8	6.72	85.0	2	4	-0.92582	**0.12901**
	Team 9	3.75	75.0	6	4	0.92582	**0.12901**
	Team 6	2.85	69.2	7	6	1.38873	**1.03208**
	Team 2	5.50	63.3	3	7	-0.46291	**1.48361**
Case 3	Team 2	4.48	96.3	1	1	-1.26491	**-1.26491**
	Team 1	4.04	88.8	2	2	-0.63246	**-0.63246**
	Team 3	3.68	86.3	3	3	0	**0**
	Team 5	3.64	85.0	4	4	0.63246	**0.63246**
	Team 4	1.52	67.5	5	5	1.26491	**1.26491**
Case 4	Team 1	7.10	95.0	1	1	-1.33631	**-1.33631**
	Team 3	5.76	85.0	2	2	-0.80178	**-0.80178**
	Team 2	4.88	84.0	3	3	-0.26726	**-0.26726**
	Team 5	4.65	83.0	4	4	0.26726	**0.26726**
	Team 6	2.80	76.0	6	5	1.33631	**0.80178**
	Team 4	2.96	73.0	5	6	0.80178	**1.33631**
Case 5	Team 1	5.32	87.5	2	1	-0.63246	**-1.26491**
	Team 2	4.52	85.0	3	2	0	**-0.63246**
	Team 3	6.12	85.0	1	3	-1.26491	**0**
	Team 4	3.52	74.0	4	4	0.63246	**0.63246**
	Team 5	2.96	62.5	5	5	1.26491	**1.26491**
Case 6	Team 5	3.48	85.0	3	1	0	**-1.26491**
	Team 4	7.68	74.2	1	2	-1.26491	**-0.63246**
	Team 3	3.00	73.8	4	3	0.63246	**0**
	Team 1	1.48	65.0	5	4	1.26491	**0.63246**
	Team 2	5.56	53.3	2	5	-0.63246	**1.26491**

Note. * Standardized within a case.

Results of Case 3, which was composed of technical students, provided supporting evidence for the existence of a relationship between the 10 roles and team innovation performance. The Kelley's index rank that each team attained matched entirely with their innovation performance rank. Likewise, the results of the Case 4 proved almost identical, with a minor deviation in the two teams that achieved the lowest Kelley's index rank.

In Case 5, three teams that scored at the top of Kelley's index scale took the top three positions in the innovation performance scale rank, with a slightly different distribution. Furthermore, Teams 4 and 5, which attained the lowest positions with regard to their Kelley's index, also attained the bottom two positions in their innovation performance rank. On the other hand, the results in Case 6 align with the hypothesis, despite the fact that one team (Team 2) did not cooperate as expected. According to observation and members' comments, they did not realize the seriousness of the task presented. However, despite noticed deviations within specific experiments and the results differentiating and varying across samples, the overall study shows the significant importance of Kelley's index when predicting team innovation performance.

The following paragraphs discuss the results and activities of each of the teams in the Case 6, which tested how these 10 types of roles work together in real-time settings. The first team included those individuals that had achieved the highest Kelley's index individually in Case 5, which in practice meant that they had significantly developed and adopted three or more different roles. The team was unsuccessful in completing the first task, which lasted eight minutes. A clash of roles appeared, and team productivity was inhibited by members spending too much time figuring out and determining their roles. Members within the team were not working as a team. Rather, they were acting as a team of non-cooperating individuals, each of them trying to find a solution individually. When asked, participants expressed their feelings, noting that the exercise was one of the worst teamwork experiences of their lives. This inability to collaborate was also reflected in their Kelley's index. According to normal expectations, a team of individuals with high individual Kelley's indexes would ultimately lead to a team with a high Kelley's index. On the contrary, their strong personalities suppressed their team roles and they rated each other poorly in the questionnaire at the end of the project.

However, despite difficulties experienced during the first task, the team achieved much better results in the second task, which was of a longer duration. Although only three members in the team actually participated in the problem-solving activity, their collaboration was taxing and full of adaptation. They came up with a solution that brought them the highest innovation performance score (of all cases). Accordingly, we can assume that innovation performance is positively related to the number and strength of roles mostly in the long run and if the roles do not overlap. Notwithstanding this, due to the equivalent weight of both tasks their average innovation performance score was still low

and matched completely with the low Kelley's index they attained.

The second and third teams were organized with participants that had not developed any significant role in their team in the first part of the experiment. According to their internal evaluation and observation, some of these individuals developed significantly more roles than in the first team, therefore the Kelley's index of newly composed teams yielded a higher value. This can be due to the fact that their team roles in Case 5 might not have been expressed and developed to their full potential. However, the same two teams ranked towards the bottom of innovation performance in Case 6, despite one of them achieving a rather good Kelley's index. Observation of the work process offered a good explanation: The members of the teams were unwilling to fill in the questionnaires carefully and thoughtfully, because some of the members were in a hurry to leave the experiment for some reason. In addition, the members of the team were not in a good mood and did not take the experiment seriously enough (their solution to the problem set was innovative but also unrealistic). Such circumstances possibly led to a bad result in innovation performance and quite good Kelley's index (they may have been too generous evaluating each other because they did not want to offend each other).

The final step included organization of the fourth and the fifth teams of participants from the participants that had expressed a maximum of two roles in the first part and whose roles did not overlap. Teams that would cover as many of the roles as possible were formed. These two teams achieved the highest rank in combined innovation performance from both problem sets. In the first problem set, which required a quick response, both teams acted as effective teams and developed brilliant solutions. Simultaneously, their high Kelley's indexes were congruent with their innovation performance rank. Moreover, according to their comments, these two teams really got along well and enjoyed working together. Great work conditions, member satisfaction, roles that did not overlap and yet covered all 10 of the roles, no strong personalities with more than one developed role, and no one that would put himself/herself forward by any means – all these components seemed to be essential to the teams' success and innovation performance. The experiment settings and findings are presented in Table 9.

Table 9: Experiment findings

Sample	Experiment number	Team	Duration	Settings	Task	Findings	General findings
Sample 1: International students of entrepreneurship	Case 1	6	5 weeks	Individuals chose their own teams	Designing a new cafeteria	Teams that achieved higher Kelley's index ranked higher on innovation performance scale.	Teams that encompass more roles (no matter which roles) are more innovative.
	Case 2	7	5 weeks	Teams were formed by instructor	Designing a marketing plan for Slovenian brand	Teams ranked in the upper half of Kelley's index results achieved better cumulative innovation performance rank.	
Sample 2: Engineering students	Case 3	5	11 weeks	Individuals chose their own teams	Business plan of their choice	Kelley's index rank that each team attained matched entirely with their innovation performance rank.	
	Case 4	6	11 weeks	Individuals chose their own teams	Business plan of their choice	Kelley's index rank that each team attained matched with their innovation performance rank.	
	Case 5	5	45 min	Individuals chose their own teams	Designing an instrument for eating out	Teams that scored in the top three positions of Kelley's index scale took the top three positions in the innovation performance scale rank.	
Sample 3: 25 random individuals, aged between 20 and 58	Case 6	5	8 min + 45 min	Teams were formed based on questionnaire results in Case 5*	Construction of a boat; designing a camera bag	Teams with higher Kelley's index ranked higher in innovation performance.	(1) Team roles should be allocated equally among members (each member should not adopt more than three roles); and (2) within the team, one prevailing personality (a person that adopts the most roles) is optimal in terms of innovation performance.

Note. * Individual scores of the roles they fulfilled enabled the formation of the following five teams: (1) Team 1 included participants who had developed several strong personal team roles in the first problem set; (2) Teams 2 and 3 consisted of individuals who had not significantly expressed any of the roles in a team; and (3) Teams 4 and 5 were composed of individuals who had expressed a maximum of two roles, and, as a combination of members, covered all 10 necessary roles.

3.5 Discussion

This research was drawn from an interesting experience-based proposal regarding how team composition may affect innovation performance (Kelley & Littman, 2005). The aim was to bring together disparate research on the effects of team role composition on innovative performance of teams by testing Kelley and Littman's theory on team structure and how it effects innovation. Specifically, this study proposes that a team structure that includes all roles proposed by Kelley and Littman (2005) will attain better innovation-related results than a randomly assigned team. This study can be seen as a starting point of empirical research on the role of team composition in innovation performance.

A multiple-experiment study was conducted to test Kelley and Littman's theory that varied team roles are needed for better team-level innovation performance. This hypothesis was supported with data from three different samples and several cases within each sample. Obviously, the initial motivation for this study was to provide advice for entrepreneurs and managers on how to structure teams with the goal of attaining the best possible team innovation performance. To examine Kelley and Littman's proposed roles, the work of 34 teams was followed and recorded within a six-month time frame. The data collected were analysed with qualitative and quantitative research methods. The results provided support for the core proposition of Kelley and Littman's theory that a balanced team structure leads to better innovation results. Furthermore, the empirical examination additionally complements Kelley and Littman's guidelines with unique insights: It provides recommendations on how to optimally allocate roles among members in a team and suggests a hands-on approach to measuring team innovation performance and composing a team.

The study shows that innovation performance is positively impacted by Kelley's index, which denotes the number of expressed roles in a team. Our study finds some specific characteristics related to this theory and makes its own contribution. Based on our findings, conclusions are drawn as follows:

(1) Teams that encompass more roles proposed by Kelley and Littman are more innovative (no matter which roles).
(2) Team roles should be allocated equally among members for a better collaboration, member satisfaction, and intra-team interactions.
(3) Each member should not adopt more than three roles.
(4) Within the team, one prevailing personality (a person that adopts the most roles) is optimal in terms of innovation performance.
(5) Finally, teams that cover all 10 roles are more innovative.

The study proposes that when structuring a team, managers and entrepreneurs should aim to include all of the 10 suggested team roles. However, it may happen that a specific role is

not permanently present in different teams. A person might possess a predisposition for certain roles, but the nature and behaviour of the roles are dynamically dependent on other roles expressed in a team. Similarly, in assessing a team's performance, questionnaires are meant to evaluate members of a certain team and cannot be used to evaluate individuals that are not part of the team. Therefore it is recommended that when a team is organized, individuals should be tested within this specific team. This team should be requested to solve at least one one-hour problem set and should be evaluated at the end of the exercise by questionnaires and observation. If the roles of the members are covered and equally arranged, then such team will work to its full potential. In contrast, if the roles are not expressed, it could mean one of the following: (1) members of a team do not meet the requirements – the roles are unexpressed and do not match to problem-solving–related assignments; or (2) the team consists of too many dominant and strong members, which ultimately inhibits the development of the roles and overall creativity of the team. The solution could be to form a team with different representation of the members, or try to determine which participants cause such a condition and allocate to them the responsibilities of the roles that are missing in a team. In essence, the process of finding an optimal team is very much a trial-and-error concept and requires persistence in finding a good working balance. However, it is worth investing more time to construct the team because the innovation performance may escalate profoundly.

3.6 Limitations and future research

There are several limitations that should be considered in interpreting the findings from this study. The first limitation is related to the boundary condition – the context specificity of a team's work. This limitation can best be explained by the fact that different participants have different styles of engaging in the working process, which can influence team output. There is a question of whether the 10 types could work together in a productive manner in every single circumstance or whether there would arise a clash of roles that undermines the creativity and performance of the team under certain conditions. Our results indicate that a team works in a productive manner when all 10 roles are adopted and allocated equally among team members. However, future research should focus on additional verification and examination of this particular insight, paying specific attention to interactions among roles and contextual conditions.

The second limitation of the study relates to role allocation among team members and team members' fulfilling of multiple roles. The study did not take into consideration the optimal combination and number of roles that an individual member should fulfil. There is an opportunity for future research to determine the most compatible and complementary role groups that may be possessed by an individual member in order to maximize effectiveness.

Third, this study did not examine the importance of individual roles and how different

roles affect innovation activity. There exists a need to assess the contribution of individual roles to a team's innovation performance and to determine which roles are more crucial to include in a team.

Fourth, the study was conducted in a non-stress environment. Despite the nature of problem sets being realistic, a monetary component was not present. People tend to accept different, less-courageous choices in real life when their decisions might have severe consequences for them or their firm. There is a need to re-conduct the study in a real work settings, in particular with teams that innovate for a living. Finally, the questionnaire used in the study was developed and tested on teams of four to six members. Future work is needed in developing a questionnaire that can fit to any team size.

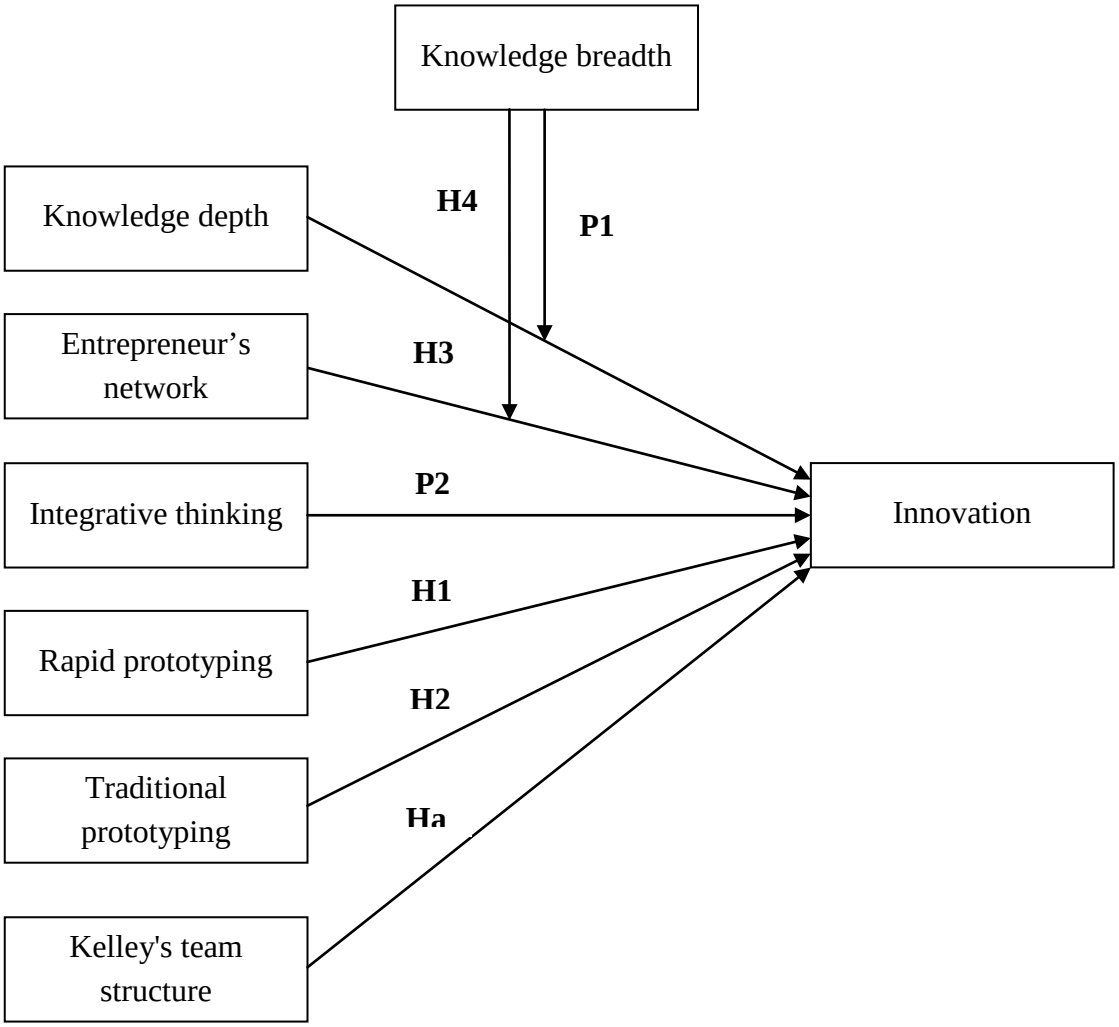
GENERAL DISCUSSION

This chapter presents an overview of this doctoral dissertation. First, we briefly summarize the main findings and discuss implications. We continue with limitations and future research opportunities. Finally, we draw a short conclusion.

