JYU DISSERTATIONS 241

Juha Saukkonen

Towards Dynamic Knowledge Management in Technology-based SMEs

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY

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Esitetään Jyväskylän yliopiston informaatioteknologian tiedekunnan suostumuksella
julkisesti tarkastettavaksi syyskuun 11. päivänä 2020 kello 12.

Academic dissertation to be publicly discussed, by permission of
the Faculty of Information Technology of the University of Jyväskylä,
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JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2020

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Cover photo by Juha Saukkonen: author's kayak heading towards Ehtama island on Lake Päijänne.

Permanent link to this publication: http://urn.fi/URN:ISBN:978-951-39-8192-1

ISBN 978-951-39-8192-1 (PDF)
URN:ISBN:978-951-39-8192-1
ISSN 2489-9003

ABSTRACT

Saukkonen, Juha
Towards dynamic knowledge management in technology-based SMEs
Jyväskylä: University of Jyväskylä, 2020, 113 p. + included articles
(JYU Dissertations
ISSN 2489-9003; 241)
ISBN 978-951-39-8192-1 (PDF)

Small- and medium-sized companies (SMEs) have an important role in net job creation in modern society. A cohort within SME sphere, technology-based companies, are special in their potential to employ, grow fast and internationalize. Simultaneously, those companies experience volatility in technology, markets and competition that exposes to the risk of devaluation of the knowledge they possess. Since the knowledge can be defined as an organization's ability to act efficiently in its environment, capabilities in managing knowledge are vital for SMEs' survival and growth.

Various frameworks and models have been presented by the research community to depict the construct of knowledge management (KM). Mainstream of research has derived KM models from large corporations and thus focused on applicability in those contexts. These models have a limited applicability in resource-constrained SME context. To focus even further, KM frameworks for technology-based SMEs have been scarce.

The existing KM frameworks developed have not embedded time-moderated dynamics, i.e. the evolution of knowledge and its management over time. In addition, the dynamics between knowledge stakeholders needs to be connected into the frameworks for research and practice. This study aims via multimethod approach at shedding light on how a framework of dynamic knowledge management could be constructed to enlarge the knowledge on the subject area for both research and practice.

The findings indicate how the contents and actions in knowledge management in technology-based SMEs change over altering states of development. The work summarizes these findings by proposing an integrative framework for dynamic knowledge management and proposes hypothetical practical instantiations of the framework.

The frameworks created should be seen as early steps in creating new knowledge in an understudied field. For the practitioner community the thesis aims at helping to identify the state of development of the assets in technology business SMEs' knowledge portfolios and to choose approaches and actions that allow them to create, protect, disseminate and exploit knowledge more efficiently.

Keywords: knowledge, management, change, growth, dynamic

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Saukkonen, Juha
Kohti dynaamista osaamisen johtamista teknologialähtöisissä PK-yrityksissä
Jyväskylä: University of Jyväskylä, 2020, 104 s. + alkuperäiset artikkelit
(JYU Dissertations
ISSN 2489-9003; 241)
ISBN 978-951-39-8192-1 (PDF)

Pienillä ja keskisuurilla (pk-)yrityksillä on tärkeä tehtävä nettotyöpaikkojen luomisessa nykyaikaisessa yhteiskunnassa. Eräs pk-yritysten kohortti, teknologialähtöiset yritykset, erottuu potentiaalillaan työllistää, kasvaa nopeasti ja kansainvälistyä. Samanaikaisesti nämä yritykset elävät teknologian, markkinoiden ja kilpailun suhteen epävakaassa ympäristössä, mikä altistaa ne olemassa olevan osaamisen arvon nopealle laskulle. Koska osaaminen voidaan määritellä organisaation kykynä toimia tehokkaasti ympäristössään, osaamisen johtamisen kyvykkyydet ovat elintärkeitä pk-yritysten selviytymiselle ja kasvulle.

Tutkimusyhteisö on luonut lukuisia viitekehyksiä ja malleja kuvaamaan osaamisen johtamisen (Knowledge Management, KM) rakennetta ja prosesseja. Mallit on pääosin johdettu suurista yrityksistä kerätyn datan avulla ja keskittynyt siten soveltuvuuteen tässä kontekstissa. Näillä mallit soveltuvat vain osin resursseiltaan rajoittuneisiin pk-yrityksiin. Vielä tarkemmin fokusoiden, teknologiapohjaisten pk-yritysten osaamisen johtamiseen suuntaava tutkimus on ollut vähäistä.

Nykyiset mallit eivät sisällä aikaperustaista dynamiikkaa, osaamisen ja sen johtamisen muutosta ajan myötä. Lisäksi osaamisen johtamisen sidosryhmien välinen dynamiikka on liitettävä tutkimuksen ja käytännön viitekehyksiin. Tämän tutkimuksen tavoitteena on tutkimusaluetta monimetodisesti lähestyen tuoda esiin, kuinka dynaaminen osaamisen johtamisen kehys voitaisiin rakentaa laajentamaan aihealueen tietämystä sekä tutkimuksen että käytännön tarpeisiin.

Tulokset osoittavat, että teknologiapohjaisten pk-yritysten osaamisen johtamisen ja hallinnan sisältö ja toimenpiteet muuttuvat osaamispääoman kehitysvaiheiden myötä. Työssä tehdään tiivistelmä nämä havainnot ehdottamalla integroivaa kehystä dynaamiselle osaamisen johtamiselle ja siitä johdettuja käytännön sovelluksia.

Luotu malli ja sen sovellukset tulisi nähdä varhaisina vaiheina uuden tiedon luomisessa alitutkitusta aihealueesta. Mallit auttavat tunnistamaan teknologialähtöisten pk-yritysten osaamissalkun osatekijöiden kehityksen tila ja valitsemaan lähestymistavat ja toimet, joiden avulla yritykset voivat luoda, suojata, levittää ja hyödyntää osaamistaan tehokkaammin.

Avainsanat: osaaminen, johtaminen, muutos, kasvu, dynamiikka

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FOREWORD

This dissertation is the final milestone of one research journey that took many years and contained both stages when the work flowed nicely as well as some doldrums, times when the researcher's sails were not filled with tailwind. But never was it boring.

I want to express my utmost gratitude to my supervisor Dr. Professor Pekka Abrahamsson for the commitment and support he showed to my work in all its stages. Prof. Abrahamsson was able to guide my effort both with encouragement and with clear practical advice when it was needed. Throughout the process he was both serious, involved and able to make me enjoy the numerous turns of the journey. It is fair to say that in my research process I did not only learn about the subject area of my study, but also a great deal of stewardship and tutoring of students in their individual efforts. Also the courses I took at JYU and INFORTE network, taught by the leading experts in their fields, widened and deepened my views of the subject areas my work was contributing to. While writing this dissertation I had the pleasure to be part of the Start-up Lab community of University of Jyväskylä, headed by Dr. Abrahamsson. The youthful team there was a great environment to get inspired and – hopefully –inspire others.

My research work was also greatly supported by my employer, JAMK University of Applied Sciences as well as the Foundation for Economic Education in Finland. Both institutions saw my project worth supporting and made it possible for me to focus to research with their investments to time for research and to monetary support. My supervisors and colleagues at JAMK, Dr. Asta Wahlgrén and Mr. Matti Hirsilä at the helm, were interested and encouraging throughout the whole process. They provided courage as well supported my study efforts by allowing me to dedicate fully to research work at times.

Using the terminology of arctic and antarctic explorers, the most demanding format of exploration is an "unsupported solo". Luckily, I did not have to go for that option. I started my baby steps in research while working at M-real group, and the curiosity and open mindedness of people in the research unit of the company attracted me originally to rejoin the world of academic research, while still being involved in business line operations. As can be seen in the author lists of the original articles making this dissertation, collaboration with people sharing my interests was vital in making my research to happen. When designing the research plans, turning them into action and reporting the findings, we were learning together and teaching each other, and strengthening our friendship at the same go. Therefore, I want to thank the co-authors of the articles included in this dissertation, as well as the co-authors of other works that do not have a place in this publication but had an important role in developing me as a researcher.

Naturally, people outside the research community directly and indirectly contributing to my growth and work are numerous, but naming them all is just impossible in this given space. My teammates from organizations I have worked for, my teammates from sports and the people who started moulding me back in

our high school years have been important enablers to the work you are reading now. You may not find your names in this publication, but without your trust and support this research would never had taken place.

My original research topic in the early 2000s concerned the changes in value networks. As we know by now, I never completed that. Perhaps I was reluctant for a reason: I have been blessed with being surrounded by people with right values all my life. I have been privileged to get encouragement and guidance from my late grandparents, my mother Eeva-Maija and my late father Keijo as well as from siblings Tero and Ullamari and their families. We are all unique, yet united and able to support each other with our own best knowledge and resources.

The biggest and warmest thanks go to my lovely wife Lilli, who has been firm in her faith in my ability to complete the work I started and has given me the energy that was needed to reach the finishing line of my doctoral studies. Her unconditional love is worth more than can be expressed in words. Last but definitely not least, our children Sini, Samu, Sanni and Sonja have been my important teachers in life, and the joy and pride they bring me every day is the type of the fuel every researcher needs to fly high and land safely. Writing these last chapters was by far the best part of the doctoral work, so let it make a nice ending to the foreword.

Jyväskylä 15.8.2020
Juha Saukkonen

FIGURES

TABLES

LIST OF ORIGINAL ARTICLES

I. Saukkonen, J., & Kreus, P. (2018). Extending the concept of knowledge management into innovation and new business creation. In *Proceedings of the International Conference on Creativity and Innovation 2018*. Japan Creativity Society and Kindai University, pp. 11-26.

II. Saukkonen, J., Harju, M. & Kreus, P. (2019). Intellectual property in the era of increased clock speed: Return of knowhow? In M. Sargiacomo (Ed.), *Proceedings of the 10th European Conference on Intangibles and Intellectual Capital ECIIC 2019, University of Chieti-Pescara, 23-24 May 2019*. pp. 244–252

III. Saukkonen, J. & Bayiere, A. 2017. Torn between funnels: Start-up entrepreneurs' dilemma of getting started and preparing for change. In J. Mitra (Ed.), *Conference Proceedings, Volume 2: Research and Reflective Papers. 15th International Entrepreneurship Forum (IEF) Conference*. Essex: University of Essex, pp. 414-433.

IV. Saukkonen, J., Vasamo, A. L., Ballard, S., & Levie, J. (2016). Anticipation of technology as an entrepreneurial skill. In *Proceedings of the 11th European Conference on Innovation and Entrepreneurship*. Reading: Academic Conferences and Publishing International Limited, pp. 717-725.

V. Saukkonen, J., Nukari, J., Ballard, S., & Levie, J. (2016). Start-up entrepreneurs and university students in a co-learning mode: Learning effects of a collaborative entrepreneurial coaching programme. *Industry and Higher Education*, 30(3), pp. 224-238.

VI. Saukkonen, J. (2018). Entrepreneurs and Growth: An Option, Obligation or Obsession. Chapter in *Entrepreneurship: Development Tendencies and Empirical Approach, 1*. Zagreb: InTech Open, pp. 3-33

CONTENTS

1 INTRODUCTION

This chapter orientates the reader to the study by providing a view on why the chosen research area is of importance and interest as well as identifying the research gaps. These gaps present a quest for added knowledge - a base on which the author has built his own research objectives and questions. The author also defines and describes the units of analysis of this study, technology-based SMEs and describes how that context is somewhat distinct concerning knowledge management. To conclude the chapter the structure of the thesis is presented.

1.1 Motivation for the study

The importance of a firm´s ability to manage its knowledge has been recognized both in research and in practice over the last decades. One often quoted (e.g. Atwood, 2009) expression of the need and difficulty of mastering knowledge is from then-CEO of Hewlett-Packard Lewis E. Platt: "If only HP knew what HP knows (we would be three times more productive)". Interestingly, Platt was elaborating on an issue Peter Drucker brought up 40 years prior to Platt. Drucker coined the move towards the information era in the term of "knowledge work (Drucker, 1957)". He continued his line of thought some 10 years later with the definition of a "knowledge worker" (Drucker, 1969) and another 30 years later with a statement that the most important single asset of 2000s for any institution is to make that knowledge worker more productive (Drucker, 1999).

Just as knowledge is a core asset for modern companies generally, economic development is dependent on the birth, success and growth of companies that can leverage on knowledge. The importance of SMEs' role in job creation has been recognized in various studies across contexts (e.g. Decker, Haltiwanger, Jarmin and Miranda, 2014; Yazdanfar and Öhman, 2018). In the Finnish context a company is categorized as a SME if it employs less than 250 people, has an annual turnover of less than 50 million Euros or has a balance sheet less than 43 million Euros (Finnstat, 2020). In addition, the SME should be independent i.e.

there is no single non-SME owner possessing 25 % or more of the share capital. SMEs constitute over 99 per cent of European business and are increasingly recognized as a job creation engine for Europe (Mandl and Ledermaier, 2017). SMEs may also be more resilient to low tide in macro environment than larger firms (Ando and Kimura, 2017).

Furthermore, the growth oriented SMEs that are based and dependent on knowledge and technology form a specific sub-segment among SMEs in terms of growth and wealth creation. SME population is heterogeneous and not all of SMEs contribute equally to employment growth. Several company elements (external and internal) influence the capability of job creation behavior of SMEs (Mandl and Ledermaier, 2017). Technology SMEs differ significantly from their more conventional counterparts in industries. Their presence indicates a significantly more favorable and longer-term impact on regional and national economies and labor market development (Keeble and Wilkinson, 2000). A study on EU-level shows that the less technology-intensive SMEs have faced sharper drop in their ability to employ in the low turns in economic cycles (Muller et al, 2015). According to OECD report SMEs and young firms that experience rapid growth impact significantly on employment creation and productivity growth, via their own innovations, heavy investments in the development in human capital and by creating new demand for advanced products and services. They also create knowledge spillovers of which other enterprises can benefit, and have effect on development of local entrepreneurial ecosystems (Cusmano, Koreen and Pissareva, 2018).

The choice of the technology-based SMEs as units of analysis in this study is justified by various viewpoints. Firstly, abovementioned societal importance of these companies motivates the research. Secondly, from the academic point of view, knowledge management (KM) has been extensively studied in large company settings. Corporate-type of companies have multiple divisions, departments as well as specific knowledge management related tasks, jobs and departments. There is smaller volume of research on how the KM concepts and processes are utilized in SMEs. The research community do has identified KM in SMEs to have its own challenges compared to the larger firms (Coehoorn, Van den Lustgraaf and Röling, 1991; McAdam and Reid, 2001; Calvo-Mora, Navarro-García, Rey-Moreno and Perianez-Cristobal, 2016; Strobel and Kratzer, 2017). Twongyirwe and Lubega (2018) conclude their review of previous KM research and model building for SME settings stating that innovative concepts, practices, technologies and methods in KM over the past two decades, have mostly focused on creation of dynamic knowledge repositories and exploitation of knowledge in large enterprises. Hence research had contributed to the understanding of the KM phenomena, however with limited emphasis in decision making in SMEs. Thirdly, since prior studies have indicated SMES to lack resources and process in managing knowledge in an efficient way, an increased understanding of the issue area is likely to have practical implications. Shin, Park, Choi and Choy (2017) state that the knowledge resource of a new firm increases the chances of survival and short-term success, so improvements in KM action pay off for newborn SMEs.

An update to the KM for SMEs frameworks is likely to be of need in the fast clock speed context where these companies operate (Fine, 1998). In addition, similar research setting has not been present in Finnish studies. The empirical data for this dissertation is coming from Finnish SMEs. Saarenketo, Puumalainen, Kuivalainen and Kyläheiko (2004) studied knowledge management issues among Finnish high-tech SMEs, but their work was focused on learning processes related to knowledge, and did not create a wider framework for KM in technology-based SMEs.

1.2 Research objective and research questions

This thesis set out to address the stated research gaps and thus contribute to the accumulation of knowledge in the fields of knowledge management, growth management, SME management and technology business. The findings potentially contribute to the managerial processes and decision-making in the target population – technology-based SMEs.

Mårtensson (2000) proposed that KM in organizations could be studied from three different perspectives: Focusing on knowledge held by individuals within organization, having knowledge itself as the center of interest or alternatively from the knowledge-based theory of the firm. This study does not see these angles as mutually exclusive: A modern firm needs to understand the nature and amount of knowledge it possesses as well as how the individuals and their cooperation within intra- and inter-organization arenas contribute to the KM.

The specific intention and interest of this research culminates in the concept of *dynamic knowledge management*. In technology business, management faces uncertainties and volatilities related to knowledge creation and acquisition (Kauffman, Liu and Ma, 2015). As a consequence of these volatilities timelines of individual products and solutions have shortened across industries (Trinkfass, 2013; Sabadka, 2013; Prostean, Prostean, Zeidert and Filip, 2018; Khan, Mittal, West and Wuest, 2018). Knowledge and its management have life cycles (Diakoulakis, Georgopoulos, Koulouriotis and Emiris, 2004). Taking these volatilities and uncertainties in account, research of time-dependent change of knowledge management processes in SMEs rather than depicting a static cross-sectional view is defendable. The definition of moderation states that a "moderator is any variable that affects the association between two or more other variables; moderation is the effect the moderator has on this association" (Dawson, 2014). In this study time and dynamic states of SME developments are seen as such moderators on KM in technology-based SMEs, directing the search for knowledge to depict a non-static framework.

The value and competitive position of a firm´s knowledge is not absolute but relative to the knowledge possessed by its competitors and to the future changes in the technology landscape. As Adomavicius, Bockstedt, Gupta and Kauffman (2008) comment, a problem for firms in their technology decisions is

to understand the effects of future technological advances on the value of present technologies. Similarly, Kauffman, Lobo and Macready (2000) address the question of how a current position of a firm in regards to the landscape of technological possibilities constrains or facilitates search for further technological improvements. Therefore, knowledge management in technology-based SMEs by definition should be non-static over time, and future-oriented – i.e. dynamic. The other element of knowledge dynamics is concerned with how a firm acquires, disseminates, transfers and exchanges knowledge across intra- and inter-organizational boundaries.

Research objective

This study aimed at creating a proposal for a new framework for dynamic knowledge management in the cohort of companies in scope, technology-based SMEs. New insights in the KM modelling were recognized to be of need, since the models produced by earlier research had gaps in addressing the critical element of time in them. In addition, earlier frameworks had a limited applicability to the scope of this study. Hence, the objective was to fill the gaps identified and contribute to the theory development in knowledge management via the framework proposal as well as to offer tools for knowledge management among practitioners.

Research questions

The resulting research question driving the thesis is:

RQ How to manage knowledge in technology-based SMEs?

To be able to answer the main question RQ as well as to elaborate on the answer ~~f~~or practical contributions, this dissertation aims at answering the following sub-questions:

RQ1 What are main driving forces and intervening factors to knowledge management in the technology-based SMEs?

RQ2 How do the intended outcomes and contents of the knowledge management process change over time in the growth trajectory of technology-based SMEs?

RQ3 What developments can be proposed for a dynamic knowledge management in technology-based SMEs?

1.3 Relationships of the included articles and their contribution to the whole

This dissertation proceeds by first examining the extant literature on the core areas of knowledge related to the phenomenon under study that gets then reflected in the initial KM framework that the author set to elaborate on. The empirical and conceptual contributions of individual articles are introduced and the summative conclusions and findings combined produce the key contribution

of the thesis – a proposal for a framework of dynamic KM in technology-based SMEs and its instantiations.

This thesis includes six original articles, each one adding with its specific focus (Figure 1) contributions to the research objectives. One of the articles (Article I) is published as a refereed journal article, one (Article VI) as a refereed book chapter and Articles I, II and IV as refereed conference papers and the conceptual Article III as a part of conference proceedings. The author of this thesis is the primary (Articles I-V) or sole author (Article VI) of the articles.