Summary of the main findings

The aim of this dissertation is to add to the understanding of the role of entrepreneurs in the innovation process and determine entrepreneurial factors which cause differences in firm-level innovation. This study examines some of the elements of design thinking on which entrepreneurs should focus to achieve greater firm innovation and better performance. A summary of confirmed hypotheses and propositions is located in Figure 6**.**

Figure 6: Summary of confirmed hypotheses and propositions



We accomplish several goals. First, we investigate and confirm the impact of entrepreneur-related factors on firm innovation. Second, we develop and test two conceptual models. We determine that knowledge breadth has an important enhancing role in the relationship between knowledge depth and innovation and in the relationship between social network and innovation. The results of the empirical analysis also suggest that experimentation (both rapid and traditional prototyping) is of key importance for innovation. Moreover, we build a construct for measuring integrative thinking and verify its positive effect on innovation. We also test a design thinking proposition on how to successfully structure a team and provide several implications. Third, we use qualitative research methods to gain in-depth insight into the studied mechanisms, complemented by a quantitative analysis to verify the models on a large sample. In Tables 10, 11, and 12 (pages 99–102) we systematically summarize the findings of each chapter.

In Chapter 1 we explore knowledge and thinking of entrepreneurs and how the two constructs determine SMEs' innovation. First, we focus on entrepreneurs' knowledge breadth and study its effect on the relationship between entrepreneurs' knowledge depth and firm innovation performance. Second, we investigate entrepreneurs' integrative thinking ability in the innovation process and seek to delineate its key determinants. We continue with an analysis of the integrative thinking process and offer an in-depth comprehension of this phenomenon. We use an interpretative phenomenological analysis (IPA) with three participants to obtain a close understanding of how entrepreneurs perceive these constructs and their behaviour in firms. These findings support the arguments about the central role of knowledge in innovation, but further develop an understanding of the interplay of its dimensions at an entrepreneurial level. We uncover three areas that characterize an entrepreneur's knowledge and its effect on innovation: (1) openness to experiences to get new ideas and new insights into the problem, (2) knowledge breadth for creative solutions by integrating different areas with one's own expertise, and (3) learnability and curiosity to constantly broaden one's knowledge base. In sum, the results demonstrate that an entrepreneur's knowledge breadth in terms of general knowledge, experiences, and skills enhances the effects of an entrepreneur's deep knowledge on firm innovation performance. The findings also suggest that an entrepreneur's integrative thinking skills are an important factor in innovation activity. We identify the most prominent determinants that allow for greater innovativeness: fast decision-making, not striving for absolutes, holistic approach, openness to complex problems, the ability to identify all the invisible components of the problem, a different perception of risk-taking, inclusion of others, and a future stance. In Appendix E we further investigate knowledge and thinking quantitatively and test their impact on firm innovation on a large sample of Slovenian entrepreneurs. We develop a measurement scale for integrative thinking. The results and contributions of this chapter are presented in Table 10 (page 99).

Chapter 2 examines the role of experimentation and an entrepreneur's social network in innovation. We start by analysing the literature on experimentation and review the contribution of experience to the innovation process. Next, we explore the construct in detail using an IPA and reveal the following prevailing determinants: (1) a trial-and-error process leads to more innovative solutions and speeds the product development process, (2) experimentation results in innovation enhancement by creating better products, (3) experimentation allows for improved insight into the market needs, and (4) rapid prototyping is the starting point of all successful innovation processes. In addition, we test the model quantitatively on a sample of 485 Slovenian entrepreneurs using a hierarchical regression analysis and determine that experimentation indeed enhances innovation performance. However, rapid prototyping is of particular importance in speeding the innovation process. We continue by exploring the effects of an entrepreneur's social network on innovation. The results suggest that an entrepreneur's social network alone does not ensure the innovation activity in a firm. There exists a strong correlation between knowledge breadth and the social network of an entrepreneur. Knowledge breadth builds trust within a social network, improves communication flow, and plays an important enhancing role in the relationship between an entrepreneur's social network and firm innovation performance. The findings of Chapter 2 are depicted in Table 11 (page 101).

The aim of Chapter 3 is to investigate the optimal structure of a team. We build this line of research on a recent call in entrepreneurial literature suggesting the importance of determining factors that affect team performance. Many scholars, specifically those in the field of design thinking, emphasize the role of collaboration and multidisciplinary teams in fostering innovation. This study adds to previous research in the field of innovative teams by drawing from an interesting experience-based theory advanced by Kelley and Littman (2005), which examines teams from a design thinking perspective. We use experimental-empirical research complemented with a quantitative analysis to test the contributions and effects of structure on a team's innovation performance. First we conducted multiple experiments on three different international samples of individuals aged 20 to 58 with diverse backgrounds using a newly developed instrument to evaluate individual members in a team. The work of 34 teams was followed and recorded over a six-month time frame. We then tested the relationship with a linear regression model. The results suggest that teams that include roles proposed by Kelley and Littman are more innovative. Any team should include the following 10 team roles: anthropologist, experimenter, cross-pollinator, hurdler, collaborator, director, experience architect, set designer, storyteller, and caregiver. These team roles should be allocated equally among members, and each member can adopt more than one role. Furthermore, we conclude that in terms of innovation effectiveness, a team should not possess more than one prevailing personality (a member who has adopted more than three roles). The results of this study are systematically presented in Table 12 (page 102).

Summary of the main contributions and implications

This dissertation makes several important contributions. The theoretical parts comprise a comprehensive literature review in the field of innovation and entrepreneur-related mechanisms in the field of design thinking that determine innovation, while the overall study offers insight into the current situation of innovative development in Slovenia, as well as directions for better implementation of design thinking by defining the crucial factors that entrepreneurs can affect in order to enhance the performance of SMEs. The dissertation provides a basis for further research of design thinking and possibly represents a first step in constructing a theoretical model of this fresh concept of innovation. More detailed contributions are:

- We develop two conceptual models of the characteristics and determinants that provide a supportive environment for implementing design thinking and thus increase innovation performance;
- This study is among the first attempts in scientific literature to deal with the concept of design thinking by determining the innovative elements of an entrepreneur's characteristics (mindset, attributes) and link them with innovation performance;
- Empirical studies contribute to a better understanding of the enhancing role of knowledge breadth in fostering innovation, in particular the effect knowledge breadth has both on knowledge depth and on entrepreneur's social network;
- Empirical studies complement our current understanding of the positive effect of experimentation and integrative thinking on innovation performance;
- We use a measure that allows capturing the real personal level of knowledge according to different fields of expertise, rather than use existing measures that rely on prior work experience (years in business) and education (education level);
- We develop a scale for measuring integrative thinking;
- We improve understanding on how to structure a team in order to be most innovative, and we develop "Kelley's index" to measure the number of expressed roles in a team (instrument for evaluation located in Appendix F).

In Chapter 1 we expand the existing view of an entrepreneur's cognitive assets and innovation to determine a strong connection between entrepreneurs and firm-level innovation (Marcati et al., 2008). We provide clearer evidence of the impact entrepreneurs have on their firms by connecting their activities to firm-level outcomes (Baron, 2013). We improve our understanding of the underlying factors of entrepreneurs' personal cognitive attributes and the impact they have on firm innovation. By utilizing IPA (Smith, 2015) we provide a detailed insight into feelings and perceptions that characterize entrepreneurs' experiences about their knowledge and thinking.

This study is among the first to examine knowledge depth and breadth at an entrepreneurial level. By bridging entrepreneurs' decisions with their SMEs' decisions, we seek to explore entrepreneurs' knowledge dimensions, the mutual interaction of these dimensions, and how they help SMEs to be more innovative. The findings highlight the important role of knowledge in innovation (e.g., Farace & Mazzotta, 2015) and complement the understanding of the interplay between its dimensions at the personal level of the entrepreneur. We reveal an important enhancing role played by knowledge breadth in terms of general knowledge, experiences, and skills in the relationship between entrepreneur expertise and firm innovation.

Similarly, entrepreneurs' thinking skills that contribute to innovation are explored in detail and linked to the theory of integrative thinking proposed by Martin (2007b). We contribute to the scientific literature by developing one of the first conceptual models of integrative thinking. We also develop its measurement scale. The findings suggest that certain attributes of entrepreneurs' thinking processes exist that facilitate entrepreneurs' success and innovation performance: fast decisions, non-perfectionism, holistic approach, inclination towards complexity, comprehensiveness, collaboration, and future stance.

In Chapter 2 we establish that social network and experimentation are related. A social network provides motivation when errors are made and the transfer of experiences in the innovation process. This study is one of the first to investigate experimentation qualitatively and to test its impact on innovation quantitatively on a large sample. We build on Thomke's insight (1998, p. 329), which suggests that "strategies and modes of experimentation can be an important factor in the effectiveness of a firm's innovation processes". We determine the positive impact of experimentation on innovation and additionally contribute by delineating the central role of rapid prototyping in innovation activity. Furthermore, we investigate an entrepreneur's social network and find knowledge breadth to be an important facilitator in its relationship with innovation. As existing measures of knowledge are based mostly on prior work experience (years in business) and education (education level) and in our opinion do not represent personal knowledge correctly, we use a measure that allows the capture of the personal level of knowledge according to different fields of expertise. The results suggest that knowledge breadth essentially contributes to the development of a personal network and improves the process of new contact acquisition through greater trust and smoother communication. Moreover, it enhances the process of identification of necessary knowledge that an entrepreneur searches for within his/her network. The facilitated process of innovative idea generation ultimately leads to positive effects on innovation.

In the next chapter the research is motivated by an interesting experience-based proposal on how to optimally structure a team which would lead to a better innovation performance. We bring together disparate research on the effects of team role composition on innovative

performance in teams by testing Kelley and Littman's (2005) theory on team structure and its effect on innovation. Therefore we develop theoretical logics to explain how a specific team structure leads to a better innovation performance. In addition, we develop an instrument for evaluation of individuals in a team (Appendix F) and introduce Kelley's index, which measures the overall team role score. This study represents a starting point for empirical research in the field of design thinking team-structuring theory. It further provides recommendations on how to optimally allocate roles among members in a team and suggests a hands-on approach to measuring team innovation performance and composing a team.

With this dissertation we make several practical implications for entrepreneurs to facilitate innovation in SMEs. First, entrepreneurs are central to their firms' performance, because their characteristics, perceptions, and inclinations towards certain processes have a strong impact on firm-level outputs. Therefore they should constantly expand their horizons by striving to be open to different experiences and hobbies and through command of several foreign languages. Entrepreneurs should be curious and eager to learn in order to gain new insights for problem solving and to build up their knowledge breadth, which ultimately increases their innovativeness and ability to execute activities. A broad knowledge base facilitates an interdisciplinary approach in finding creative solutions. Furthermore, it helps entrepreneurs accept human-resource–based decisions by identifying effective employees for a certain activity.

Second, an entrepreneur should build the capacity for integrative thinking. In order to achieve a greater level of innovativeness and a better innovation performance, an entrepreneur must have an ability to make quick decisions. It is better not to invest all the time in searching for a perfect solution to a problem, but rather to allow more time for experimentation. A problem must only be solved to the point of determining whether it is worth digging in deeper. An entrepreneur should embrace complexity, possess a capability to identify components of the problem others do not see, and constantly absorb other people's opinions to understand different perspectives of the problem. Finally, it is important to always keep the whole structure of the problem firmly in mind while working on individual parts of the problem and to constantly think about the future.

Third, we find entrepreneurs in favour of experimentation to be an essential part of firm innovation. Entrepreneurs who use prototyping provide a clearer concept transfer to the market and attain a better feedback. Prototypes, especially in the early stages of a product development cycle, may discover hidden market needs as they use people's feedback to enhance the innovativeness of the product. Furthermore, the utilization of rapid prototyping yields a more creative and innovative feedback, which results in an enhanced innovation performance. Therefore entrepreneurs should bring prototyping into their firm's processes and promote a trial-and-error culture among employees.

Fourth, entrepreneurs should be aware of the strong relationship between their social networks and their knowledge breadth. It is knowledge breadth that facilitates a positive impact of a social network on innovation. An entrepreneur with a greater knowledge breadth understands others better, identifies important topics of conversation, and builds trusting relationships effectively.

Fifth, when structuring a team to found a firm or to deal with certain problem-solving activities, entrepreneurs should include all of the following ten roles in a team: anthropologist, experimenter, cross-pollinator, hurdler, collaborator, director, experience architect, set designer, storyteller, and caregiver. If the roles are covered and equally arranged, such a team will work to its full potential. An entrepreneur must make sure that team roles are allocated equally among members, which ultimately results in greater member satisfaction and more effective collaboration. Furthermore, each team member should adopt up to three different roles and only one prevailing personality should be included in a team. The process of finding an optimal team is very much a trial-and-error concept and requires persistence in finding a balance that works well. However, it is worth investing more time to construct team because the innovation performance may escalate profoundly.

In addition, this study provides implications for the educational community and policy-makers. Pink (2006) and Gardner (2006) argue in favour of the development of key competencies in people in order to deal with today's challenges. The most valuable competencies involve knowledge, skills and attitudes (Ananiadou & Claro, 2009; Boyatzis & Boyatzis, 2008; Wagner, 2010; Zupan, 2015): critical thinking and problem solving, decision-making, management of feelings, collaboration across networks, agility, adaptability, perseverance, initiative and entrepreneurialism, effective communication, ability to analyse information, ability to cope with uncertainty, risk-taking, emotional and social intelligence, curiosity, and imagination. Therefore Scheer et al. (2012) argue that inclusion of design thinking in educational programs "facilitates constructivist learning in order to foster 21st century skills". The findings of this dissertation align with this and several other scholars' suggestions (Dunne & Martin, 2006; Rauth et al., 2010; Ulibarri et al., 2014; Zupan et al., 2013), which see design education as a means to develop design creativity in order to enhance the capability of solving complex problems. Students need to develop design thinking skills, gain concrete experience, learn to observe, make abstract conceptualizations, gain practice in experimentation, and learn to work in multidisciplinary teams to be productive in the workplace (Hodgkinson-Williams & Deacon, 2013; Rauth et al., 2010; Rauth & Nabergoj, 2016). In accordance with this call, our findings offer practitioners several indications and ideas for modifying their current educational practices in order to develop previously mentioned competences, enhance entrepreneurial education, and bring up actionable entrepreneurs. Policy-makers could take actions to integrate design thinking into education curricula and effectively promote the importance of a design

thinking mindset in the innovation process. Ultimately, that would improve the potential and creativity of “soon-to-be” entrepreneurs.