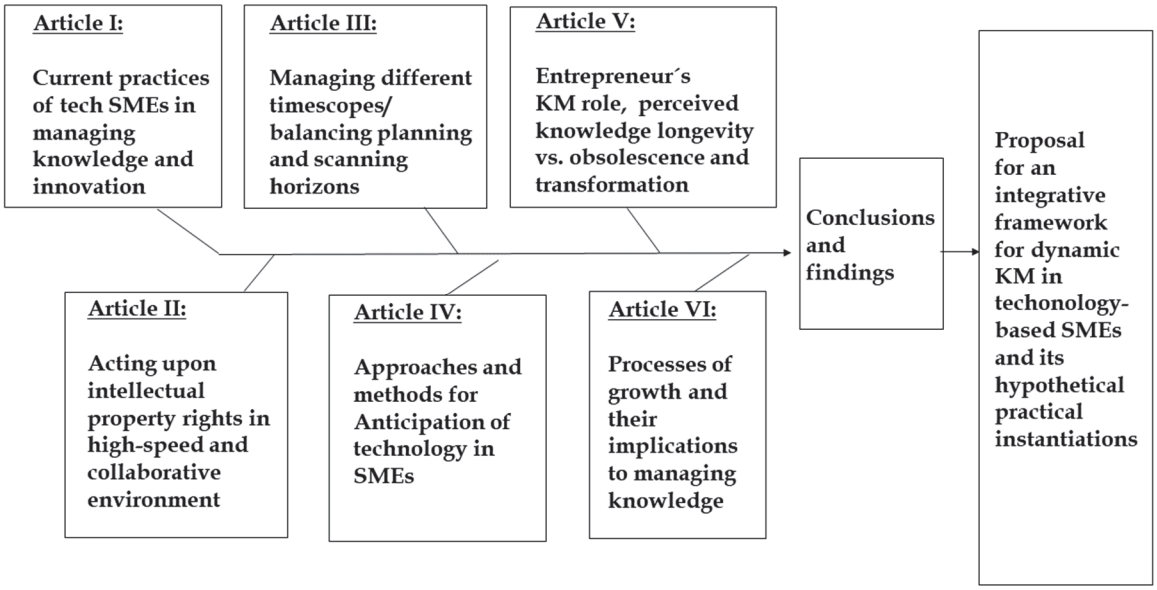

FIGURE 1 Original articles' main foci and their contributions to the whole

Article I lays the foundation to the study by analyzing the way technology SMEs, the scope of this research, currently conceptualize and operationalize their management action for both existing knowledge as well as novel knowledge sought. Article I identifies the current KM practices in technology-based SMEs as rather person- than purpose-driven and geared towards operational and internal dimensions at the expense of strategic and external orientation of KM.

The focus of Article II is on a crucial subset of knowledge artifacts in technology business, IPRs (intellectual property rights). Article questions the viability of current practices in the current business environment that stresses agility (ability to proceed with velocity) and ability to collaborate. Article II proposes incorporation of wider meta-knowledge on KM (knowhow) and propagates for deployment of wider scale of KM artefacts that better comply with current demands of high process speeds within collaborative environment.

Article III elaborates on the issue of temporal scopes of KM, discussing how the scanning (of future opportunities) and planning (of development of solutions based on existing knowledge) horizons could be combined in KM in technology business environment for SMEs. Article III concludes that the viable view when studying timespans of KM for technology-based SMEs is the temporal ambidexterity i.e. that the scanning and planning horizons exist in parallel but

their relative weights and tools usable vary between the different scopes, firm´s resource positions and types of the industry the firm pertains to.

The future horizon i.e. anticipation of technological changes and resulting opportunities is further studied in Article IV. The article identifies a large heterogeneity and relatively short timespans applied in the anticipation practices in technology-based SMEs.

Article V studied the stickiness, volatility and devaluation of entrepreneurial knowledge in early-stage technology-based SMEs. The resulting view was that as the firm and entrepreneurial firm and its key stakeholders proceed in their development trajectory, the knowledge base needs to be adapted (renewed and enlarged) to meet the demands met at the real-life operating environment.

Article VI presents the typical phenomenon for the companies in the research scope – growth - to KM processes. The impacts of growth to roles and contents of key individuals' role vs. move towards management systems are discussed in Article VI. Article VI also suggest a new two-cyclical model of SME growth, that supports the earlier findings of iterative nature of growth processes but also questions the division of development of technology SMEs to start-up and growth phases and, instead, suggest those firms should be seen as entities that are simultaneously operating in knowledge search and knowledge exploitation.

As a result of this additive process of the theoretical base and article contributions, the study offers its summative contributions by answering the research questions.

1.4 Structure of the thesis

This thesis proceed from laying out the foundations for the study (motivation, objectives and research questions) to reviewing the earlier research on the topic and observed gaps in it. The contributions of the author to fill the gaps observed are explained by first introducing the findings of individual articles and then consolidating them into an integrative framework and practical instantiations derived from it.

Chapter 1 of the thesis summarizes the base for the research by introducing the background, aims and context of the research and the quest for knowledge on the research area that the thesis seeks to answer. Chapter 2 introduces the theoretical foundations of the research via prior literature on issues relevant to the subject area. The chapter also depicts an initial framework the author set to expand. Chapter 3 familiarizes the reader with the research philosophy, approach and method choices and their justification. Chapter 4 includes the description of the goal and findings of the individual articles that form this thesis. The contributions of each article are introduced in form of PECs – Primary Empirical Contributions – or PCCs – Primary Conceptual Contributions (from Article III) as they contribute to the whole study. Chapter 4 concludes by

proposing a new integrative framework that addresses dynamic knowledge management in technology-based SMEs.

Chapter 5 discusses the contribution of theory-related PECs and PPCs to development to knowledge management research and theory. The chapter also summarizes the practice-related PECs/PCCs and discusses their takeaways to practitioners in the field in the form of hypothetical practical instantiations of the new framework. Chapter 6 concludes the research by clearly answering the research questions and discusses the quality and limitations of the study as well as points out directions for further research on the topic.

This dissertation includes six articles, where five of them have used single or multiple case studies or small samples of technology SMEs as objects of study. Original articles are to be found in the Appendices of this thesis. Figure 2 summarizes the path of proceeding of the thesis to address these quests for knowledge.

The research circle starts from the introduction at the top right of the vertical axis. The segments of the circle define the core contents of each step. The thesis proceeds step-by-step following the chapter and section order of the thesis. The arrows within the circle indicate steps where the previous chapter/knowledge area does not act as an input to the next stage immediately, but two or more earlier steps are combined in the integrative sections at later stage. Thus, the concepts and processes of knowledge and knowledge management (the second step) are joined with the concept of time-dependent moderators of development (third step) when indicating the research gaps and initial framework (fourth step). Likewise, the primary empirical and conceptual contributions (PECs and PCCs) are, in addition to their imminent impact on the next step of the proposal for an integrative framework, influencing the Discussion and Conclusions, as well as to the creation of hypothetical practical instantiations of the framework.

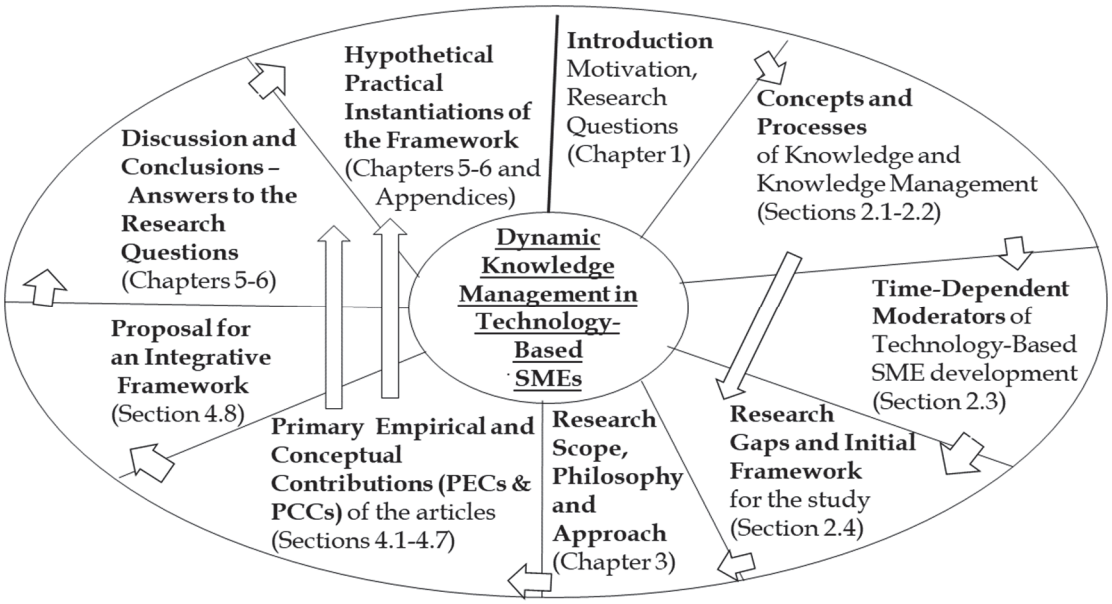

FIGURE 2 Structure of the thesis by themes and chapters

2 THEORETICAL BACKGROUND

The theoretical base for this thesis derives mainly from the extant literature of knowledge and knowledge management studies as well as from futures research. The knowledge base also includes considerations of growth and change management as the phenomena studied in those fields represent the time-dependent moderators for KM in an organization. The thesis operates at intersections of these streams of research as Figure 3 illustrates.