First, there is a need to incorporate design thinking in entrepreneurship courses so young entrepreneurs become more capable of complex problem-solving and prepared for the real challenges. Students should deal with real-life problems and learn how to reach the solution in order to become motivated for exploration and gain new ideas. The aim of such a course should be to build a community that recognizes knowledge as a core value. This would help students design more-creative solutions and become more innovative by letting them understand how important it is to constantly deepen and broaden their knowledge base, be open to the world, be curious, and internalize empathy. Students would then understand users more easily and thus learn to make products people actually need.

Students should learn how to integrate knowledge from different disciplines in order to produce innovative ideas. Teachers should provide rich feedback to help grow students’ cognitive attributes. These courses should also give students an opportunity to get to know different industries and to participate in student exchange programs. This would facilitate students’ lifelong learning and their creativity, because they would see problems from completely different cultural perspectives. They would also understand the importance of expanding their social network more easily. Similarly, such a program would be beneficial for organizations. Policy-makers could create and promote employee exchange programs, which would allow employees to see different ways of problem solving in different places and countries. At the same time, they would build their personal networks, which would ultimately result in more-effective business and cross-country collaboration.

Second, such a course should be an integral part of all studies at a university level. For example, students of technical studies would benefit from this course because they would understand how to meet consumer needs, how to create a product that people want, and how to commercialize it. They would also be able to identify new opportunities that emerge from integrating different industries into their own more easily.

Third, there are several attributes that lead to an enhanced innovativeness of a person, such as the ability to see all the salient information, fast decision-making, and holistic thinking. Students should get to know these attributes, understand them, and constantly try to improve them. Teachers should also encourage students to practice reasoning skills in different settings to gain confidence. Moreover, important competencies such as emotional skills and empathy should be developed. This would create a solid foundation for their ability to think integratively. The course should also include real-life exercises and cases to understand and internalize integrative thinking skills.

Next, by building design thinking into curricula and through facilitating interdisciplinary projects, students should spend a great portion of their time working in different teams to understand how different members contribute differently to final outcomes, to learn how to optimally work together despite possible differences, to gain confidence, and to learn to express their opinions and share knowledge. The course should help people from multiple disciplines to work in groups effectively. These students should learn about the important role each team member plays in innovation process. To make a course more practical, we suggest the use of an experiment, similar to the one conducted in our research (Chapter 3). In addition, such a course should teach students the importance of networking and allow them to start building their personal networks, which would prove essential when they enter the market.

Finally, entrepreneurship courses should emphasize the culture of experimentation. Students should realize that they are allowed to fail and understand how to learn from that failure. Constant use of prototyping would eventually boost their confidence and help them comprehend how to build a more-creative and superior product or service by integrating feedback from each product iteration.

Tables 10, 11, and 12 systematically summarize the main findings, theoretical contributions, and practical implications of our dissertation.

Table 10: Summary of the main findings and contributions – Chapter 1

Chapter 1: Exploring the interplay of an entrepreneur's thinking, knowledge, and firm-level innovation	
Research questions	How does an entrepreneur's knowledge affect firm innovation? How do knowledge breadth and knowledge depth influence each other? How does the combination of knowledge breadth and knowledge depth impact firm innovation performance? What are the key determinants of an entrepreneur's thinking that enhance his or her problem-solving skills? How does an integrative-thinking entrepreneur differ from other entrepreneurs? How does an integrative-thinking entrepreneur affect firm innovation performance?
Research type	Interpretative phenomenological analysis – 3 respondents
Main findings	P1: Breadth of an entrepreneur's knowledge, in terms of general knowledge, experiences, and skills, enhances the effect that the entrepreneur's deep knowledge has on firm innovation performance. P2: By using integrative thinking in problem solving, entrepreneurs improve creativity and enhance firm innovation performance.
Emerging themes	Knowledge: (1) openness to experiences, (2) knowledge breadth and depth, and (3) learnability and curiosity. Integrative thinking: (1) fast decision-making, (2) 80/20 rule, (3) holistic approach, (4) embracing complexity, (5) comprehensiveness, (6) risk perception, (7) inclusion of others, and (8) future stance.
Theoretical contributions	Development of two conceptual models merged into one: knowledge depth/breadth, integrative thinking, and innovation. Contribution to a better understanding of the enhancing role of knowledge breadth in fostering innovation performance. Development of a scale for measuring integrative thinking.*
Practical implications	Entrepreneurs should constantly expand their horizons by striving to be open to different experiences and hobbies. Entrepreneurs should be curious and eager to learn in order to gain new insights for problem solving. Entrepreneurs should build a broad knowledge base to find creative solutions and accept human-resource–based decisions. Entrepreneurs should build their capacity for integrative thinking in order to become more innovative. Entrepreneurs must have an ability to make quick decisions, learn not to invest all the time in searching for a perfect solution, embrace complexity, possess a capability to identify components of the problem others do not see, and constantly absorb other people's opinions to understand different perspectives of the problem. Entrepreneurs should always keep the whole structure of the problem firmly in mind while working on its individual parts and focus on the future.

(table continues)

(continued)

	Entrepreneurship courses should incorporate design thinking in their curricula so students would gain 21st century competencies and would be more capable of complex problem-solving. Entrepreneurship courses should teach students to constantly deepen and broaden their knowledge base, be curious and open, and internalize empathy. Entrepreneurship courses should emphasize the importance of integrating knowledge from different disciplines and encourage student exchange programs. Entrepreneurship courses should constantly improve student innovativeness by practicing their reasoning skills and developing their integrative thinking skills.

**Located in Appendix D*

Table 11: Summary of the main findings and contributions – Chapter 2

Chapter 2: The interaction of an entrepreneur's social network, knowledge breadth, experimentation, and innovation	
Research hypotheses	H1: Rapid prototyping positively impacts firm innovation performance. H2: Traditional prototyping positively impacts firm innovation performance. H3: An entrepreneur's personal network positively impacts firm innovation performance. H4: An entrepreneur's personal network and knowledge breadth combined positively affect firm innovation performance.
Research type	Interpretative phenomenological analysis – 3 respondents Hierarchical regression analysis – 485 respondents
Main findings	Rapid prototyping positively impacts innovation by enhancing visual feedback and identifying latent market needs. Experimentation (all modes of prototyping) leads to enhanced innovation. With broad knowledge an entrepreneur can exploit his network better and connect different areas in order for the firm to be more innovative.
Emerging themes	Experimentation: (1) trial and error, (2) innovation enhancement, (3) improved feedback, and (4) rapid prototyping. Social network: (1) knowledge as a foundation for networking, (2) trust through knowledge, (3) communication, and (4) mutual benefit.
Theoretical contributions	Development of two conceptual models merged into one: rapid prototyping, traditional prototyping, social network/knowledge breadth, and innovation. Contribution to a better understanding of the enhancing role of knowledge breadth in the relationship between social network and innovation. Delineating the central role of rapid prototyping in the innovation process. Measuring personal knowledge according to different fields of expertise, rather than relying on prior work experience (years in business) and education (education level).*
Practical implications	Entrepreneurs in favour of experimentation are an essential part of firm innovation. Entrepreneurs who use prototyping provide a clearer concept transfer to the market, attain more-creative feedback, and may discover latent market needs easier. Entrepreneurs should propagate the culture of trial and error in firms. Entrepreneurs should have a broad knowledge base to understand others better, identify important topics of conversation, and build trusting relationship effectively. Entrepreneurs must build their knowledge breadth to enhance the effect of their social networks on innovation. Entrepreneurship courses should emphasize networking and help students learn how to grow their personal networks. Entrepreneurship courses should help students internalize the culture of prototyping and encourage them to learn from failure.

**Located in Appendix C*

Table 12: Summary of the main findings and contributions – Chapter 3

Chapter 3: Effects of team structure on innovation performance: An empirical study	
Research hypotheses	A team structure that includes the roles proposed by Kelley and Littman (2005) will lead to better innovation performance than a team structure that includes a random combination of individuals.
Research type	Multiple experiments – sample of 34 teams Linear regression model
Main findings	Teams that encompass more roles proposed by Kelley and Littman are more innovative (no matter which roles). Innovation performance = 0.68 × Kelley's index The following roles should be in a team: anthropologist, experimenter, cross-pollinator, hurdler, collaborator, director, experience architect, set designer, storyteller, and caregiver.
Theoretical contributions	Bringing together disparate research on the effects of team role composition on innovative performance. Development of theoretical logics to explain how Kelley and Littman's (2005) proposition of a team structure leads to better innovation performance. This study is a starting point of empirical research in the field of design thinking team-structuring theory. Provides recommendations for how to optimally allocate roles among members in a team and suggests a hands-on approach to measuring team innovation performance and to composing a team. Development of Kelley's index to measure the number of expressed roles in a team. Development of an instrument to evaluate individuals in a team.*
Practical implications	When composing a team, entrepreneurs should include more roles proposed by Kelley and Littman in order to be more innovative. Team roles should be allocated equally among members for better collaboration, member satisfaction, and intra-team interactions. Each member should adopt no more than three roles. Having only one prevailing personality (a person who adopts the most roles) on a team is optimal in terms of innovation performance. Teams that cover all 10 roles are more innovative. Entrepreneurship courses should encourage students working in interdisciplinary teams to learn how to effectively work in a team and experience enhanced contribution to innovation.

**Located in Appendix F*

Limitations and future research suggestions

There are several limitations to the research we have conducted. We acknowledge them in this chapter and open avenues for future research opportunities.

Qualitative research methods raise concerns of subjectivity, sampling, validity, reliability, and statistical generalization (Carr, 1994; Neergaard & Ulhři, 2007; Stritar & Drnovšek, 2015). Despite the small number of cases used in the qualitative research analysis, the aim of IPA is to gain rich descriptions of the studied phenomenon, identify its essential components, and explore individuals' perceived insights of different situations, rather than making more general claims (Pietkiewicz & Smith, 2014). In order to determine mechanisms that facilitate innovation, we selected participants on the basis of their own success stories, which may lead to a sample selection bias (Heckman, 1977). Nevertheless, future research should focus on additional exploration of entrepreneurs' cognitive aspects and their impact on innovation. There is also a need to make results statistically significant and test propositions regarding an entrepreneur's knowledge and integrative thinking without the interference of the researcher's presence, which can affect subjects' responses. We include a basic quantitative analysis in the Appendix E to create a foundation for further research opportunities. Moreover, there is a need to study these phenomena qualitatively on a larger scale and to use a uniform schedule.

Second, the qualitative study may introduce the issue of hindsight bias, which affects individuals' ability to recall their experiences and circumstances accurately (Cassar & Craig, 2009; Henriksen & Kaplan, 2003). Therefore our IPA may overlook some of the more complex determinants of knowledge, thinking, social network, and experimentation. There is a need for further research to focus on particular factors which may be subject to hindsight bias.

Third, measures in this dissertation are self-reported, which threatens its validity (Donaldson & Grant-Vallone, 2002) and causes biases towards more-confident participants (Lasagni, 2012). The data may also include socially desirable responses. In addition, the quantitative models used for knowledge, integrative thinking, social network, and experimentation are constructed based on a sample of Slovenian SMEs entrepreneurs. Future research should include cross-national comparisons and extension to other industries as well. There is also a need to address and investigate other possible mediators or moderators in the mentioned models. Finally, due to inhibition of causation, another research opportunity may be to make a longitudinal study to explore the differences in reports.

Fourth, development of a scale for measuring integrative thinking is conducted in a simplified method of a scale development process (DeVellis, 2003). We consider all the

necessary steps, but make some minor adjustments where possible, which speeds the process due to time and financial constraints. The measure is constructed only as a demonstration of integrative thinking skills, but needs further complements.

Fifth, the limitation of Chapter 3 is related to the context specificity of a team's work: would these 10 roles actually work together in a productive manner no matter the circumstances or would there appear a clash that would undermine the creativity and performance of a team under certain conditions? Therefore future research should pay attention to role interactions and contextual conditions. Furthermore, the study does not consider the optimal combination and number of roles each team member should possess. We also do not address the contributions of individual roles to a team's innovation performance. Thus an opportunity exists to determine more complementary roles that a member may hold and which roles are more essential in order to enhance team effectiveness. Finally, the study in the field of innovative teams was conducted in a non-stress environment, with realistic problems but lacking a financial component. It may happen that people would accept less-courageous decisions in real life, which may ultimately result in compromised innovation. We suggest future research to be conducted in the field.

Conclusion

This dissertation provides a better understanding of the design thinking mechanisms that drive innovation in small firms, such as knowledge breadth, knowledge depth, social network, integrative thinking, and experimentation. We offer one of the first attempts to comprehend the importance of individual knowledge dimensions and its effect on social networks. We empirically verify the significant role of experimentation in innovation and determine the important cognitive aspect of entrepreneurs, integrative thinking. Additionally, we expand prior views of innovative team structure. Combining different methodologies allows us to provide advancements that should help entrepreneurs and policy makers in achieving a greater level of innovation and motivate scholars to further research the field of innovative mechanisms.

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APPENDICES

LIST OF APPENDICES

Appendix A: Profiles of interviewees

Profession	Industry	Number of employees	Residence	Gender	Duration of the interview (min)	Leader
CEO	Manufacture of paints	750 – 1000	Slovenia	Male	25	Yes
Professor, investor, and entrepreneur	Education, parenting	1 – 10	Slovenia	Male	29	Yes
CHRO	Manufacture of beverages	500 – 749	Slovenia	Female	37	Yes
Professor and entrepreneur	Education, IT	10 – 19	Slovenia	Male	30	Yes
Director	Textile cleaning	200 – 249	Slovenia	Male	38	Yes
CEO	IT, entertainment	1 – 10	UK	Male	18	Yes
CEO	IT, digital communication	20 – 49	Slovenia	Male	36	Yes
CEO	IT	10 – 19	UK	Male	26	Yes

Appendix B: Interview protocol (IPA)

Hello!

Thank you very much for taking the time to talk with me today. My name is Miha Prebil, a PhD student at the Faculty of Economics, University of Ljubljana. I am conducting research in the field of entrepreneurial characteristics to examine their impact on business activity and innovation. I would like to hear your entrepreneurial story.

The interview will last approximately 1 hour. There are no right or wrong answers, since I am only interested in your personal experiences and insights. Please use as much detail as possible when providing answers and feel free to share any associations that may occur to you during the interview.

Before we begin, I would kindly ask you for permission to record the conversation. I will keep the whole discussion confidential; however, I will use certain parts and overall analysis for research purposes. Your story will not be personally attributed to you and I will not forward this conversation to anyone.