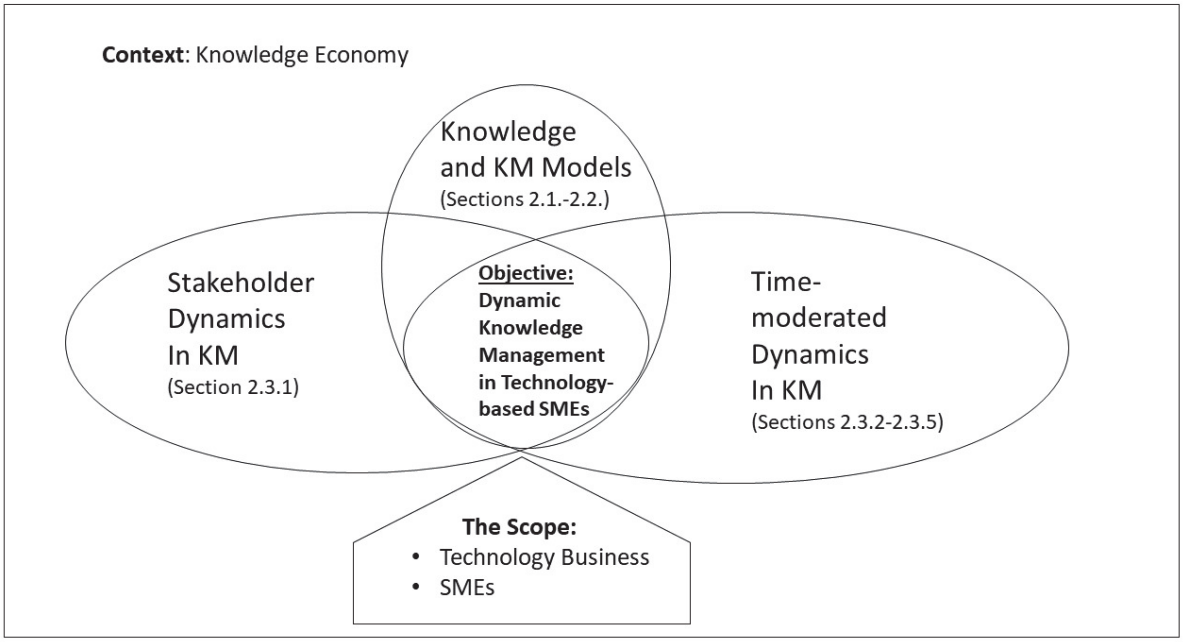

FIGURE 3 The research areas contributing to the knowledge base for the thesis

The current era has been widely described as era of knowledge economy. Powell and Snellman (2004) define the new economy as a system of "…production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence". Parallel concepts such Knowledge Capitalism (e.g. Burton-Jones, 1999) underline the key role of knowledge as a source of advantage and wealth. Knowledge is a fundamental asset – capital – for companies to succeed. The shift to the new era that stresses the importance of knowledge asset also has destructive capacity, since adjusting to the new environment can cause organizational crises (Freeman and Perez, 1988). Simultaneously, knowledge intensity creates new entrepreneurial opportunities via knowledge creation and resulting differentiated offer advantage (Moore, 2000).

The knowledge economy is also characterized by volatility. The era in which current firms operate could be called "wicked environments" (Haapasalo and Kess, 2001) that are characterized by uncertainty and call for new capabilities in both technological and behavioral issues and their combinations (Haapasalo and Kess, 2001). There is a non-static nature in knowledge - it is seen as a volatile asset for a company and its network. To succeed in the new and volatile knowledge economy environment characterized by uncertainties firms need two sets of differing capabilities. The first need is of operational capabilities for earning a living in the present (Winter, 2003). Second, a firm needs dynamic capabilities that allow a firm to purposefully create, extend and modify its resource base (Helfat et al., 2009). Dynamic capabilities lean on the principles of evolutionary economics and thus partly takes distance to resource-based view paradigms, that largely build on the limits set for a firms' s future by its current positions and paths of the past (Helfat et al., 2009).

An organization can widen its range and depth of capabilities via acquisition of capabilities and/or inter-firm knowledge sharing. These external sources of capability enhancement, once coupled with internal capabilities in knowledge development and knowledge deployment act as sources of competitive advantage, if the capabilities are cumulated, amplified and renewed for changing conditions.

One approach showing increasing yet still low volume of scholarly research is inclusion of futures research and foresight approaches into KM. The research so far (e.g. Kaivo-Oja and Lauraeus, 2017; Rechberg, 2018) has mostly laid conceptual reasoning why the futures-dimension should be incorporated into KM frameworks and agenda. Frameworks of such inclusion and empirical support for such models are largely lacking. Berry and Johnston-Jewell (2014) proposed an interlink in the opposite direction, proposing KM approach and practices have potential to improve futures foresight. Time-moderation (of futures) on knowledge and KM is thus a required dimension for framework building.

Oikarinen, Salminen and Mäkimattila (2012) point out that organizations who need to operate in volatile and uncertain environments with scarce resources, such as SMEs in the focus of this study, typically face challenging in

perceiving new insights that deviate from their past and present knowledge base. As CEN (2004b) summarized the importance of KM and change for SMEs:

- Knowledge in SMEs tends to be tacit/informal/not recorded
- Know-how in SMEs may not be valued highly enough
- Lack of knowledge and know-how may be hard to talk about in SMEs
- Short-term approaches to knowledge gaps may work sufficiently to make change appear unnecessary
- Know-how in an SME may easily be lost or fragmented when the owner sells the business or retires.

So there is a pragmatic need for frameworks that facilitate this combination of KM and foresight views and allows agile KM approaches that are still systematic vs. person-based.

Since KM as a research area is wide and well-developed, it is plausible to start the building of the new integrative framework for dynamic KM from models of extant literature and to modify them with empirical and conceptual contributions of the articles this study is based on.

The following Sections 2.1-2.3 introduce the key concepts and models of knowledge, knowledge management processes and stakeholders, growth, change and anticipation. The summative Section 2.4 addresses the research gap that motivates this study and presents a synthesis of earlier scholarly work as the initial framework the author set to elaborate on.

2.1 Knowledge and its relation to close concepts

The research on nature of knowledge and possibilities to understand, analyze and develop knowledge is faced with the dilemma stated by Polanyi (1966): "we know more than we can tell". If articulating knowledge is complicated, defining is a difficult task as well. Boisot, MacMillan and Han (2007) made a remark of both the importance of knowledge in today´s world as well as difficulties of elaborating on it: "With the rise of the knowledge economy, the knowledge content of goods and services is going up just as their material content is declining. Economic value is increasingly seen to reside in the former - that is, in intangible assets - rather than in the latter. Yet we keep wanting to turn knowledge back into something tangible, something with definite boundaries which can be measured, manipulated, appropriated, and traded. In short, we want to reify knowledge."

Prior to moving to build knowledge of knowledge management, a researcher needs to build a definition on what is included in the construct under study. This section introduces the ways knowledge is described in earlier research and consequently defined and made operational in this research. Also the relationships and differences of knowledge to related concepts get treated to clarify the paradigm of the thesis.

Ontology aims at telling us what exists. Blaikie (1993) defines ontology as the study of "claims and assumptions that are made about the nature of social reality, claims about what exists, what it looks like, what units make it up and how these units interact with each other." Ontology studies what we mean when we say something exists whereas epistemology is concerned with what we mean when we claim that we know something (Mack, 2010). Crotty (1998) defined epistemology as "the theory of knowledge embedded in the theoretical perspective and thereby in the methodology". The epistemological position assumes that there are ways of knowing of the subject existing, and thus methods can be chosen and applied to move from epistemology to research action. Together, ontological and epistemological assumptions make up a paradigm.

Since knowledge is a wide and multifaceted concept, various scholars have worked on dividing knowledge into sub-segments as well as making a distinction of knowledge to related concepts and showing their linkages to knowledge. Zack (1999) preceded the upcoming development of intellectual capital (IC) concept by dividing knowing into areas of: a) Know what (possession of knowledge artefacts: Data, patents etc.) b) Know how (processual competence) c) Know why (recognizing goals and paths to them) d) Know who (having in place the needed relationships) e) Know where (understanding the potential sources of added knowledge and application areas for the knowledge possessed).

Ambiguity over the distinction between what is information and what is knowledge has been a major source of difficulty (Mårtensson, 2000). Various scholars (e.g Zeleny 1987; Ackoff 1989) have worked on a hierarchical model of knowledge and near-by concepts called DIKW (Data-Information-Knowledge-Wisdom). The model was extended by Hey (2004) in to DIKIW (Figure 4) by introducing a layer of Intelligence between Knowledge and Wisdom elements. Various researchers have built on the DIKW taxonomies across application areas (Rowley, 2007; Baskarada and Koronios 2013; Cooper, 2014). According to Gamble and Blackwell (2001), knowledge can be described as information that has been processed further from sets of different information items such as experiences, values, contextual information and expert insight. For an organization´s development in DIKW/DIKIW hierarchy, achievements and quality of work done in one layer affect the layers that follow and thus enable better situational awareness (Yusof, Zainol, Zakaria and Ananthan, 2018).

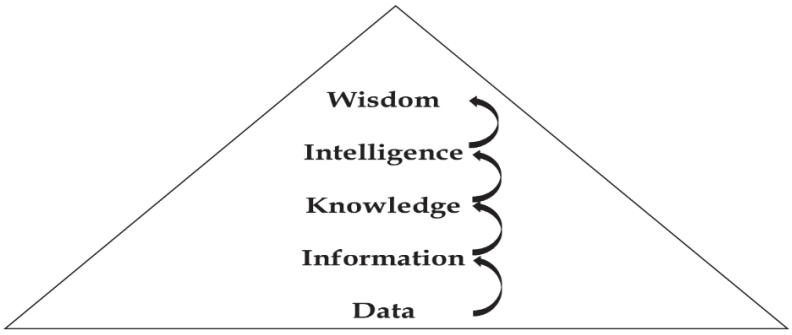

FIGURE 4 Data-Information-Knowledge-Intelligence-Wisdom hierarchy (adapted from Hey, 2004)

Rowley (2007) stated that the lines between the categories blur yet the differences need to be discussed and clarified. The recent rise of issue areas of Big Data, Business Analytics and IoT (Internet of Things) that multiply the amount of data and combinations has intensified the discussion of the relationship between data and knowledge. Concentrated business intelligence effort is seen to enhance the capabilities of a firm in their analysis, planning and decision-making. Chen, Chiang and Storey (2012) proposed that the emergence of Business Intelligence and Analytics (BI&A) has been of need for both practitioners and researchers, "reflecting the magnitude and impact of data-related problems to be solved in contemporary business organizations". As a response to the overwhelming amount and increasing accumulation of data processes such as automated knowledge mining applications have been proposed (e.g. Merolla et al., 2014; Zatsman and Buntman 2015). Advancement in information and communication technologies (ICT) and applications built on them has been accredited to offer advantage in business processes by improving efficiency and effectiveness in them and offering competitive advantage creation (Leem and Kim, 2002; Yoon, 2011). Information and communication infrastructure has been seen to play a vital role both in knowledge creation and dissemination. Watson and Wixon (2007) state that "business intelligence reduces IT infrastructure costs by eliminating redundant data extraction processes". These views contradict with the hierarchy of Hey´s (2004) DIKIW pyramid as they propose a direct link from data to intelligence.

As can be seen, definitions and descriptions of business intelligence tend to be incluce data and information layers. Critical or complementary voices in research (Brynjolfson, 1998; Melville, Kraemer and Gurbaxani, 2004; Mithas, Ramasubbu and Sambamurthy, 2011) have proposed that the true improvements in technology-based business process do not live up to their potential without the presence of other assets and capabilities within business processes. Gamble and Blackwell (2001) state the pyramid can even be partly inverted in some cases, as knowledge can also be made of a grounded intuition which can lead to derive new information and practices for the organization gaining knowledge.

Some data-focused researchers go to the extent of claiming that the knowledge holder does not have to be a human any more (e.g. Nefedov, Pavlikovsakya and Afanasev, 2018) while others stress the importance of human agents in the conversion of data to information and further to knowledge. Martìnez-Caro, Cegarra-Navarro, Garcia-Perez and Cepeda-Carrión (2018) claim that it is the combinatory capabilities in technological assimilation, absorptive capacity and organizational agility that need presence of each other element to fully affect a firm's performance. Botha (2018) concludes that technology has reshaped knowledge work and will continue doing so. Information capture and codification will be automatized, but that in turn frees up knowledge workers' time and energy to focus on production of providing personalized and conceptualized data. This will "make provision for sharing and leveraging knowledge above and beyond the cyberspace" (Botha, 2018).

These relationships and sharing are often embedded into models of knowledge and its management. Meta-knowledge i.e. knowledge on knowledge

helps the acquirers of new knowledge to improve the ways they learn, thus facilitating transfer from one application domain to new ones, and finally enabling them to learn more and more autonomously (Paquette, 1999). Thus, knowledge is dynamic over time, but also dynamic over boundaries of individuals and organizations, since knowledge emerges from social interactions amongst individuals and organizations (Nonaka, Toyama and Konno, 2000). In the SECI model of knowledge by Nonaka and Takeuchi (1995) knowledge is created in the moves between stages of Socialization, Externalization, Combination and Internalization. During this process the knowledge transforms from tacit to explicit (from non-codified to codified) and back. Knowledge also is context-specific, as it depends on a particular time and space, as was noted by Hayek (1945) already in the early stage of organizational knowledge research.

One stream in recent knowledge management research has been focusing on the intellectual capital (IC) of the firm. IC has been further divided into:

- relationship capital (Edvinsson and Malone, 1997; Nahapiet and Ghoshal, 1998),
- human capital where knowledge is the sum of intellectual skills, education, knowledge of its stakeholder individuals,
- structural capital in firms' structure and process to act on and for knowledge, renewal capital in terms of innovative solutions (e.g. Kianto, 2008),
- trust capital embedded in firm´s relationships for sharing and cross-utilizing mutual knowledge (e.g. Mayer, Davis and Schoorman, 1995),
- entrepreneurial capital in terms of capabilities and mindset related to entrepreneurial activities in the firm (e.g. Erikson, 2002).

On the other hand, Reed, Lubatkin and Srinivasan (2006) do not agree on the idea of Intellectual capital as an overarching umbrella term, but claims that IC is a mid-range term that tries to capture three separate types of knowledge-based resources: Human, Structural and Relational Capital.

This thesis is built on a paradigm derived from the frameworks reviewed above. The definitions of knowledge and its elements in the previous research that have given insight into this research are summarized in Table 1. The ontological stance of this study is that knowledge is an ability and a process of an individual and organization (and the networks they form) to utilize information and capabilities in a relevant way for their business activity and context. Knowledge partly resides and is utilized in interactions inside and across firm boundaries. Knowledge is not seen to be originate solely from data and thus limit what information and knowledge a firm can have. Still, information arising from data can play a role in knowledge creation. Likewise, information and communication technologies systems as instruments of knowledge creation and dissemination are outside the scope of this research. The epistemological position taken assumes that by studying the views, actions and experiences of key persons that have access to, as well as responsibility for, knowledge processes and knowledge-related artefacts in their organizations, understanding of knowledge and dynamic processes on it in the target population can accelerate.

TABLE 1 Definitions of knowledge and related concepts with their contributions to the thesis

Core tenets	Contribution to this study	Key sources
Knowledge division: (Know) What, How, Why, Who	Artefacts, Processes and Actors in KM interact	Zack (1999)
Data=>Information=>Knowledge (=> Intelligence => Wisdom) hierarchy Business Analytics and Intelligence enhance knowledge creation	Data differs from knowledge but supports it via supply of information	Rowley (2007); Watson and Wixon (2007); Botha (2018); Chen et al. (2012)
Knowledge created in social interactions	Role of intra- and interfirm knowledge exchange	Nonaka and Takeuchi(1995); Nonaka and Nishiguchi (2001)
Knowledge is made of separate knowledge assets that interact:	A portfolio view of firm´s knowledge: Knowledge contents, processes, infrastructure and knowledge culture	Birchall and Tovstiga (1999;2002)
Intellectual Capital consisting of Human, Relationship, Structural, Renewal, Trust, Entrepreneurial Capital	Focus on elements most associated with KM dynamics: Relationship, Structural and Renewal capital	Erikson (2002); Reed et al. (2006); Kianto (2008)

2.2 Knowledge management

Knowledge management (KM) is a widely used and extensively researched issue in management science of 2000's. Demarest (1997) coined the term as a "systematic underpinning, observatism, measurement and optimization of company's knowledge economies". CEN´s (2004) definition sees KM as a *"purposeful management of activities and processes for leveraging knowledge to keep and improve competitive positioning by using well individual and collective knowledge resources of the firm and its stakeholders"*. Systematic knowledge management constructs an important fundament for competitive advantage in the knowledge economy (Czarniewski, 2014) yet it is not always clearly visible in the organigrams of firms. In some frameworks (e.g. Suresh and Mahesh, 2006; Mahesh and Suresh, 2009) knowledge management has been proposed to take more expressed organizational role e.g. by creation (or at least recognition) of specific knowledge units or roles such as chief knowledge officers. Some other models stress the multiparty and multifunctional nature of knowledge management in a modern company.

2.2.1 Processes of knowledge management

Most KM definitions and frameworks are founded on a process view that is further divided into sub-processes (Castañeda and Ignacio, 2015). The frameworks aim at shedding light on how knowledge is created (continuously), stored, utilized and shared. The models mostly put up a resembling sequential order of the sub-processes, but e.g. the definition by Lin (2014) lists protection of knowledge as the last element. One can argue that protection would be too late if it has not been applied already in the earlier stages to a certain extent. Different studies have addressed the relative weights of the sub-processes within KM systems, but these findings are typically context-bound and situational and thus no generalizations of them can be drawn.

The main stage-based models have much in common. They typically include stages of creating, storing, protecting and disseminating knowledge. There are also some discording views (e.g. Dickel and de Moura, 2016) who state that knowledge management and innovation management are separate streams (Figure 5). The division of Dickel and De Moura however contains processes that most scholars place under the same term of knowledge management and that in practice would overlap. The model by Dickel and de Moura (2016) serves in depicting that abilities and processes of creation of unique new knowledge (innovation) as well as managing knowledge further are required for business performance. Accordingly Alegre, Sengupta and Lapiedra (2013) claim that "KM dynamic capabilities act as a mediating variable between KM practices and innovation performance". Thus, innovation (search and creation of new knowledge) management is rather a part of KM than a process parallel to it. Table 2 summarizes the knowledge management categorizations in the earlier literature on dividing knowledge management into its sub-processes.

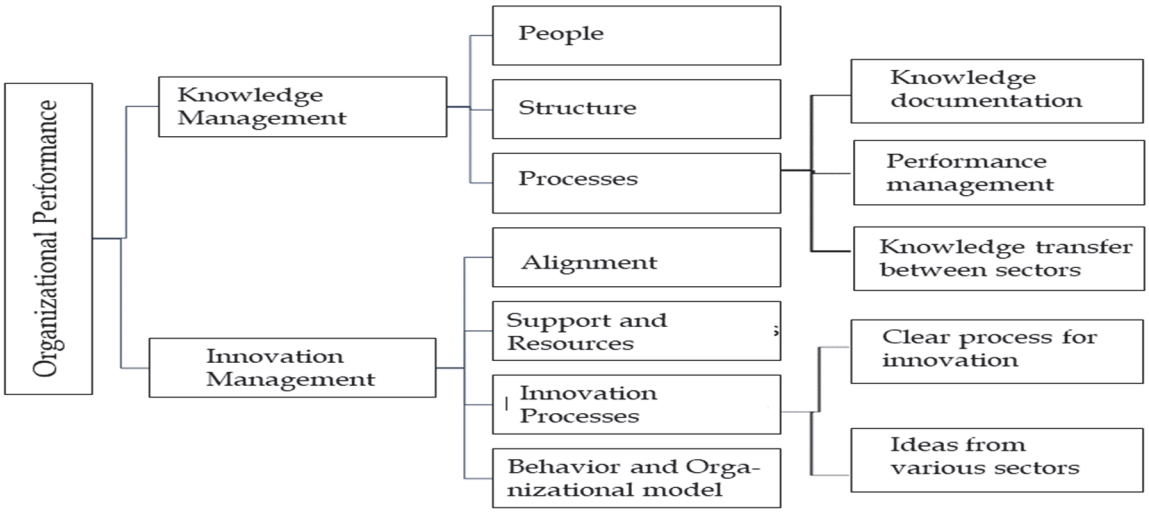

FIGURE 5 Structural model of innovation and knowledge management processes - adapted from Dickel and DeMoura (2016)

TABLE 2 Sub-processes of KM as in earlier literature

Key sources	KM sub-processes
Nonaka and Takeuchi (1995)	Creation, access, dissemination, application
Wiig (1997)	Creation, maintenance, renewal, organization, transference
Liebowitz (1999)	Identification, capture, storage, sharing, application and selling
Alavi and Leidner (2001)	Creation, storage, retrieval, transference, application
Lin (2014)	Generation, access, facilitation, integration, embedding, application, transfer, protection
Castañeda and Ignacio (2015)	Creation, acquisition, documentation, storage, electronic transference, face-to-face sharing, use, reuse
Dickel and de Moura (2016)	Cross-sector ideation, innovation process, documentation, performance management, cross-sector knowledge transfer

This study uses the framework in which both the actions on knowledge that already exists and on knowledge not yet created are included in the knowledge management process. The two streams coexist in the majority of KM process models in prior studies. Also in the context of this study, growth aspiring technology-based SMEs the two are intertwined in practice. The second conceptual layer of Dickel and DeMoura (2016) model contributes to this study as it proposes the elements that could be studied: 1) People (individuals) 2) Structure (teams, departments, organization, networks) and its alignment 3) Resources 4) Organizational behavior and culture 5) Processes combining the aforementioned elements. This is in accordance with the view by Simone (2011) who links organizational dimensions of knowledge and the enterprise in two distinct ways.