Permission to record: YES NO

Do you have any questions before we begin?

_____

_____

Questions and probes

Knowledge

1. Please tell me how did you begin your entrepreneurial story?
    a. What was the business about?
2. How do you distinguish the following terms: your innovativeness, innovation activity, firm innovation?
    a. Would you say your firm is innovative? Why?
3. What are the most important sources of your firm's competitive advantage, performance, exploiting opportunities, and innovation?
    a. What about your personal characteristics?
    b. How do you find the relationship between your characteristics, your innovativeness, and your firm innovation?
4. Please describe your personal attributes that played a crucial role in building your business?
    a. Where and how do these characteristics reflect?

    b. How do these characteristics impact your firm's innovation?
5. How does your knowledge help you run business?
    a. How did formal and informal education add to your business (innovation)?
    b. What do you use your knowledge for?
    c. Where and how do you acquire new knowledge?
    d. How did your knowledge help you in innovation activity?
    e. Which fields of knowledge helped you the most in business and how?
6. How do you use your expertise and general/vast knowledge and skills in different fields in your business?
    a. Do you find your expertise essential for your success and the success of your firm?
    b. Do you think broad experiences and skills in different fields added anything to the success, and how so? Firm innovation?
    c. How are general knowledge (breadth) and expertise (depth) related in your experience?
        i. Can you do without any of them?
    d. What hobbies do you have, where have you been in the last year, and how many languages do you speak?
        i. How do these things affect your personality and your firm's performance/innovation?

Networks

1. How do you see the relationship between your personal business contacts and your business?
    a. How do you see the role of your personal network on your firm's performance and innovation?
2. How did you use contacts for the purposes of your business?
3. Do you think you are successful in exploiting the potential of your social network?
    a. What are the important predispositions and components you have that facilitate successful exploitation of your social network?
    b. Which components do you lack?
4. How does your knowledge help in benefiting from your social network?
    a. Do you think your diverse knowledge affects the effective use of your social network?
    b. How do your (diverse) experiences impact social network exploitation?

Experimentation

1. Can you describe the process of developing new products/services from idea to product?
    a. How long do you discuss the concept before creating the prototype? Time?

   b. Do you experiment?
   c. Do you use visualizations, cheap, simple, quickly constructed and easily changeable prototypes? (More powerful explanation)
   d. Do you use computer simulation, modeling, laser cutting, 3d printing…?
   e. What do you learn from that?
   f. Do you share the early prototypes with potential customers?
   g. Why do you think your process is best for your firm's performance and innovation?
2. Do you support learning from mistakes?
3. Do you use prototypes in the early process?
   a. Cheap, no-frills, easy to construct prototypes?
   b. Why is that good?
   c. What can you learn by constantly making prototypes?
4. How do you see the role of prototyping in firm success and innovation?

Integrative thinking

1. Can you recall your recent business challenge? How did you tackle it?
2. How does your thinking process differentiate from others? Do you think your way leads to success?
   a. Can you describe your process of thinking when seeking a solution to a problem?
   b. How did you identify the problem components? Did you first consider all the features to the problem or focus on particular?
   c. Are you capable of identifying salient features of the problem others usually miss?
   d. In problem-solving, do you try to take a broader view of what is salient than is expected of you?
   e. Do you believe you can find a better solution to existing problems?
3. How do you deal with two diametrically opposing constraints when searching for solution?
   a. Enjoy? Challenge? Do you search for creative resolution of tensions?
   b. Do you accept unpleasant trade-offs? Do you accept easier solutions?
   c. Do you simplify the problem or always think of multidirectional and nonlinear causality?
4. How do you perceive a problem?
   a. Do you try to keep the whole problem in mind while working on the individual parts of a solution? Or do you focus on each part individually?
   b. Do you usually avoid unnecessary complexity by settling for 80% of the perfect solution?
   c. Do you think it is worth investing 80% more effort in hopes of reaching an answer that would at best be only 20% better?

5. Do you enjoy reasoning about what might be - about models that don’t yet exist?
6. How are you with risk-taking?
7. What do your employees say about your communication skills?
8. How open are you?
9. Do you like to learn? Do you think knowledge you possess is sufficient?
10. How do you see yourself in this world?
    a. What is your motivation?
    b. What tools do you use to organize your thinking and understand the world?
11. How does your knowledge help you in solving problems?
12. How do you think these features are connected to your previous success and firm’s innovation?

Do you have any additional comments about the questions?
Thank you for taking the time for this interview!

Appendix C: Measures

Construct	Scale type	Questions	Source	Anchors	
Innovation	Likert type (7)	The number of new products our firm has introduced to the Market The number of our new products that are first-to-market (or early market entrants) The speed of our new product development Number of changes in processes introduced (new for a firm) Pioneer disposition to introduce new processes Clever responses to new processes introduced by other companies in the same sector	Yang, Wang and Cheng (2009) Jiménez-Jiménez and Sanz-Valle (2011)	1 Much worse than competition	7 Much better than competition
Entrepreneur's network	Numerical	The average number of hours per week the respondent spends maintaining contacts (e.g., face-to-face, email, telephone) with people with whom he or she discusses business matters (e.g., commercialization, marketing, finance) The average number of hours per week the respondent spends developing new contacts with people to discuss business matters The total number of people with whom the respondent discussed business matters during the previous week	Greve (1995) Renzulli, Aldrich, Moody (2000)	0	∞
Experimentation	Likert type (5)	How often do you use the following experimentation techniques in new product development process on average: - Rapid prototyping - Computer simulation - Modeling - Other traditional techniques	Thomke (1995)	1 Never	5 Always

(table continues)

(continued)

Integrative thinking	Likert type (7)	In problem-solving, I always try to take a broader view of what is salient than is expected of me. I can keep the entire problem firmly in mind while working on its individual parts. I keep the whole interlocking structure of causal relationships in mind while working on the individual parts of a solution. I am capable of identifying the salient features of a problem that rivals overlook. I am able to distinguish elements that are important for a certain decision. I enjoy dealing with complicated problems. I always analyse all relationships and directions between alternative ideas. When searching for a solution, I tend to go beyond conventional notions of what is generally considered as salient. I do not flinch from considering multidirectional and nonlinear causal relationships.	Self developed	1 Strongly disagree	7 Strongly agree
Knowledge	Likert type (7)	Evaluate your knowledge, skills and experience in the following fields of knowledge: /List of all fields of education and training from ISCED (e.g., accounting and taxation; law; mathematics)/	Adapted from Sullivan and Marvel (2011) and The international standard classification of education (ISCED) (Organisation for Economic & Development, 1999)	1 Do not have knowledge	7 Excellent knowledge

Appendix D: Developing a measure of integrative thinking

Although the concept of integrative thinking originates from the personal experiences of Roger Martin (2007b), and both the literature and practitioners emphasize its central role in innovation, our current understanding of this construct remains limited. The lack of empirical research at an individual level in SMEs results in uncertainty when integrative thinking is undertaken by an entrepreneur and when trying to explain differences in innovation. To our knowledge, no instrument has yet been developed to capture integrative thinking skills. Therefore we develop a measure using a simplified procedure to enhance our understanding of this construct.

This Appendix describes the process of developing a measurement scale for integrative thinking to provide a foundation for future research. Steps for scale development followed the principles of DeVellis (2003), Hinkin (1998), and Slavec and Drnovsek (2012). First, the research objectives were determined clearly (DeVellis, 2003, p. 60), followed by generation of an item pool (DeVellis, 2003, p. 63). The next step comprised an expert review of an item pool – inclusion of validation items was considered – and development of a questionnaire (DeVellis, 2003, p. 87). We conducted a scale testing on an adequate sample (DeVellis, 2003, p. 88) and scale length optimization (DeVellis, 2003, p. 96). The scale development concluded with a reliability assessment (DeVellis, 2003, p. 90).

Step 1: Content domain specification

In the first step of constructing a new measure we clearly defined what we intend to measure. We established what the new construct encompasses based on the in-depth literature review of Martin and other authors (e.g., Karakas & Kavas, 2008; Martin, 2007b). This activity was crucial to determine the boundaries of the construct and to exclude any potential factors in another construct's domain. (Netemeyer et al., 2003). Moreover, interviews with the relevant entrepreneurial audience (entrepreneurs, professors, and others) suggested the need for existence of the measure. In the end of this phase, following the principles of several authors (Kitzinger, 1995; Krueger & Casey, 2015; Morgan, 1996), we conducted a small focus group with diverse-background participants. This group included four entrepreneurs, one doctoral student, two SME employees, and an assistant professor from Slovenia. We realized that there exists a need to investigate the construct more deeply to understand its specifics, because it seems to exist and to positively affect innovation activity. In addition, the importance of the measure is indicated by the fact that no such measure is in use, despite its suggested importance in the literature and by several practitioners (Slavec & Drnovsek, 2012).

Step 2: Item pool generation

After the construct had been clearly defined, we generated a large pool of items that captured the integrative thinking construct and could possibly be included in the scale. First, an initial list of items was made based on the literature review, which was then complemented by three expert judges' opinions, web search, popular scientific magazines, and the focus groups completed in the first step (Churchill Jr, 1979; Hardesty & Bearden, 2004; Hinkin, 1998). We discussed the construct of integrative thinking with three entrepreneurs in Slovenia (from Chapters 1 and 2), and they provided an additional set of items. The final list therefore comprised a large number of items and was subject to over-inclusiveness (DeVellis, 2003). In order to create a short and clear scale, we improved items during the focus group discussion. Thus we omitted double negatives and the use of slang words, which made the items more readable.

Step 3: Content validity evaluation

To assess the relevance and representation of items of the construct, eight expert judges familiar with the research reviewed the content and construct validity of the items. This group consisted of individuals from different professions working in various fields in Slovenia to obtain as broad a sample as possible (Nunnally et al., 1967). We interviewed one assistant professor and entrepreneur; one professor, investor, and entrepreneur; three successful entrepreneurs; and three top management representatives. Interviewees came from different sectors: manufacturing, food production, information and communication technology, and the textile industry (see Appendix A). Once interviews yielded no further information, we finished this phase (Connelly et al., 2012). This procedure was also executed in the previously mentioned focus group.

The participants evaluated to what degree items from the initial pool were relevant to our construct. They were given the definition of integrative thinking and were asked to evaluate each item as "clearly representative", "somewhat representative", or "not representative" (Zaichkowsky, 1985). In addition, some suggestions for improvements, modification, and exclusion of items were made. After each interview, the item pool was modified (Clark & Watson, 1995). We have taken into account all the comments, although the final decision as to which items to accept for scale was ours as the lead researcher (DeVellis, 2003).

Of 76 initial items, 33 were deleted based on judges' insights that they did not represent the construct directly, were repetitive, or were unclear. This phase yielded 43 items that we used in our pilot study.

Step 4: Questionnaire development and pilot study

We followed Dillman's (2007) tailored design method for questionnaire development and distribution. First we tested our questionnaire by administering it to three expert entrepreneurs. This gave us solid feedback on the quality of our research. The questionnaire was first prepared in English, then translated to Slovenian, and then back-translated (Brislin, 1970; Craig & Douglas, 2000; Hambleton, 1993). A preliminary study was conducted on a small sample of 25 entrepreneurs within our target population. Respondents were asked to indicate the level of agreement with the statements describing integrative thinking on a 7-point Likert scale. The study yielded some potential problems with the questionnaire, which resulted in a minor questionnaire adaptation. Specifically, reasons for failure to complete the questionnaire and lack of comprehension of certain items were taken into consideration. Additional items were excluded, and some were merged with others. Eventually, 23 items were extracted to measure integrative thinking.

Step 5: Sampling and data collection

We followed the suggestion by Hinkin (1998) to administrate the questionnaire to the targeted population. In particular, our sample consisted of entrepreneurs and SME business owners that were randomly selected from the Business Directory of the Republic of Slovenia (PIRS). We received 485 completed questionnaires, following Dillman's tailored design method to enhance response rates, yielding a 19.9% completion rate. The number of responses surpasses the recommended suggestions regarding sample size. Devellis (2003) propounds 300 responses for a scale of about 20 items, whereas Hinkin (1998) emphasizes the necessity of at least 200 responses for factor analysis.

Step 6: Factor analysis and reliability assessment

We first examined the inter-item correlations of the variables and omitted all items that correlated less than 0.40 with other variables. Coefficients closer to 1 indicate greater internal consistency of the scale items. We ran an exploratory factor analysis and removed items that loaded on multiple factors or had a loading less than 0.40 (Ford et al., 1986). We repeated the process until the remaining items loaded on one factor, which indicates a unidimensional measure (Clark & Watson, 1995). With this model we explained 44.36% of the variance, which is an acceptable target for new scale development (Hinkin, 1998). The contents of the items all described the same process, distinctive of integrative thinking. The KMO measure of sampling adequacy was 0.85, which is above the suggested level of 0.6 (Hair, 2010). Bartlett's test of sphericity was significant (chi-square = 1757.695, $p = 0.000$), which shows a significance of all correlations within a correlation matrix (Hair, 2010). The exploratory factor analysis resulted in nine extracted items with loadings greater than 0.527. To conduct an internal consistency analysis, we calculated Cronbach's

alpha coefficient. It amounted to 0.876, which suggests a reliable measure (Hair, 2010). According to DeVellis (2003), a scale is internally consistent if items are highly intercorrelated, indicating measurement of the same construct.