According to Simone knowledge management means: 1) Orientation and culture that favors knowledge as a value and 2) operational mechanisms that support knowledge processes (tools, reward processes etc.). Thus, there are contextual factors such as the structure and culture of the industry and of the firm as well as processes and actions within those contexts where KM takes place. These processes performed by knowledge actors and actions are assumed to be simultaneous and iterative in a modern firm. An organization does not possess just a single state and studies on organizational processes can indicate the different prevailing states of certain processes and/or subsystems (Dooley and Van de Ven, 1999). This versatility and simultaneousness of knowledge processes and actions suggests seeing a firm as a collection of resources, actions and outcomes (like artefacts) of the knowledge management. Birchall and Tovstiga (2002) propose to assess the knowledge portfolio of a firm in terms of four domains - content, process, infrastructure and culture.

This view of modern innovative enterprises as non-linear complex systems fits the population of this study, technology-based SMEs. As Cheng and van de Ven (1996) point out, seemingly chaotic patterns in these innovative processes do

have a hidden order consisting of relatively simple nonlinear dynamic systems with a limited set of variables, proposing that there are processes that can be identified, studied and to a certain extent replicated even in the volatile context.

2.2.2 Stakeholders in knowledge management

Can firms know something, or create? Sanin and Szczerbicki (2008) propose that a company can build up a decision-making DNA by implementing a Smart Knowledge Management System. The advocates of the "nexus of contracts" theory (Jensen and Meckling, 1976; Easterbrook and Fischel, 1989) assert that companies can be considered as a collection of contracts between different internal and external parties. Thus they are unable to create knowledge above those contracts. In the opposing approach, human is taken as the knowledge actor and knowledge management is built up from an individual hierarchically: to teams, departments, functions and finally the whole company.

In the units of analysis of this study, growth-aspiring SMEs, in the early phases of the firm evolution the key individuals´ knowledge may largely equal to firm´s knowledge. Both Hedlund (1994) and Mentzas, Apostolou, Young and Abecker (2001) categorize KM to consist of four dimensions or "arenas": There are Personal, Team-Level and Organizational-level as well as Inter-Organizational levels within KM. Yiu, Sankat and Pun (2013) add the technical layer. Mentzas (2004) proposes a knowledge asset framework that aims at depicting how these different layers interact and meet in the full-scale KM implementation. In their model (Figure 6), the core element is the knowledge assets affecting the other set of elements: structure, systems, processes and strategy of the firm. All these have an effect on all hierarchical layers of operating environment: Individual, Team, Organizational and Inter-Organizational layers.

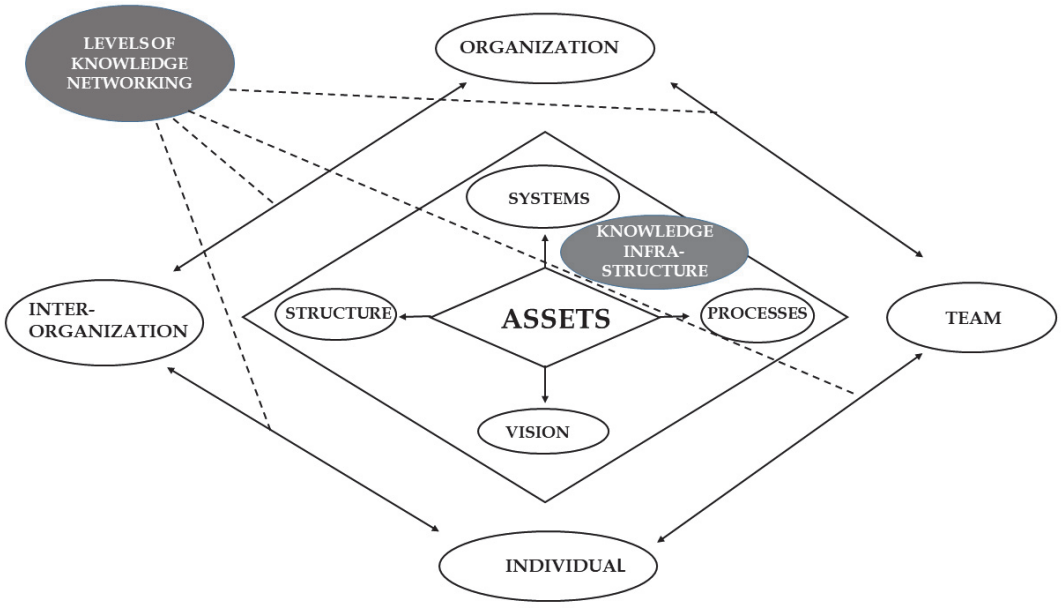

FIGURE 6 Holistic knowledge asset framework (adapted from Mentzas, 2004)

The depiction and definition of KM by Mentzas (2004) include some overlapping of elements in the model, since the knowledge asset is defined as an entity that creates, stores and/or disseminates knowledge object". In the model of Mentzas (2004):

- A person is a knowledge asset that can create knowledge objects like new ideas, learnings, proposals, white papers etc.
- A community of interest is a knowledge asset that creates new ideas and best practices.
- A process is a knowledge asset that can create store and disseminate practices, standards and R&D objects.
- A vision can be a knowledge asset that creates mission statements, strategic plans and goals.

The holistic model by Mentzas serves for this study by making a difference between concepts of knowledge assets and objects, the latter being caused by the previous, as well as presenting different hierarchical levels as knowledge assets instead of just knowledge contexts.

One of those organizational assets, core individuals for KM have drawn an ample body of research interest. Key individuals in an organization play a crucial role in their capability and motivation for knowledge management (Muhammed, Doll and Deng, 2008), up to the point where Peschl (2018) states that "the innovator becomes his/her innovation due to personal change". Also the presence of a specific Chief Knowledge Officer (CKO) in a firm supporting knowledge-related processes and facilitate the success of knowledge management have been proposed (Davenport and Prusak, 1998; Bell de Tienne, Dyer, Hoopes and Harris, 2004; Liu, Tsui and Kianto, 2018). Human asset quality (both general and firm-specific) may associate with the specific growth achievements via internationalization (Almodóvar, Verbeke and Rodríguez-Ruiz, 2016). The human asset impact covers also other than the managerial levels of the firm, thus knowledge capabilities and processes are needed to move the outcomes of human capital assets across internal boundaries of the firm. Similarly, Barile, Saviano and Simone (2015) conclude that to foster innovation and competitiveness both the firm and individuals in it need to possess "T-shaped" knowledge capabilities i.e. deep, specified competences and wide, combinatory (dynamic) capacities.

Defining knowledge that is relevant for the company is challenging. Root-Bernstein et al. (2013) note that relevant knowledge for entrepreneurial efforts may contain elements that are at first sight rather distant to what the entrepreneurial firm produces and sells to the market. While having individuals with unique knowledge and motivation is fundamental for a knowledge-based firm, creation of a wider knowledge pool is embraced as a way to enhance knowledge management by creating a synthesis of individuals' specific knowledge within specific situations (Alavi and Tiwana, 2002). The entrepreneurs and companies who identify and utilize allies to create larger knowledge reservoirs are more likely to survive (Gonzalez, 2017) and more able to assess the value of new information and opportunities sometimes via

constructive dissent in the collaboration (De Dreu and West, 2001). These joint knowledge pools have been called as Communities of Practice (Wenger, Snyder and McDermott, 2002; Jørgensen, Edwards and Ibsen, 2018) characterizing the intra- and inter-firm actors who jointly deepen their knowledge and expertise by interacting on an ongoing basis. The concept of firm´s knowledge portfolio (Birchall and Tovstiga, 1999; 2002) proposes a map that points out where knowledge resides in the firm and what are the key knowledge processes as well as how knowledge flows between processes and between people.

Knowledge sharing processes are often plagued with difficulties in them. Vestal and Danneels (2018) found that R&D teams whose inventors hold different technological knowledge possess a greater variety of perspectives and ideas, which increases teams' potential to create higher quality inventions. However, effectively sharing and integrating technologically distinct know-how is difficult. If the knowledge sets are too distant or too close, the bridges between them are non-doable or non-existing (Vestal and Danneels, 2018). The barriers to knowledge creation can be both organizational, e.g. lack of leadership and recognition + monetary fairness, as well as individual, e.g. lack of trust between individuals and lack of expressive ties (Anand, Csepregi and Bogdány, 2018).

Sung and Choi (2012) studied the effects of Team Knowledge Management (TKM) to firms creativity (knowledge creation) and potential association to financial performance of the firm. Team´s knowledge stock and knowledge utilization did not have a significant direct relationship financial performance, but marginally significant indirect effect on financial success. This effect was caused by the interaction of these team characteristics and the systematic cognitive style of the team leader, proposing that the different layers of knowledge stock (individual, team, management) need to be aligned to make an effect on performance.

Thanasopon, Papadopoulos and Vidgen (2016) studied teams working on high uncertainty stage of innovation process (fuzzy-front-end). Their study indicated a strong relationship between the team´s openness competence and the reduction of uncertainty, i.e. turning to other holders of information (e.g. a technology-driven team gathering market information) is likely to improve the results of the innovation process. This confirmed the earlier proposal of Ray, Barney and Muhanna (2004). However, Mercado Salgado, Cernas Ortíz and Nava Rogel (2018) state that despite the whole idea of relational capital is built on collaboration, that action is affected by emotional factors such as trust between the network members. Thus, knowledge sharing processes should not be configured or practiced merely on assumptions of rationality.

The spread of knowledge within the organization is one parameter that defines the low or high value in knowledge extraction. In the AKRI-model knowledge points towards low-value category if a clear minority of the employees share it (Piri, Zahedi, Goodarzi and Mohammadpanah, 2020). The other parameters in AKRI- model defining the risk that the firms may bear in its knowledge domain are e.g. the importance of the knowledge in question, complexity of the knowledge sharing and the knowledge type that may be explicit or tacit (Piri et al., 2020). Methods such as Lessons Learned and AAR

(After Action Review) that are institutionalized and individualized codified mechanisms work well for sharing of tacit knowledge, which is of high importance and low complexity (Azizi, Rowlands and Haass, 2018). For sharing of knowledge not easily recordable or documentable due to its high complexity, interaction-based institutionalized and individualized mechanism are more commendable.