Table D.1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequany	0.850
Approx. Chi-Square	1757.695
df	36.000
Sig.	0.000

Table D.2: Total variance explained

Total Variance Explained						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	4.533	50.36666	50.36666	3.99191	44.35456	44.35456
2	1.022762	11.36402	61.73069			
3	0.82191	9.132335	70.86302			
4	0.743827	8.264744	79.12777			
5	0.585278	6.503088	85.63086			
6	0.433358	4.815092	90.44595			
7	0.357558	3.972869	94.41882			
8	0.307432	3.415906	97.83472			
9	0.194875	2.165277	100			

Table D.3: Factor matrix

Factor 1	The process of I.T.
1. In problem-solving, I always try to take a broader view of what is salient than is expected of me.	0.786
2. I can keep the entire problem firmly in mind while working on its individual parts.	0.717
3. I keep the whole interlocking structure of causal relationships in mind while working on the individual parts of a solution.	0.695
4. I am capable of identifying the salient features of a problem that rivals overlook.	0.668
5. I am able to distinguish elements that are important for a certain decision.	0.659
6. I enjoy dealing with complicated problems.	0.641
7. I always analyse all relationships and directions between alternative ideas.	0.643
8. When searching for a solution, I tend to go beyond conventional notions of what is generally considered as salient.	0.627
9. I do not flinch from considering multidirectional and nonlinear causal relationships.	0.527

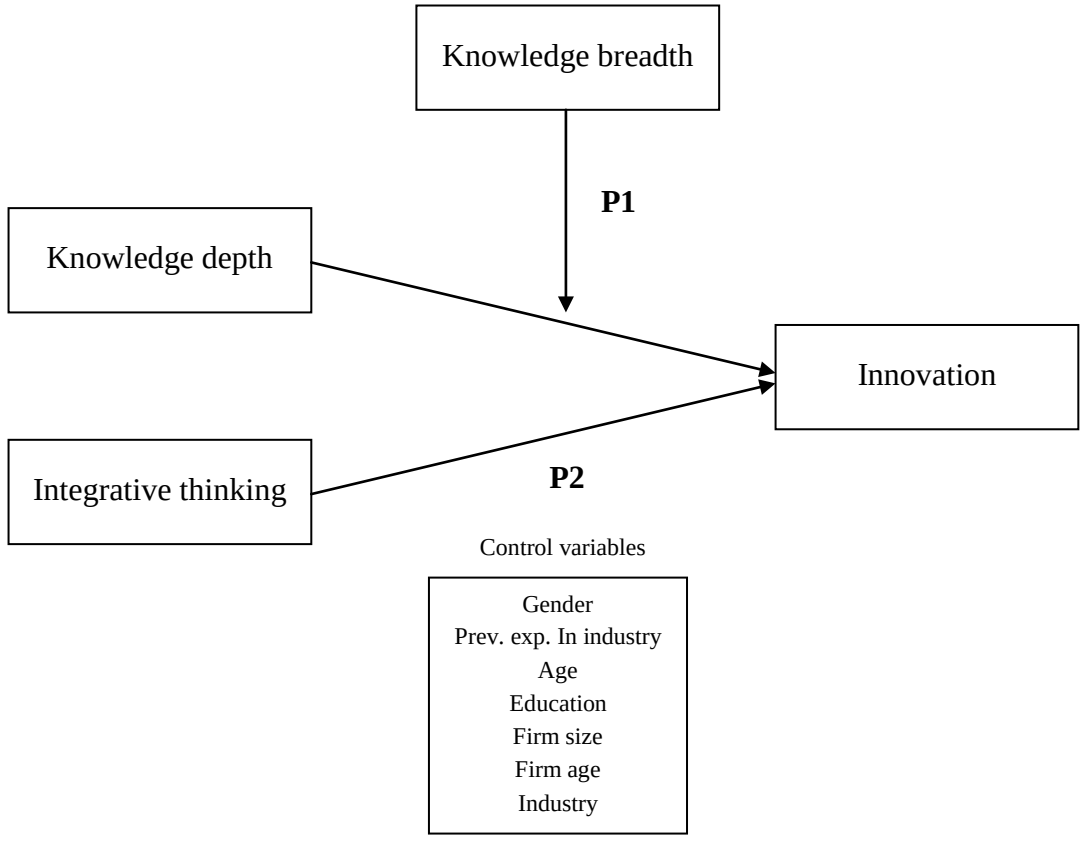
Table D.4: Inter-item correlation matrix

	1	2	3	4	5	6	7	8	9
1	1.000								
2	0.535	1.000							
3	0.511	0.802	1.000						
4	0.542	0.415	0.371	1.000					
5	0.666	0.432	0.426	0.441	1.000				
6	0.478	0.424	0.433	0.401	0.430	1.000			
7	0.501	0.425	0.412	0.423	0.440	0.385	1.000		
8	0.473	0.392	0.391	0.504	0.387	0.521	0.339	1.000	
9	0.357	0.307	0.277	0.479	0.224	0.358	0.539	0.353	1.000

Appendix E: The relationship between knowledge depth, knowledge breadth, and integrative thinking: A hierarchical regression analysis

In addition to the qualitative research analysis on the interplay between an entrepreneur's knowledge breadth, knowledge depth, integrative thinking, and innovation conducted in Chapter 1, we also examined the relationship quantitatively on a large sample. Sampling, dependent variable (innovation), independent variables (knowledge breadth, knowledge depth) and control variables are explained in Chapter 2. Additionally, in Appendix D we explained the development of the measure of integrative thinking. So here we provide only a description of data analysis and results.

Figure E.1: The conceptual model of knowledge depth, knowledge breadth, integrative thinking, and innovation



Data analysis and results

First we used Cronbach's alpha to verify whether a model meets the criteria for validity and reliability. The constructs surpass the acceptable limit of 0.60 (Hair, 2010). Cronbach's alpha for integrative thinking is 0.869; for knowledge breadth, 0.791; for knowledge depth, 0.635; and for innovation, 0.911. There are no multicollinearity problems found in the

model, because all correlation coefficients were under 0.80 level. Furthermore, variance inflation factors (VIF) of the regression model range from 1.049 to 1.110 (Hair, 2010). We used a hierarchical regression analysis using SPSS 16.0 and following procedures by Cohen et al. (2003) to identify possible changes in the model encompassing different variables. Entrepreneur gender, previous experience in industry, age, and level of education and firm size, age, and industry were entered in the first step. Knowledge depth was added in the second step, knowledge breadth in the third, a product of knowledge breadth and depth in the fourth, and integrative thinking in the fifth step. Table E.1 presents descriptive statistics.

The base model first analysed the impact of the control variables. Results show that only level of education has a significant positive effect on innovation. Neither entrepreneur gender, age, nor previous experience nor firm size, age, nor industry have a significant effect on innovation in the base and subsequent models.

Model II incorporated knowledge depth. The relationship is positive and significant ($\beta = 0.13$, $p < 0.01$). The coefficient of determination is 0.032, meaning that only a portion of the total variance in innovation is explained by this model.

Model III additionally included knowledge breadth. R^2 rises to 0.041 and the effect of knowledge depth is still significant ($\beta = 0.106$, $p < 0.05$). Knowledge breadth yields a beta coefficient of 0.116 ($p < 0.05$). In this model both variables are significant.

In Model IV we added the interaction variable (a product of knowledge breadth and knowledge depth) to see how knowledge breadth in relation to knowledge depth affects innovation. Both knowledge depth ($\beta = 0.126$, $p < 0.05$) and knowledge breadth ($\beta = 0.110$, $p < 0.05$) are still significant. In addition, their interaction also has a significant effect on innovation ($\beta = 0.101$, $p < 0.05$). R^2 is 0.048, which indicates a low explanation of the total variance. However, knowledge is such a complex construct that it is very difficult to capture it correctly.

Model V additionally included integrative thinking. The overall coefficient of determination (0.140) indicates that 14% of the total variance in innovation is explained by this regression model. In this model, knowledge depth and knowledge breadth are insignificant, but their product is significant ($\beta = 0.090$, $p < 0.05$). Integrative thinking yields a beta coefficient of 0.32 ($p < 0.001$), meaning that it largely affects innovation. Results are depicted in Table E.2.

This quantitative analysis provides an insight into entrepreneurs' knowledge and integrative thinking skills. We see that both knowledge breadth and knowledge depth have a significant impact on innovation when the model includes only those two factors or their

product. We expected that the interaction between knowledge breadth and depth would yield a significant impact on innovation, which was confirmed in all models. Despite the fact that the coefficient of determination is rather low, we confirm Proposition P1 that the breadth of an entrepreneur's knowledge, in terms of general knowledge, experiences, and skills, enhances the effect of the entrepreneur's deep knowledge on firm innovation. Integrative thinking is perceived as an important factor affecting innovation, which gives support to Proposition P2. Entrepreneurs improve the innovation activity of their firms if a higher level of integrative thinking is used in problem-solving process.

Table E.1: Descriptive statistics and inter-correlation matrix

	Mean	S.D.	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)
1) Innovation	4.53	1.02	1.00											
2) Knowledge depth (KD)	5.92	0.98	0.21**	1.00										
3) Knowledge breadth (KB)	0.13	0.09	0.17**	0.25**	1,00									
4) KD × KB	0.25	1.03	0.04	-0.16**	-0.01	1.00								
5) Integrative thinking	5.37	0.84	0.32**	0.23**	0.21**	-0.02	1.00							
6) Prev. exp. In industry	18.09	10.06	-0.03	-0.09	-0.06	0.08	-0.06	1.00						
7) Gender	1.68	0.47	0.03	0.09	0.10*	0.00	0.09	0.22**	1.00					
8) Age	44.47	10.69	-0.05	-0.19**	-0.05	0.09	-0.01	0.70**	0.15**	1.00				
9) Education level	4.24	1.2	0.15**	0.18**	0.31**	-0.09	0.13**	-0.21**	0.01	-0.08	1.00			
10) Firm size	7.29	30.65	0.07	0.01	-0.02	-0.02	-0.01	0.03	0.06	0.06	0.09	1.00		
11) Firm age	13.43	11.72	-0.08	-0.14**	-0.09*	0.01	-0.09	0.32**	0.08	0.33**	-0.09	0.24**	1.00	
12) Industry	2.57	1.22	-0.07	-0.15**	-0.17**	0.00	-0.04	0.27**	0.15**	0.20**	-0.14**	-0.04	0.23**	1.00

*** Correlation is significant at the 0.01 level (2-tailed).*

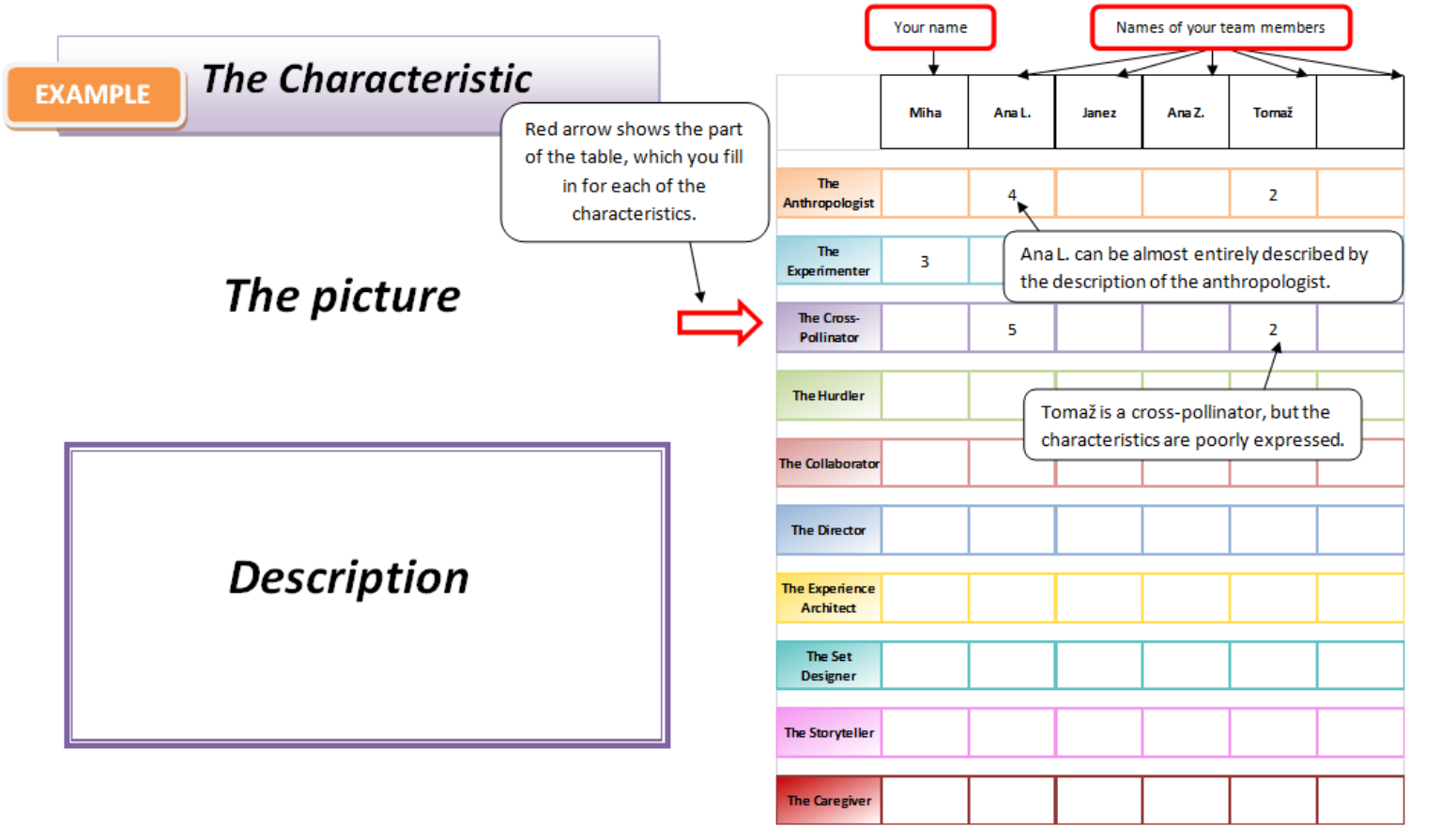
** Correlation is significant at the 0.05 level (2-tailed).*

Table E.2: Results of hierarchical regression

Variable / model Innovation	Model I	Model II	Model III	Model IV	Model V
Control variables					
Gender	0.06	0.04	0.04	0.04	0.02
Prev. exp in industry	0.05	0.03	0.03	0.02	0.05
Age	-0.06	-0.03	-0.03	-0.03	-0.07
Level of education	0.10 *	0.09 *	0.06	0.07	0.04
Firm size	0.08	0.08	0.08	0.08	0.08
Firm age	-0.07	-0.06	-0.06	-0.06	-0.03
Industry	-0.07	-0.05	-0.04	-0.04	-0.05
Independent variables					
Knowledge depth (KD)		0.13 **	0.11 *	0.13 *	0.06
Knowledge breadth (KB)			0.12 *	0.11 *	0.07
KD × KB				0.10 *	0.09 *
Integrative thinking					0.32 ***
Model					
Ajd. R^2	0.02	0.03	0.04	0.05	0.14
R^2	0.04	0.05	0.06	0.07	0.16
R^2 change		0.02	0.01	0.01	0.09

** p < 0.05, ** p < 0.01, *** p < 0.001*

Appendix F: Developed instrument for evaluating individuals in a team



Please evaluate each of the characteristics on a sample of your team members (including yourself) in the part of a table, which is indicated by a red arrow. Select those team members (max 2), who in your opinion, possess the mentioned characteristics. Rate the selected members on a scale from 1 (the characteristics are poorly expressed) to 5 (the personality can be completely related to the mentioned characteristics). If no such characteristics exist in your team, leave blank. A team member can possess different characteristics.

1

Appendix G: Summary in Slovenian language / Daljši povzetek v slovenskem jeziku

Ozadje doktorske disertacije

Inovacije so temeljno gonilo uspeha in preživetja podjetja (Alegre & Chiva, 2008; Davis, 2010; Wheelwright & Clark, 1992). Zato morajo podjetja uspešno uresničevati kreativne ideje, da bi izboljšala svojo inovacijsko aktivnost (Myers & Marquis, 1969). Pravila današnjega trga in njegova zasičenost zahtevajo proizvode in storitve z visoko stopnjo novosti in odlično uporabniško izkušnjo. Da bi dosegla konkurenčno prednost, morajo tako podjetja razvijati proizvode in storitve, ki popolnoma izpolnjujejo potrebe trga in zadostijo skritim potrebam kupcev (Lynn et al., 1996; McDermott & O'Connor, 2002). Zaradi tega je treba razmišljati drugače, bolj intuitivno in kreativno.