Adding the division of knowledge by actors (Individual, Group, Organization, Inter-organization) into types of knowledge to be shared - articulated vs. tacit knowledge (e.g. Nonaka and Takeuchi, 1995) - further complicates successful system-wide knowledge management since operative arrangements differ in all of the cells in this type of 8-cell matrix (4 layers * 2 types of knowledge). When looking at the extremes of the continuum, there are needs to act on tacit knowledge of an individual as well as on explicit knowledge between organizations. Hedlund (1994) saw that the traditional M-form (M for Multidivisional) organization was not well suited to the new "multiarena" and knowledge-intensive management, and as a response to the demands of the time he proposed a N-form (N for New/Novelty). The principles he set for a new type of organization better suited to the era of knowledge economy were:

1. Putting things together i.e. combining instead of dividing.
2. Temporary constellations of people and units.
3. The importance of personnel at 'lower' levels in dialogues, rather than coordination from the top.
4. Lateral communication and dialogue instead of vertical.
5. Top management catalyzing, maintaining and developing architecture of communications infrastructure and protecting knowledge investment
6. Focusing on areas with potential for combining knowledge elements.
7. Heterarchy as the basic structure instead of hierarchy.

The N-form type of organization is likely to picture a technology-based SME better than the M-form, yet it is not guaranteed that action follows the natural starting point for such a company, of which Anand et al. (2018) suggest that smaller size and proximity of people create stronger ties.

The concept mentioned in Hedlund´s point nr 7 – heterarchy – has not been widely used in managerial research and literature. The amount and intensity of network research seems to have pushed heterarchy into a lower hand position. The definition or heterarchy by Aime, Humphrey, DeRue and Paul (2014) captures something essential of how modern firms work and the way knowledge reshapes within them: power heterarchy –paradigm sees teams as relational systems in which the relative power among members shifts over time. The resources of specific members become more relevant (and the resources of other members less relevant) due to changes in the situations and tasks (Aime et al., 2014). Widening the scope of heterarchy to company departments/functions or to companies that collaborate, the volatile and contextual nature of modern knowledge management can be captured.

TABLE 3 Summary of models of stakeholder participation and interaction in KM

Core tenets	Key sources
Personal, Team-Level, Organizational- and Inter-Organizational levels within KM	Hedlund (1994); Mentzas et al. (2001)
Crucial role of key individuals for KM	Muhammed et al., 2008; Sung and Choi (2012)
Necessity of knowledge pool widening	Alavi and Tiwana (2002); Gonzalez (2017); Vestal and Danneels (2018)
Difficulty of knowledge sharing	Mercado Salgado et al. (2018); Vestal and Danneels (2018)
Need for mechanisms for interaction (internal and external parties)	Piri et al. (2020); Azizi et al. (2018)
The (relative) resources of KM stakeholders shift over time	Hedlund (1994); Aime et al. (2014)

Table 3 draws together the key contributions of earlier research related to stakeholder layers, roles and interactions between them. These core tenets of earlier research acted as inputs to the initial framework in terms of stakeholder intrecation that the author of this thesis set to elaborate on.

This thesis builds on the findings of earlier research that in order to understand knowledge management in technology-based SMEs, different organizational layers from individuals to teams and further to external partner companies need to be studied. The core individuals, typically entrepreneurs/start-up team members are assumed to have a larger role than managers in larger companies. The study assumes that knowledge sharing and collaboration are important in the studied type of companies, yet they also bring challenges to the firm (e.g. trust and risk issues). Another core assumption adopted for this thesis is that the roles and relevancies of knowledge actors are contextual and situational, dependent on the development state of the SME as well as the tasks of knowledge process in hand. These dynamics over time are discussed in more detail in the following section.

2.3 Dynamics in knowledge management

Adding dynamism to the KM paradigm widens the scope in which the knowledge management needs to be performed. Dynamics in this research refers to variation of type, goals, direction, artefacts and stakeholders in the KM activity as technology-based SME evolves over time.

The theme of dynamism within KM discussion in itself is not new. Already in 1998 it was remarked that successful KM and organizational learning and knowledge transfer are interactive, ongoing, and dynamic processes that cannot be assumed to act on a static body of knowledge (O'dell and Grayson, 1998). The discussion of dynamics of young, growth-oriented companies and entrepreneurship as a whole is not a new phenomenon, yet foci of the study in

dynamics has varied. Dynamics have been treated in relation to opportunity recognition (e.g. Sarasvathy, 2001), innovation and product development (Van de Ven, Polley, Garud and Venkataram 1999) and in the overall models of growth of new and small organizations (e.g. Greiner, 1972; Wickham, 1998). Thomas, Sussman and Henderson (2001) claimed that learning within the company and its network becomes "inexorably entwined" with the understanding processes that facilitate sensemaking. In these processes, relevant learning becomes dynamized over time, as it requires new and highly interactive forms of transfer and transformation. Castaneda, Manrique and Cuellar (2018) reported in their meta-analysis of organizational learning and knowledge management literature that the two fields have started to include each other´s vocabulary. The time-bound relevance of knowledge artefacts and knowledge processes in the development trajectory of a firm is recognized as an area that is worthy of additional study.

2.3.1 Knowledge dynamics between stakeholders

The dimension of equilibrium (as part of considerations on dynamics) is concerned on how the knowledge is (or is not) shared within a system. Research has indicated that moving knowledge between actors within a system enhances new business creation via knowledge spillover. New knowledge that can be commercialized emerges from knowledge spillovers that foster innovation and growth in industries (Audretsch, Keilbach and Lehmann, 2006; Acs, Braunerhjelm, Audretsch and Carlsson, 2009). Knowledge spillovers carry an "opportunity-enhancing logic": New knowledge through academia, companies and networked industries is an important incentive for firms to cluster and work together (Acs et al., 2009). The counter effect is that dissemination of the knowledge that its proprietor would rather keep and control can be spread more easily in the dynamic environment. Firms active in knowledge search and exchange across industry boundaries have been coined with the term of knowledge brokers (Hargadon, 1998).

The discussion of clusters has been to a certain extent been replaced by elaboration on business networks/business nets (Powell, 1990; Möller and Svahn, 2006) or value constellation systems/value nets (Parolini, 1999). These directions of business research and development reflect the general societal move towards networked type of acting (Castells, 1996). Firms in a modern operating environment cannot create innovations or systemic product offerings alone, because knowledge and technological resources are dispersed within value nets/value system (Möller and Svahn, 2006). A managerial response to this dispersion is knowledge transfer and joint creation of new knowledge through networking both horizontally as well as vertically (Kogut and Zander, 1992; Möller and Svahn, 2003; Powell, Koput and Smith-Doerr, 1996). Inability to tap into other network actors' knowledge may lead e.g. an science-based innovator to fail in the product launch or target cost reach if wider knowledge pool leading to proceeding in the technology readiness level (TRL) and manufacturing readiness level MRL cannot be operationalized (Ballard, Levie, Nukari,

Saukkonen and Suhr, 2013). As De Michelis (in Nonaka and Nishiguchi, 2001) points out, knowledge creation is a principal factor in the increase of the value/cost ratio of a cooperative process since it can enhance the ability of participants to deal with complexity in the early stages of the innovation process by understanding the challenges from multiple angles.

The underlying dilemma of knowledge dynamics between different actors in the business ecosystem is coined in the I-space model by Boisot, MacMillan and Han (2007) proposes that the value of information that is abstract, non-codified and non-diffused (to anyone else or at least enough of them in the relevant network) is unable to reach its full value potential. But so is also knowledge that is spread to all, as it no more allows control of it nor competitive advantage built on it. In short, managing knowledge dynamics within a business system is a delicate act calling for strategies and process framework for knowledge. The choices of knowledge management elements (artefacts, actions, stakeholders) need to take place in the correct mode and time in relation to firm´s goals, resources and position within a business system. Choi and Lee (2003) found that this type of dynamic method is one option for KM style (different to system-, human-oriented, and passive styles). Dynamic KM style is characterized by both knowledge reachability via information technologies and knowledge sharing via informal discourse between employees.

2.3.2 Time-dependent knowledge dynamics

Knowledge management has been a sub-topic in various models of SME growth, like in the stage-based model from Marmer, Herrmann, Dogrultan and Berman. (2011a) or the model by Levie and Lichtestein (2010) that picture an entrepreneurial firm as an organism moving between *dynamic states*. Levie and Lichtenstein depict that the concept of dynamic states describes the firm evolution better than the earlier theories on sequential and well-definable stages. Those dynamics states are typically open (Ashmos and Huber, 1987) as well as complex adaptive systems (Axelrod and Cohen, 2000) where a constant and altering flux of resources including knowledge is omnipresent. Thus, discussion of the role and value of knowledge of a firm should include the time dimension.

The time dimension in new business creation is not a new topic of interest. The importance of time-to-market of new products as a factor of competitive advantage is widely recognized (Afonso, Nunes, Paisana and Braga, 2008; Griffin, 1997). Griffin (2002) analyzed the relationship of time-to-market with the use of multifunctional teams and the use of formal processes of new product development. Multifunctional teams operating with differing sets of knowledge were associated with significant reductions in the development cycle time for new products. They also showed higher degree of originality. On the other hand, formal processes associated with the largest reductions in the development cycle time of complex products (Griffin, 2002). Thus, knowledge sharing practices affect the time the new product development takes (Griffin, 2002; Hong, Doll, Nahm and Li., 2004).

The need to adapt to time-to-market pressures along with market, technology and competition volatilities has been a driving force of methods and tools aimed to cope with these accelerated speeds. This is true in software development, a subcategory of technology business in the focus of this thesis. For the software industry, these approaches are labelled as agile approaches. However, it has been stated that there are misconceptions and disagreements in organization what agility truly is (Laanti, Similä and Abrahamsson, 2013), what it demands from organizations (Appelo, 2011) and what it brings to the organization (Kontio, Höglund, Ryden and Abrahamsson, 2004). Agile methods can reduce cycle times of development processes and deploy a wider pool of knowledge to seek a viable solution to the challenge (Abrahamsson, Salo, Ronkainen and Warsta, 2002; Abrahamsson, Warsta, Siponen and Ronkainen, 2003). Agile collaborative approaches become complex systems to manage, and make those systems prone to various risks related to the aim of speed and distributed nature of work, which is hard to manage in commitment, coordination and communication. Furthermore, acting in an agile way demands of reconfiguration of roles, responsibilities and attitudes of the people.