Podjetja se zatorej z namenom kreiranja inovativnih proizvodov in storitev poslužujejo različnih metodologij. Obstajajo tri uporabniško usmerjene inovacijske strategije, ki so v zadnjem času pridobile večjo pozornost in so pokazale precejšnjo učinkovitost pri razvoju novih izdelkov in spodbujanju inovativnosti: vitka metoda (angl. *lean*), gibka metoda (angl. *agile*) in dizajnersko razmišljanje (angl. *design thinking*). Čeprav različne po imenih, imajo omenjene strategije v razvojnem ciklu izdelka podobne značilnosti, lastnosti in cilje (Lindberg et al., 2011; Müller & Thoring, 2012). Najizrazitejša razlika je v koraku inovacijskega procesa, ki ga posamezna strategija poudarja. Inovacijski proces se začne z vpogledom v potrebe trga ter se nadaljuje z razumevanjem problema, iskanjem rešitev in oblikovanjem poslovnega modela (Furr & Dyer, 2014). Dizajnersko razmišljanje v tem procesu identificira problem, ki komu kaj pomeni, ter odkrije uporabnike in njihove potrebe. Vitka metoda je poslovni proces, ki odkrije, ali je problem vreden reševanja in ali ga je možno rešiti, medtem ko je gibka metoda tehnološki proces, ki omogoči vpogled v to, ali uporabniku rešitev koristi.

Skupni imenovalec vseh inovacijskih strategij je izražena miselnost posameznika, ki strategijo uporablja. Obstajajo značilnosti, ki spodbujajo inovativnost in hkrati izboljšajo proces vseh omenjenih metodologij. Ker disertacija sloni na predpostavki, da je razumevanje uporabnika ključno za inovacijski proces, je naš poudarek predvsem na miselnosti podjetnika, ki izhaja iz teorije dizajnerskega razmišljanja in je hkrati značilna tudi za drugi dve strategiji: usmerjenost v človeka, pozornost, empatija, nagnjenost k eksperimentiranju, poudarjanje sodelovanja, integrativno razmišljanje in optimizem (Fraser, 2007; Zupan, 2015).

Dizajnersko razmišljanje je uporabniško usmerjena inovacijska strategija, ki jo je v poznih devetdesetih letih razvilo inovacijsko svetovalno podjetje IDEO. Čeprav se prve omembe dizajnerskega razmišljanja pojavljajo že v delih Petra G. Rowea (1987), je metodologija, kot jo poznamo danes, širšo prepoznavnost dobila z ustanoviteljem podjetja IDEO

Davidom Kelleyem (Kelley & Littman, 2005) in njegovim izvršnim direktorjem Timom Brownom (Brown & Katz, 2009). Dizajnersko razmišljanje služi kot inovativno orodje za identifikacijo potreb potrošnikov s stimulacijo različnega dojemanja kompleksnih situacij in z integracijo dizajnerskih pogledov pri reševanju problemov. Brown (2008) dizajnersko razmišljanje definira kot metodologijo, ki širok nabor inovacijskih aktivnosti povezuje s k človeku usmerjenim dizajnerskim pristopom. Je "disciplina, ki uporablja dizajnersko čutnost in metode, da bi povezala potrebe ljudi s tistim, kar je tehnološko izvedljivo in kar lahko uspešna poslovna strategija pretvori v vrednost za kupca in priložnost na trgu". Cilj je izboljšati uporabniško izkušnjo z razvojem globokega poznavanja potrošnikov in identifikacijo latentnih potreb trga (Nussbaum, 2004). Martin (2009) in Leavy (2010) trdita, da stalno iskanje ravnotežja med intuicijo in analitiko, med raziskovanjem in izkoriščanjem, med veljavnostjo in zanesljivostjo, podprto z abduktivnim sklepanjem, preskrbijo podjetja z dolgotrajno poslovno prednostjo. Pomembnost dizajnerskega razmišljanja v poslovnem svetu potrjujejo tudi mnogi drugi avtorji (Lester et al., 1998; Liedtka, 2004; Liedtka, 2015; Senge, 1990; Simon, 1981).

Dizajnersko razmišljanje je odprt, ponavljajoč, kaotičen in nelinearen proces, ki vodi do uspešnih inovativnih rezultatov in se precej razlikuje od tradicionalne poslovne prakse. Brown (2008) ga orisuje kot sistem prekrivajočih se prostorov (inspiracija, pridobivanje idej, izvedba) in ne kot sistem zaporednih korakov. Uspešna implementacija dizajnerskega razmišljanja v inovativni proces potrebuje posebno okolje, naklonjeno opazovanju, hitremu učenju, hitremu prototipiranju, vizualizaciji idej, globokemu in celostnemu razumevanju potrošnika, odprtemu sodelovanju, multidisciplinarnim delovnim skupinam in divjim idejam (Brown, 2005; T. Lockwood, 2009). V literaturi najdemo mnogo atributov in značilnosti podjetnika, ki naj bi bile bistvene za dobro izvedbo inovativnega procesa: T-struktura podjetnika, drugačen vpogled, empatija, odprtost, naklonjenost tveganju, razmišljanje izven okvirjev, intuicija, vizualizacija, učinkovito sodelovanje, optimizem in okolje, naklonjeno hitremu prototipiranju, abduktivni logiki, vztrajnosti, domišljiji, radovednosti, integrativnemu razmišljanju, pozornosti, zaupanju in fleksibilnosti (Brown & Katz, 2009; Carlgren, 2013; Martin, 2009; Rauth et al., 2010). V nasprotju z bolj raziskano teorijo dizajnerskega razmišljanja na ravni podjetja se v tej disertaciji osredotočamo na raven podjetnika in na to, kako njegove značilnosti (znanje, integrativno razmišljanje, mreža, nagnjenje k eksperimentiranju, delovanje znotraj tima) prek uspešne vzpostavitve dizajnerskega procesa vplivajo na inovativnost podjetja.

Ker uporaba dizajnerskega razmišljanja kaže velik potencial pri spodbujanju inovativnosti (Holloway, 2009; Leavy, 2010) in ker je tovrstna načela mogoče enostavno uporabiti v podjetništvu (Dunne & Martin, 2006; Stolterman, 2008), menimo, naj si podjetniki prisvojijo dizajnerske značilnosti z namenom izboljšati inovativnost svojih podjetij (Mootee, 2013). Liedka (2015), na primer, prepoznava dizajnersko razmišljanje kot učinkovito metodologijo, s katero se podjetja lahko uspešno soočajo z izzivi inovacij in

rasti. Zato v disertaciji podjetnika in njegovo sposobnost inoviranja raziskujemo glede na značilnosti dizajnerskega razmišljanja. V miselnosti dizajnerjev in podjetnikov obstaja več podobnosti, kar omogoča enostaven prenos značilnosti dizajnerskega razmišljanja na podjetnika (Zupan, 2015).

V zadnjih letih je količina raziskav na področju dizajnerskega razmišljanja precej narasla (e.g., Brown & Wyatt, 2015; Liedtka, 2015; Martin, 2009; Plattner et al., 2011), kar nakazuje popularnost tematike in rastočo uporabnost metodologije v poslovnem svetu. V tej raziskavi se osredotočamo na podjetnike malih in srednje velikih podjetij (MSP), saj so te vrste podjetij ključne za svetovno ekonomsko rast in tehnološki napredek (Lin, 1998). Zaradi mnogih omejitev, na primer pri znanju, finančnih virih in tehnoloških zmožnostih (Parker et al., 2009), je raziskovanje dejavnikov inovativnosti MSP zelo koristno. Navkljub številnim raziskavam mehanizmov, ki v podjetjih vodijo do inovacij (e.g., Keizer et al., 2002; Lee et al., 2010; Terziovski, 2010), so se podjetniki izkazali za ključne pri sprejemanju odločitev v MSP in za bistveno gonilo inovacij (Marcati et al., 2008). Zato je pomembno raziskovati naprej, da bomo bolje razumeli vlogo podjetnika v inovacijskem procesu in odkrili individualne dejavnike, ki povzročajo razlike v inovacijah na ravni podjetja (Baron & Tang, 2011).

V disertaciji se posebej osredotočimo na globino in širino podjetnikovega znanja ter na obnašanje obeh dimenzij v razmerju do inovativnosti. Poleg tega raziskujemo koncept integrativnega razmišljanja, opredelimo njegove komponente, razvijemo mersko lestvico in preverimo njegov doprinos k inovativnosti. Nadalje preiskujemo, kako širina podjetnikovega znanja vpliva na njegovo socialno mrežo in posledično na inovativnost. Ker dizajnersko razmišljanje postavlja eksperimentiranje v središče procesa, ki vodi do inovacij, skušamo globlje razumeti, kakšna je njegova vloga in kako različni načini eksperimentiranja vplivajo na inovacijsko aktivnost. Na koncu iščemo teoretične in praktične dokaze za nedavno teorijo o optimalni strukturi tima, ki jo predlagata Kelley in Littman (2005), ter razložimo, katere vloge v timu so ključnega pomena za izboljšanje inovativnosti.

Cilji disertacije in raziskovalna vprašanja

Z disertacijo želimo raziskati značilnosti na ravni podjetnika in podjetja v povezavi z dizajnerskim razmišljanjem in ugotoviti, kako vplivajo na inovativnost podjetja. Cilj je identifikacija in preverba tistih elementov dizajnerskega razmišljanja, na katere bi morali podjetniki pri doseganju boljše inovativnosti in konkurenčne prednosti njihovega podjetja še posebej paziti. Podrobnejši cilji so:

- Analiza vpliva podjetnikovih značilnosti (znanje, integrativno razmišljanje, mreža) in ostalih konstruktov dizajnerskega razmišljanja (eksperimentiranje in struktura tima) na inovativnost podjetja.
- Razvoj konceptualnih modelov s področja dizajnerskega razmišljanja in inovacij:
    - preveritev, ali je lahko koncept T-oblike (horizontala predstavlja širino znanja, vertikala globino znanja) prenesen z ravni podjetja na raven podjetnika in pri tem še vedno obdrži pozitiven vpliv na inovacijsko aktivnost;
    - preveritev obstoja spodbujevalne vloge, ki jo ima širina znanja v razmerju med socialnimi mrežami oziroma globino znanja in inovacijami;
    - empirična preveritev pomembnosti eksperimentiranja za inovacije na večjem vzorcu ter določitev najkoristnejših oblik;
    - izgradnja konstrukta za merjenje integrativnega razmišljanja in empirična preveritev predlaganega pozitivnega vpliva integrativnega razmišljanja na inovacijsko aktivnost;
    - preveritev Kelleyeve teorije o inovativni strukturi tima in pregled njegovih prispevkov k inovacijam.
- Kvalitativna argumentacija in podpora modelov ter kvantitativna raziskava, izvedena v Sloveniji na večjem vzorcu podjetnikov MSP.

Vodilo raziskovanja predstavljajo naslednja raziskovalna vprašanja:

1. Kako znanje podjetnika vpliva na inovativnost na ravni podjetja? Kako širina njegovega znanja vpliva na globino znanja? Ali obstaja povezava med širino in globino podjetnikovega znanja ter inovativnostjo podjetja?
2. Kako je razmišljanje podjetnika vključeno v raziskovanje problemov? Ali obstajajo, in če obstajajo, katere so ključne determinante podjetnikovega razmišljanja, ki izboljšajo reševanje problemov? Kako se integrativno razmišljanje razlikuje od konvencionalnega razmišljanja? Kakšno je razmerje med uporabo integrativnega razmišljanja in inovativnostjo na ravni podjetja?
3. Kako eksperimentiranje pomaga podjetniku? Kateri načini eksperimentiranja imajo vpliv na inovativnost podjetja? Kakšen je doprinos hitrega prototipiranja v procesu razvoja novega produkta/storitve?
4. Kateri dejavniki določajo učinkovito izrabo podjetnikove mreže v inovacijski aktivnosti? Kako širina podjetnikovega znanja prispeva k razmerju med njegovo mrežo in inovativnostjo podjetja?
5. Katere značilnosti tima so ključne za boljšo inovativnost? Katere vloge mora imeti tim, da bi bil bolj inovativen? Kakšna je optimalna oblika tima?

Pregled najpomembnejših ugotovitev

V prvem poglavju raziskujemo znanje in način razmišljanja podjetnikov ter ugotavljamo, kako določata inovativnost podjetja. Najprej se osredotočamo na širino znanja pri podjetniku in pregledamo, kako se ta prepleta z globino njegovega znanja in inovativnostjo podjetja. Nadalje analiziramo zmožnost podjetnikovega integrativnega razmišljanja v inovacijskem procesu in skušamo določiti ključne determinante tega procesa. Nadaljujemo z razčlembo procesa integrativnega razmišljanja in ponudimo poglobljeno razumevanje tega fenomena. Za potrebe raziskave uporabimo interpretativno fenomenološko analizo (IPA) s tremi udeleženci, da bi dobili najboljši vpogled v to, kako podjetniki dojemajo raziskovane konstrukte in kakšno je njihovo obnašanje v podjetju. Rezultati potrjujejo argument o osrednji vlogi podjetnikovega znanja pri inovativnosti podjetja, zato nadalje razvijemo poznavanje medsebojnega delovanja dimenzij znanja na ravni podjetnika. S pomočjo raziskave odkrijemo tri področja, ki označujejo znanje podjetnika in njegov vpliv na inovativnost: (1) odprtost do novih izkušenj z namenom pridobivanja novih idej in novih vpogledov v problem, (2) širina znanja kot pospeševalec kreativnih rešitev z integracijo različnih področij s specializiranim znanjem ter (3) učljivost in radovednost, ki vodita v neprestano širjenje baze znanja. V splošnem rezultati pokažejo, da širina podjetnikovega znanja (v smislu splošnega znanja, izkušenj in veščin) okrepi pozitivni učinek, ki ga ima globina njegovega znanja na inovativnost podjetja.

V poglavju ugotovimo tudi, da ima podjetnikov način razmišljanja velik vpliv na inovativnost tako na ravni posameznika kot tudi podjetja. Integrativno razmišljanje podjetnika prepoznamo kot ključni dejavnik pri inovacijski aktivnosti. Najpomembnejše determinante, ki omogočajo višjo inovativnost, so: (1) hitro sprejemanje odločitev, (2) zadovoljitev z zadostno rešitvijo (pravilo 80/20), (3) celosten pristop k reševanju problemov, (4) sprejemanje kompleksnih problemov, (5) zmožnost prepoznavanja nevidnih značilnosti problema, (6) različno dojemanje tveganja, (7) vključevanje ostalih in (8) stalna naravnanost na prihodnost. Glavne ugotovitve so prikazani v tabeli G.1. V prilogi D znanje in način razmišljanja podjetnikov pregledamo še kvantitativno in ju testiramo na večjem vzorcu slovenskih podjetnikov. V ta namen razvijemo tudi lestvico za merjenje integrativnega razmišljanja (priloga C).

Drugo poglavje raziskuje vlogo eksperimentiranja in podjetnikove mreže pri inovativnosti podjetja. Začnemo z analizo literature o eksperimentiranju in pregledamo njegov doprinos k inovacijskemu procesu. Ugotovimo, da raziskava, ki bi vpliv eksperimentiranja na inovativnost preverila kvantitativno na večji bazi podjetij, še ne obstaja. Da bi pridobili poglobljen vpogled v konstrukt, ga najprej analiziramo z metodo IPA in odkrijemo naslednje prevladujoče determinante: (1) metoda poskusov in napak vodi do inovativnejših rešitev in pospeši proces razvoja produkta, (2) eksperimentiranje izboljšuje inovativnost z izgradnjo boljših proizvodov in storitev, (3) eksperimentiranje omogoča izboljšan vpogled

v potrebe trga, (4) hitro prototipiranje je ključno za izvedbo uspešnega inovacijskega procesa. Dodatno model testiramo še kvantitativno na vzorcu 485 podjetnikov z uporabo hierarhične regresije in potrdimo pomembno vlogo eksperimentiranja pri inovativnosti podjetja. Izkaže se, da ima še posebej močan doprinos k inovativnosti hitro prototipiranje. Osredotočimo se tudi na razmerje med podjetnikovo socialno mrežo in inovativnostjo. Rezultati in literatura kažejo, da sama podjetnikova mreža še ne zagotavlja inovacijske aktivnosti v podjetju, odkrijemo pa močno povezanost širine podjetnikovega znanja z njegovo socialno mrežo. Širina znanja spodbuja gradnjo zaupanja znotraj mreže, izboljša komunikacijo in igra pomembno spodbujevalno vlogo v razmerju med podjetnikovo mrežo in inovativnostjo na ravni podjetja. Ugotovitve so sistematično prikazane v tabeli G.2.

Namen tretjega poglavja je raziskati, kakšna bi bila optimalna struktura tima, ki bi vodila do višje stopnje inovativnosti. Raziskovanje gradimo na pozivu podjetniške literature, ki poudarja, da je pomembno razkrivati dejavnike uspešnosti tima, saj danes velik del podjetij ustanovijo prav podjetniški timi. Poleg tega številni raziskovalci, še posebej na področju dizajnerskega razmišljanja, poudarjajo pomembnost sodelovanja in multidisciplinarnih timov za izboljšanje inovacijske aktivnosti. Ta študija dopolnjuje dosedanje raziskovalno delo na področju inovativnih timov s črpanjem iz zanimive teorije, ki je nastala skozi perspektivo dizajnerskega razmišljanja in ki sta jo nadgradila Kelley in Littman (2005). Ker teorija o desetih timskih vlogah prihaja iz osebne izkušnje avtorjev, primanjkuje pa empiričnih dokazov, so potrebne dodatne študije, ki bi pokazale pozitivno razmerje med predlagano timsko strukturo in inovativnostjo. Na podlagi dejstva, da imajo nekatere sestavine vlog pozitiven vpliv na inovativnost, lahko predpostavljamo, da tudi struktura tima, ki vsebuje omenjene vloge, pomembno napoveduje inovativnost.

V poglavju uporabimo eksperimentalno-empirično analizo, ki jo dopolnimo s kvantitativno analizo, da preverimo doprinos in vpliv strukture tima na njegovo inovacijsko uspešnost. Z uporabo na novo razvitega instrumenta za vrednotenje posameznih članov v timu izvedemo več poskusov, in sicer na treh različnih mednarodnih vzorcih posameznikov, ki so stari od 20 do 58 let in prihajajo iz različnih okolij. V ta namen šest mesecev spremljamo in beležimo delo 34 timov, nato preverimo učinek na inovacijsko uspešnost še z linearnim regresijskim modelom. Rezultati kažejo, da so ekipe, ki vključujejo vloge iz teorije Kelleya in Littmana, bolj inovativne. Vsak inovativni tim naj bi zato obsegal naslednjih 10 vlog: antropolog, preizkuševalec, navzkrižnik, premagovalec ovir, sodelovalec, direktor, arhitekt izkušenj, prostorski dizajner, pripovedovalec zgodb in skrbnik. Te vloge morajo biti med člani razporejene enakomerno, pri čemer ima lahko vsak izraženih več vlog. Poleg tega ugotavljamo, da za doseganje višje stopnje inovativnosti tima ekipa ne sme imeti več kot eno prevladujočo osebnost (član, ki ima izražene več kot tri vloge). V tabeli G.3 sistematično povzamemo glavne ugotovitve poglavja.

Tabela G.1: Povzetek glavnih ugotovitev in implikacij – 1. poglavje

1. poglavje: Raziskovanje medsebojnega delovanja znanja in načina razmišljanja podjetnika na inovativnost podjetja	
Raziskovalna vprašanja	Kako znanje podjetnika vpliva na inovativnost podjetja? Kakšen medsebojni vpliv imata širina podjetnikovega znanja in globina njegovega znanja? Kakšno je medsebojno delovanje širine in globine podjetnikovega znanja na inovativnost podjetja? Kateri so ključni sestavni deli podjetnikovega načina razmišljanja, ki izboljšajo njegove veščine reševanja problemov? Kako se podjetnikovo integrativno razmišljanje razlikuje od konvencionalnega razmišljanja? Kako integrativni način razmišljanja podjetnika vpliva na inovativnost podjetja?
Raziskava	Interpretativna fenomenološka analiza – 3 udeleženci
Glavne ugotovitve	P1: Širina podjetnikovega znanja (v smislu splošnega znanja, izkušenj in veščin) okrepi vpliv, ki ga ima globina njegovega znanja na inovativnost podjetja. P2: Z uporabo integrativnega načina razmišljanja pri reševanju problemov podjetnik izboljšuje kreativnost in dviguje inovativnost podjetja.
Izluščene teme	Znanje: (1) odprtost do novih izkušenj, (2) širina in globina znanja kot pospeševalec kreativnih rešitev, (3) učljivost in radovednost. Integrativno razmišljanje: (1) hitro sprejemanje odločitev, (2) zadovoljitev z dobro, a nepopolno rešitvijo, (3) celosten pristop, (4) sprejemanje kompleksnih problemov, (5) zmožnost prepoznavanja nevidnih značilnosti problema, (6) različno dojemanje tveganja, (7) vključevanje drugih in (8) stalna naravnanost na prihodnost.
Implikacije za podjetniško teorijo	Razvoj konceptualnega modela: globina znanja/širina znanja, integrativno razmišljanje, inovativnost. Doprinos k boljšemu razumevanju spodbujevalne vloge, ki jo ima širina znanja pri pospeševanju inovacijske aktivnosti. Razvoj merske lestvice integrativnega razmišljanja*.
Implikacije za prakso	Podjetnik mora neprestano širiti svoja obzorja z naklonjenostjo odprtosti in hobijem. Podjetnik mora biti radoveden in se pripravljen učiti, da bo pridobil nove vpoglede v reševanje problemov. Podjetnik si mora zgraditi širok nabor znanj, da lahko najde kreativne rešitve in učinkoviteje sprejema kadrovske odločitve. Podjetnik si mora za boljšo inovativnost pridobiti zmožnost integrativnega razmišljanja. Podjetnik mora biti sposoben hitrega odločanja, zadovoljitve z 80-odstotno rešitvijo, reševanja kompleksnih problemov, prepoznavanja tudi tistih značilnosti problema, ki jih drugi ne opazijo, in stalnega spremljanja mnenj drugih, kar je pomembno za razumevanje različnih pogledov na problem. Podjetnik mora v glavi vedno zadržati celotno strukturo problema, tudi med tem, ko dela na posamičnih rešitvah. Podjetnik mora biti usmerjen v prihodnost.

(table continues)

(continued)

	Podjetniški programi bi morali vključevati pristope dizajnerskega razmišljanja, da bi študentje lažje pridobili kompetence, potrebne za 21. stoletje, in bi bili bolj usposobljeni za reševanje težavnih problemov. Podjetniški programi bi morali študente stalno spodbujati k pridobivanju novega znanja, k radovednosti in k razvijanju empatije. Podjetniški programi bi morali poudarjati pomembnost integracije znanj različnih disciplin in spodbujati mednarodne izmenjave študentov. Podjetniški programi bi morali stalno izboljševati inovativnost študentov z urjenjem spretnosti sklepanja in razvijanjem sposobnosti integrativnega razmišljanja.

**v prilogi C*

Tabela G.2: Povzetek glavnih ugotovitev in implikacij – 2. poglavje

2. poglavje: Medsebojno vplivanje podjetnikove socialne mreže, širine znanja, eksperimentiranja in inovativnosti	
Hipoteze	H1: Hitro prototipiranje pozitivno vpliva na inovativnost podjetja. H2: Tradicionalno prototipiranje izboljšuje inovativnost podjetja. H3: Podjetnikova socialna mreža pozitivno vpliva na inovativnost podjetja. H4: Kombinacija podjetnikove socialne mreže in širine znanja izboljšuje inovativnost podjetja.
Raziskava	Interpretativna fenomenološka analiza – 3 udeleženci
Glavne ugotovitve	Hitro prototipiranje pozitivno vpliva na inovativnost podjetja z izboljšanjem vizualne predstave in učinkovitejšo identifikacijo latentnih potreb trga. Vse oblike prototipiranja vodijo do izboljšanja inovativnosti podjetja. Širina znanja podjetniku omogoča učinkovitejši izkoristek njegove socialne mreže, kar vodi do boljše inovativnosti podjetja.
Izluščene teme	Eksperimentiranje: (1) metoda poskusov in napak, (2) izboljšana inovativnost, (3) izboljšan vpogled na trg, (4) hitro prototipiranje kot ključni element uspešnega inovacijskega procesa. Podjetnikove mreže: (1) znanje kot osnova za mreženje, (2) grajenje zaupanja skozi znanje, (3) znanje kot ključni element učinkovite komunikacije, (4) vzajemna korist.
Implikacije za podjetniško teorijo	Razvoj konceptualnega modela: hitro prototipiranje, tradicionalno prototipiranje, podjetnikove mreže/širina znanja, inovativnost. Doprinos k boljšemu razumevanju spodbujevalne vloge, ki jo ima širina znanja v razmerju med podjetnikovimi mrežami in inovativnostjo podjetja. Izpostavitev ključne vloge hitrega prototipiranja v inovacijski aktivnosti. Merjenje podjetnikovega znanja glede na različna področja znanja, in ne kot rezultat delovnih izkušenj (leta v poslu) in izobrazbe (stopnja izobrazbe)*.
Implikacije za prakso	Podjetnik, ki je naklonjen eksperimentiranju, je ključni dejavnik inovativnosti podjetja. Podjetniki, ki se poslužujejo prototipiranja, poskrbijo za razumljivejši prenos koncepta na trg, pridobijo kreativnejše povratne informacije in lažje odkrijejo skrite potrebe trga. Podjetniki bi morali za boljšo inovativnost v podjetjih spodbujati kulturo poskusov in napak. Podjetniki morajo imeti široko znanje, da lahko bolje razumejo druge, lažje določijo pomembne teme pogovora in vzpostavijo zaupanja vreden odnos. Podjetnik mora širiti svoje znanje, da okrepi vpliv svoje mreže na inovativnost podjetja. Podjetniški programi bi morali poudarjati pomembnost podjetnikovih mrež ter študente spodbujati in učiti, da in kako naj jih gradijo. Podjetniški programi bi morali pomagati študentom ponotranjiti kulturo prototipiranja in učenja na napakah.

**v prilogi D*

Tabela G.3: Povzetek glavnih ugotovitev in implikacij – 3. poglavje

3. poglavje: Vpliv strukture tima na njegovo inovativnost: Empirična raziskava	
Hipoteza	H1: Struktura tima, ki vključuje vloge iz teorije Kelleya in Littmana (2005), vodi do višje inovativnosti kot struktura tima, ki vključuje naključno kombinacijo posameznikov.
Raziskava	Poskusi – vzorec 34 timov Linearni regresijski model
Glavne ugotovitve	Timi, ki vključujejo več vlog, ki jih predlagata Kelley in Littman, so bolj inovativni (ne glede na pojavnost vlog). Inovativnost tima = 0.68 × Kelleyev indeks V timu morajo biti izražene naslednje vloge: antropolog, preizkuševalec, navzkrižnik, premagovalec ovir, sodelovalec, direktor, arhitekt izkušenj, prostorski dizajner, pripovedovalec zgodb in skrbnik.
Implikacije za podjetniško teorijo	Združevanje različnih raziskav o učinkih sestave tima na povečanje inovativnosti. Razvoj teoretične logike, ki pojasni, kako predlog Kelleya in Littmana vodi k boljši inovativnosti tima. Študija je izhodišče za nadaljnje empirične raziskave na področju sestave tima po metodi dizajnerskega razmišljanja. Priprava priporočil, kako optimalno razporediti vloge med člani v timu, in predlog pristopa za merjenje inovativnosti tima in sestave tima. Razvoj indeksa Kelley za merjenje števila izraženih vlog v ekipi. Razvoj inštrumenta za določitev vlog članov tima*
Implikacije za prakso	Pri sestavljanju inovativnega tima bi morali podjetniki vanj vključiti več vlog, ki jih predlagata Kelley in Littman. Vloge je treba med člane tima razporediti enakomerno, in sicer zaradi boljšega sodelovanja, zadovoljstva članov in medsebojnih interakcij. Posamezni član ima lahko izraženih več vlog, vendar ne več kot tri. Za potrebe doseganja višje inovativnosti naj bo v timu le ena prevladujoča osebnost. Timi, ki zajemajo vseh deset vlog, so bolj inovativni. Podjetniški programi bi morali spodbujati delo študentov v interdisciplinarnih timih ter študente naučiti, kako učinkovito delati v takem timu, in jim pomagati spoznati boljše učinke timskega dela na inoviranje.

**v prilogi F*

Implikacije za podjetniško teorijo

Doktorska disertacija doprinese k boljšemu razumevanju determinant, ki na ravni posameznika in podjetja v povezavi z dizajnerskim razmišljanjem določajo inovativnost MSP. Z njo razširjamo dosedanja dognanja na področju inovativnosti podjetij in nudimo vpogled v zapleten proces osebnih dejavnikov in naklonjenosti podjetnika do določenih postopkov, ki vodijo do višje stopnje inovativnosti podjetij.

Obstoječi pogled na kognitivne značilnosti podjetnika in inovativnost nadgradimo s potrditvijo močne povezave med podjetnikom in inovativnostjo na ravni podjetja (Marcati et al., 2008). Z analizo podjetnikovega obnašanja in njegovih značilnosti v razmerju do rezultatov podjetja ponudimo jasne dokaze o njegovem vplivu na delovanje podjetja (Baron, 2013). Izboljšamo tudi razumevanje osnovnih dejavnikov kognitivnih lastnosti podjetnikov in pokažemo, kakšen vpliv imajo na inovativnost podjetja. Z uporabo interpretativne fenomenološke analize (IPA) (Smith, 2015) ponudimo poglobljen vpogled v občutke in zaznave, ki določajo podjetnikove izkušnje, znanje in razmišljanje.

Ta raziskava je med prvimi, ki preučujejo globino in širino znanja na ravni podjetnika. S povezovanjem podjetnikovih odločitev in odločitev MSP želimo raziskati razsežnosti podjetnikovega znanja, medsebojno povezavo teh dimenzij in možnosti, kako MSP pomagati, da bi bila bolj inovativna. Rezultati pokažejo pomembno vlogo, ki jo ima pri inovativnosti znanje, in dopolnijo razumevanje medsebojnega delovanja dimenzij znanja na ravni podjetnika. Odkrijemo spodbujevalno funkcijo, ki jo ima v razmerju med strokovnim znanjem podjetnika in inovativnostjo podjetja širina podjetnikovega znanja v smislu splošnega znanja, izkušenj in sposobnosti.

Poleg tega raziščemo način podjetnikovega razmišljanja, ki pripomore k višji inovativnosti, in ugotovljene značilnosti predstavimo v povezavi Martinovo (2007b) teorijo integrativnega razmišljanja. Naš doprinos k podjetniški teoriji je razvoj enega prvih konceptualnih modelov integrativnega razmišljanja in merskega instrumenta. Odkrijemo tiste značilnosti razmišljanja, ki spodbujajo ne le inovativnost, ampak tudi uspeh podjetja.

V nadaljevanju ugotovimo povezavo med podjetniškimi mrežami in eksperimentiranjem. Podjetniške mreže priskrbijo motivacijo v primeru napak in poskrbijo za prenos izkušenj v inovacijskem procesu. Disertacija torej ponuja eno prvih študij, ki raziskuje pomen eksperimentiranja in preveri njegov vpliv na inovativnost podjetja na večjem vzorcu podjetnikov. Rezultati pokažejo, da eksperimentiranje v podjetju vodi k doseganju višje inovativnosti, in hkrati razkrijejo osrednjo vlogo hitrega prototipiranja v inovacijski aktivnosti. Dodatno se osredotočimo na analizo podjetniških mrež in ugotovimo, da je podjetnikova širina znanja pomemben pospeševalec v razmerju med podjetnikovo mrežo in inovativnostjo podjetja. Ker se obstoječe lestvice za merjenje znanja zanašajo predvsem na podjetnikove pretekle izkušnje v industriji in njegovo stopnjo izobrazbe, za katere menimo, da znanja ne označujejo pravilno, v analizi uporabimo lestvico, ki skuša ujeti osebno raven znanja glede na različna področja. Tako pokažemo, da širina znanja bistveno okrepi učinek podjetniških mrež ter s pomočjo povečane stopnje zaupanja in lažje komunikacije izboljša proces pridobivanja novih stikov in določanja potrebnih znanj znotraj obstoječe mreže. Vse to pa se izraža v višji inovativnosti podjetja.

V tretjem poglavju disertacije se osredotočimo na izkustveno teorijo o sestavi tima, ki vodi do inovacijske uspešnosti. Naš cilj je združiti različne raziskave o učinkih sestave tima na povečanje inovativnosti, in sicer s pomočjo testiranja teorije o inovativni strukturi tima (Kelley in Littman, 2005). V ta namen razvijemo teoretično logiko za pojasnjevanje, kako taka sestava tima vodi do povečane inovativnosti (instrument za vrednotenje posameznikov v timu je prikazan v prilogi E). Predstavljamo torej izhodišče za nadaljnje empirične analize sestave tima glede na teorijo dizajnerskega razmišljanja. Dodatno nudimo tudi priporočila, kako optimalno porazdeliti vloge med člani znotraj tima, kako sestaviti inovativen tim in kako meriti njegovo inovacijsko uspešnost.

Implikacije za prakso

Disertacija ponudi številna priporočila za podjetniško prakso in dvigovanje inovativnosti znotraj MSP. Izsledki raziskave kažejo, da igra podjetnik osrednjo vlogo pri uspešnosti podjetja, saj imajo njegove lastnosti, prepričanja in naklonjenost določenim procesom velik vpliv na delovanje podjetja. Zato naj podjetniki stalno širijo svoje obzorje z odprtostjo do najrazličnejših izkušenj, hobijev in znanja tujih jezikov. Podjetnik naj bo radoveden in željan učenja, da pridobi nove poglede na svet in tako gradi svojo širino znanja. Prav ta na koncu poveča njegovo inovativnost, inovativnost njegovega podjetja in zmožnost efektivnega izvajanja delovnih aktivnosti s pomočjo interdisciplinarnega pristopa pri iskanju kreativnih rešitev, hkrati pa mu omogoča lažje in učinkovitejše sprejemanje kadrovskih odločitev in izvajanje nadzora z identifikacijo primernih kadrov za določeno nalogo.

Podjetnik naj gradi zmogljivost integrativnega razmišljanja. Da bi dosegel višjo inovativnost, mora biti zmožen sprejemati hitre odločitve in reševati probleme le do točke, na kateri se potrdi naslednji korak in se vidi, ali se splača zadevo globlje raziskati. Kompleksni problemi naj mu bodo v veselje in vedno naj razišče različna mnenja, da pridobi različne vpoglede v situacije, tako bo lažje odkril tudi tiste sestavine problema, ki jih drugi spregledajo. Na koncu pa je pomembno tudi, da začetni problem vedno zadrži v mislih, medtem ko išče rešitve za njegove posamezne dele, in da ima miselnost naravnano v prihodnost.

Podjetniki, ki so naklonjeni eksperimentiranju, so bistveni člen inovativnosti podjetja. Uporaba prototipov omogoča jasnejši prenos koncepta na trg in boljšo, kreativnejšo povratno informacijo. Prav tako s pomočjo prototipov v zgodnjih fazah razvoja proizvoda hitreje odkrijemo skrite potrebe in želje ljudi, ki s še ne dovršenim proizvodom lažje kreativno razmišljajo o potencialnih spremembah in njegovi inovativni uporabi. To je še posebej očitno pri ustvarjanju hitrih prototipov. Zato morajo podjetniki med zaposlenimi spodbujati kulturo poskusov in napak, da na koncu procesa pridejo do čim bolj inovativne rešitve.

Podjetniki naj se zavedajo močne soodvisnosti med njihovo mrežo in širino znanja. Ta dimenzija znanja je namreč tista, ki podkrepi vpliv podjetnikove mreže na inovativnost podjetja. Podjetnik s širšim znanjem lažje razume sogovornika, ugotovi, katero znanje potrebuje znotraj mreže, določi pomembne tematike pogovora in vzpostavi zaupanja vreden odnos.

Pri sestavi tima za zagon podjetja ali delovne skupine za reševanje določenega problema naj podjetnik poskrbi, da ima tim izraženih vseh 10 potrebnih vlog: antropolog, preizkuševalec, navzkrižnik, premagovalec ovir, sodelovalec, direktor, arhitekt izkušenj, prostorski dizajner, pripovedovalec zgodb in skrbnik. Le tako bo lahko izkoristil potencial dela v timu. Prepričati pa se mora, da bodo vloge med člane tima razporejene enakomerno, kar se odraža v višjem zadovoljstvu in učinkovitejšem sodelovanju članov. Vsak član tima lahko izraža največ tri od navedenih vlog, vendar tim ne sme vsebovati več kot eno prevladujočo osebnost. Postopek sestavljanja optimalnega tima temelji na preizkušanju in napakah, zato pri iskanju dobro delujočega ravnotežja potrebuje veliko mero vztrajnosti. Kakorkoli že, v sestavo tima je vredno vložiti več časa, saj obstaja velika verjetnost, da se bo ob upoštevanju pravil inovativnost skupine precej povečala.

Praktični prispevek disertacije je namenjen tudi obstoječemu izobraževalnemu sistemu in oblikovalcem politik. Rezultati ponujajo več idej za spremembo trenutnih izobraževalnih praks, ki bi po novem vključevale dizajnerski pristop in tako omogočale učinkovitejši razvoj kompetenc 21. stoletja in uspešnejše soočanje s težavnimi problemi ter bi tudi pomagale izoblikovati bolj kreativne podjetnike. Podjetniški programi morajo graditi skupnost, ki prepoznava znanje (globino in širino) kot osnovno vrednoto za grajenje kreativnejših rešitev. Študente bi morali spodbujati k integraciji znanj različnih disciplin, k pridobivanju novega znanja, k radovednosti in razvijanju empatije. Vključevati bi jih morali v mednarodne izmenjevalne programe, kjer bi lažje spoznali drugačne poglede na enake probleme. Tako bi študentje tudi že začeli graditi svoje mreže, ki bi jim pomagale do učinkovitejšega poslovanja in mednarodnega sodelovanja, ko bodo na trgu dela.

Podjetniški programi bi morali stalno izboljševati spretnost sklepanja ter spodbujati razvoj kompetenc, ki so potrebne za proces integrativnega razmišljanja. Študentje bi z novimi usmeritvami lažje ponotranjili kulturo prototipiranja za lažji prenos konceptov in učenja na napakah za potrebe izboljšav. Spodbujalo naj bi se tudi delo v multidisciplinarnih timih, da bi se študentje naučili takega sodelovanja in hkrati spoznali njegove pozitivne učinke na inoviranje.

Dizajnerski pristop pa ni pomemben le za študij podjetništva, temveč bi ga morali vključiti v vse študijske programe. Študentje tehničnih področij bi tako lažje razumeli, kako identificirati potrebe trga, kako narediti proizvod, ki ga ljudje hočejo, ter kako ga prodati.

Omejitve in priložnosti za nadaljnje raziskave

Disertacija ima določene omejitve, ki odpirajo možnosti za nadaljnje raziskovanje.

Prvič, uporaba kvalitativnih metod zbuja pomisleke glede subjektivnosti, vzorčenja, veljavnosti, zanesljivosti in statističnega posploševanja (Carr, 1994; Neergaard & Ulhři, 2007; Stritar & Drnovšek, 2015). Kljub majhnemu številu primerov, ki smo jih uporabili pri izvedbi kvalitativnega dela raziskave, je cilj interpretativne fenomenološke analize (IPA) pridobiti bogate opise proučevanega pojava in opredeliti bistvene sestavine ter raziskati posameznikov pogled na različne situacije, raje kot postaviti splošne trditve (Pietkiewicz & Smith, 2014). Da bi natančneje določili mehanizme, ki spodbujajo inovativnost, smo posameznike za analizo izbrali na podlagi uspešnih podjetniških zgodb, kar pa lahko vodi to nepristranskosti vzorca (Heckman, 1977). Zato naj se prihodnje raziskave osredotočijo na dodatno analizo kognitivnih vidikov podjetnikov in njihovega vpliva na inovativnost podjetja. Upoštevajo naj tudi potrebo po statistično pomembnih rezultatih in po preveritvi odnosa med podjetnikovim znanjem, integrativnim razmišljanjem in inovativnostjo brez vmešavanja raziskovalca, ki lahko vpliva na odzive intervjuvancev. Osnovno hierarhično analizo razmerja sicer dodajamo v prilogo, vendar jo je treba nadgraditi na večjem vzorcu in uporabiti enoten razpored.

Drugič, kvalitativna raziskava je lahko predmet retrospektivne pristranskosti, ki vpliva na nezmožnost posameznika, da se natančno spomni svojih izkušenj in okoliščin (Cassar & Craig, 2009; Henriksen & Kaplan, 2003). Zato smo z uporabo interpretativne fenomenološke analize morda spregledali nekatere kompleksnejše dejavnike podjetnikovega znanja in načina razmišljanja ter njegovih mrež in nagnjenosti k eksperimentiranju. Prihodnje raziskave bi se torej lahko osredotočile na posebne dejavnike, ki nastanejo kot posledica pristranskosti intervjuvanca.

Tretjič, mere konstruktov v disertaciji temeljijo na samoocenah, kar ogroža njihovo veljavnost (Donaldson & Grant-Vallone, 2002) in pri bolj samozavestnih udeležencih povzroča pristranskost (Lasagni, 2012). Pridobljeni podatki lahko vključujejo tudi družbeno zaželene odgovore. Poleg tega so konceptualni modeli, ki združujejo znanje, integrativno razmišljanje, podjetniške mreže in eksperimentiranje in ki smo jih preverili s hierarhično regresijo, zgrajeni na podlagi slovenskih podjetnikov iz MSP. Zanimivo bi bilo dodati mednarodno primerjavo z vključitvijo dodatnih držav v vzorec in preveritvijo v ostalih industrijah. Treba je obravnavati tudi druge potencialne mediatorje in moderatorje v omenjenih modelih. Nenazadnje pa se lahko konstrukte preuči še v longitudinalni študiji in se razišče razlike v posameznih obdobjih.

Četrtič, razvoj lestvice za merjenje integrativnega razmišljanja je narejen po poenostavljeni metodi procesa (DeVellis, 2003). Vsi koraki so upoštevani, vendar so, kjer je mogoče,

narejene manjše prilagoditve, ki pospešijo proces. Mera je nastala le kot prikaz pomembnosti integrativnega razmišljanja, in zato potrebuje dodatne nadgradnje.

Petič, omejitve tretjega poglavja se nanašajo na kontekstne posebnosti timskega dela. Bi omenjenih deset vlog dejansko lahko sodelovalo produktivno ne glede na okoliščine ali pa bi prišlo do nesoglasij, ki bi pod določenimi pogoji vplivala na zmanjšanje ustvarjalnosti in uspešnosti tima? V prihodnje bi se lahko raziskave še posebej osredotočile na interakcijo vlog in vsebinske pogoje. V študiji ne upoštevamo optimalne kombinacije in števila vlog, ki naj bi jih imel posamezni član tima. Prav tako ne obravnavamo prispevka posameznih vlog k inovacijski uspešnosti tima. Tako obstaja priložnost, da se določi najbolj komplementarne vloge, izražene v posameznem članu, in najkoristnejše vloge, ki bolj kot druge izboljšujejo učinkovitost tima. Dejstvo je tudi, da raziskava poteka v okolju brez stresa in ob pomanjkanju financ. Lahko se zgodi, da bi opazovani v realnem življenju sprejeli manj pogumne odločitve, kar bi lahko zmanjšalo inovativnost. Priporočamo torej, da se prihodnje raziskave izvedejo v podjetjih s pravimi zaposlenimi in podjetniki.

Sklep

Disertacija omogoča poglobljeno razumevanje mehanizmov dizajnerskega razmišljanja, ki poganjajo inovativnost MSP in med katere spadajo širina znanja, globina znanja, podjetnikova mreža, integrativno razmišljanje in eksperimentiranje. Ponujamo enega prvih poskusov razumevanja pomena posameznih dimenzij znanja in njegove vloge v podjetnikovi mreži. Empirično pokažemo pomembnost eksperimentiranja pri višanju inovativnosti podjetja in razkrijemo pomembno kognitivno značilnost podjetnika – integrativno razmišljanje. Poleg tega razširimo dosedanji pogled na sestavo inovativnega tima. Združevanje različnih metodologij nam omogoča, da podjetnikom in oblikovalcem politik nudimo priporočila za doseganje višje stopnje inovativnosti in da motiviramo raziskovalce za nadaljnje raziskave neskončnega področja inovativnih mehanizmov.