To summarize, knowledge and its management vary in amount, action, type and value across points in time. The view of Bratianu (2007) is adopted: "Time means more than just intervals elapsed between different moments or stages of some considered processes. Time has direction, from past toward present and from present toward future". This time-dependent change is called "dynamics" in this study.

2.3.3 Embedding anticipation into knowledge management

Knowledge for a company may include concrete knowledge artefacts (conceptual or material) or objects such as practices, ideas, models, representations (Paavola and Hakkarainen, 2009). Bell (2003) proposes as objects 'dispositions' to future, situations that may become actual if they are properly activated. Thus, knowledge management should include goals and practices for acquiring potentially relevant information that may materialize in the future i.e. anticipation. Anticipation is a close term to the foresight process that is a "joint effort of stakeholders to explore futures and interpret them to present actions" (Dufva and Ahlqvist, 2014). This interchange of ideas and interpretations requires processes and tools such as technology roadmapping (TRM), radical technology inquirer (RTI) and technology radar (TR). Key principles of anticipation by Poli (2014) state that:

- anticipation is concerned with calculable risks and incalculable uncertainties
- distant futures and future in the present differ; the latter one refers to the future as projections of the past and former one to "proper" anticipation
- recognition of both continuous and discontinuous futures
- systems and organizations vary in their capability to use futures.

The stance an organization takes to anticipate affects its knowledge management process, since there is a cognitive effect to the organization in addition to the primary utility function of providing relevant knowledge to management for decision-making (Boe-Lillegraven and Monterde, 2015). As Peschl (2018) states, novelty is not that much a projection of our own ("out-of-the-box") ideas or past experiences (Grisold and Peschl, 2017) into the future, but rather the future potentials can teach and attract us (in the sense of final cause or emerging purpose). By that process *future is co-created* in a process of joining, making use of the dynamics and shaping the process of reality that unfolds.

In the concept of innovation funnel (Flynn, Dooley, O'Sullivan and Cormican, 2003) a company proceeds from a large to a decreasing number of ideas and opportunities to be included in the final solution brought to the market. This shorter-term and narrowing type of process has been described as the planning horizon for a firm (Kuusi, Cuhls and Steinmüller, 2015). The scenario funnel introduced by Gustafsson, Kuusi and Meyer (2015) operates in reverse: the farther we look from today´s towards the future, the more possibilities open up. Kuusi et al. (2015) call this mode of anticipation as a firm´s scanning horizon. Müller (2012) used the metaphor of "continuous branching in the landscape" when describing this opening and widening funnel.

The decreasing uncertainty inside the innovation funnel and increasing uncertainty inside the scenario funnel may favor short-term views. Some research findings do indicate imbalance in the behavior of start-up companies favoring shorter term – the planning horizon - over longer-term – the mapping/scanning horizon. Despite the importance of exploitation (using identified knowledge) and exploration (searching for relevant knowledge for future), companies face the trade-off between the two due to limits of managerial attention and organizational resources (Yan, Yu and Dong, 2016). Most organizations concentrate on exploitation while investing less effort in exploration. (ibid.) However, this imbalance is potentially self-destructive, as organizations are exposed to the risk of obsolescence and loss off competitive positions in future markets (March, 1991). In the same vein, organizations that engage in endless and widest possible exploration – also called shotgun sampling in technology anticipation by Fleming and Sorenson (2003) - will suffer from considerable uncertainties and will finally exhaust their resources (Auh and Menguc, 2005). Kuwada (1998) suggests a systematic processual approach for organizational learning, making a note of continuous approach to map out these discontinuous environments and discontinuous changes taking place in it.

Thus, it is important for organizations to develop organizational ambidexterity related to time for gaining and sustaining competitive advantage. Some early work on this temporal ambidexterity (for new ventures) has been put out by Wang, Luo, Maksimov, Sun and Celly (2019), proposing that firms can develop capability to demonstrate simultaneous and strong commitments to actions with both short and long term implications.

2.3.4 Growth in technology-based SMEs

A phenomenon or a character often linked to technology-based companies is growth. This concept has various interpretations and models in economics and entrepreneurial research. As Brenner and Schimke (2015) put it: growth is a complex and heterogeneous process. It contains multiple individual characteristics as well as various combinatorial and strategic issues (i.e. additive and multiplicative contributions by different stakeholders).

Richters and Siemoneit (2017) suggest that there is a certain imperative in modern economy for growth that is "massively and systematically lopsided towards net investment". They claim that just a few firms are able to escape this race, successfully surviving without growth, but usually in niche areas only. Accordingly, Coad (2009) identifies the interest towards growth phenomenon with the dissatisfaction to conventional static approach of economic theory. This disenchantment of static models has resulted in the emphasis shifting to prevalence of uncertainties, change and bounded rationalities, these in the context of volatile economies. Coad (2009) summarized that growth has replaced firm size as the central variable in industrial economics.

Richters and Siemoneit (2017) assert that the defense for the growth imperative/impetus lies in the view that longer term, growth of the company is a prerequisite to achieve accounting profit. There are also other than direct economical drivers for growth. Coad (2007) argued that future evolutionary models should abandon the view of a direct relationship between profit rates and growth rates. Companies may also be forced to grow fast to profit from the potential network externalities or economies of scale (Oliva, Sterman and Giese, 2003) or to reach an unchallengeable long-term cost advantage (Rothschild, 1990).

Even if growth is close to an obligation in modern economic systems, growth does not touch every firm within those systems. Gray (2002) argues that few SMEs are seriously interested in growth. Some scholars do not argue for interest/no-interest of growth for these SMEs but just by looking at the statistical data (of sales revenue and personnel measures) identify that growth companies are rare. In the main societal context of this research, Finland, the proportion of fast-growing, so-called "gazelle" firms in Finland (firms whose personnel has grown over 20% annually for minimum three years in a row), has varied over the business cycles, but in long term remained at about 5% (Vanhala and Virén, 2019). In the previous statement, growth is seen as a numerical instantiation of success. Growth can also be seen as a process that interlink dimensions such as strategic growth, asset growth and organizational growth (Wickham, 1998).

The fast growth of firms has been attributed to founders' and managers' characteristics (Gherhes, Williams, Vorley and Vasconcelos, 2016; Davidsson, Kirchhoff, Hatemi-j and Gustavsson, 2002), business environment, demand and industry growth (McDougall, Covin, Robinson and Herron, 1994; Perren, 2000; Gherhes et al., 2016) , and business practices (Barringer, Jones and Nuebaum, 2005) as well as access to resources (Perren, 2000). The assets deployed into a company do not offer just an opportunity for growth but may demand growth as a component of the return on those assets. High-risk venture capital investors

engage SMEs (typically at start-up stage) in order to drive management and strategic decisions towards long-term corporate gains (Colwell and Mowday, 2011) that only materialize via growth. In this resource/asset based view of growth it is assumed that differences in companies' resources and capabilities determine the survival and growth of companies (Barney, 1991). In the process of deploying the benefits of specific resources and capabilities, a company will achieve a short-term performance. These unique capabilities include e.g. innovativeness (Coad and Rao, 2008), customer-focused flexibility, commitment to research and development and employee engagement (Ng and Hamilton, 2016). Resource and capability sets that are internalized as organizational capacity cannot be easily transacted, meaning that the firm can realize growth based on its long-term competitive advantages (Wade and Hulland, 2004). Innovativeness fosters survival-enhancing attributes (e.g. market power and cost efficiency by growth) and capabilities (e.g. the absorptive capacity of the firm) (Hyytinen, Pajarinen and Rouvinen, 2015).

Earlier research has produced an array of models depicting the growth trajectory. These models are used and referred to despite views claiming that none of them can fully describe the somewhat unique path of growth of each SME (Levie and Lichtenstein , 2010; Muhos, Kess, Phvat and Sanpanich, 2010) and also that the models do not carry in them a path determinism (Muhos, 2015). The most common anatomy of the growth models (more than 100 of them identified by Levie and Lichtenstein (2010) has been that of a stage-based or stage-gate models. Cooper (1990; 2006; 2008) developed, copyrighted and trademarked the stage-gate model to enhance new product development in firms, but the model can be seen as analogically adaptable to system (such as a company) or process (such as growth) design and research.

The stage-gate approach consists of sequential stages where essential activities are performed. The stages are complemented by gates at which interim achievements are evaluated. The early stages typically contain activities that focus on opportunity discovery and ideation, while the later stages are more about concept development and testing as well as commercialization (Grönlund, Sjödin and Frishammar, 2010).

The common view in most growth models is that there is a transformation in firm structure, priorities, core capabilities and actions over time. This inherently implies that any model of knowledge management in technology SMEs is likely to have a time axis along which the changes (and iterations) take place. The options for this sequencing are, as stated above, next to inexhaustible. An early model is the one by Scott and Bruce (1987) that divides the change continuum into Inception, Survival, Growth, Expansion and Maturity. Skok (2017) sees that a firm develops by following stages in its process of moving towards decreased risk and increased value: Ideation, Confirmation, Creation, Validation, Repeatability, Scalability and Profitability. The model by Skok is a fine-grained one and has elements suited for technology-related industries/markets as it brings the issues of repeatability and scalability to the forefront. For example, the stages of creation vs. ideation seems to be in discord

with the knowledge management literature that would place both concepts under the action of knowledge creation.

The Start-up Genome-model by Marmer et al. (2011a) is based on a data from a dynamic industry (internet start-ups) and from a dynamic marketplace both for the end-customer market as for the resources (mostly US companies in the dataset). In addition the data is deriving from the time of post 2008 economic crisis start, if can be assumed to reflect relatively well the current operating environment for new technology firms. The so-called "Marmer stages" that the firms performing in a consistent manner need to pass through – often via iterations - while growing are Discovery, Validation, Efficiency, Scaling. If the firm succeeds to pass these four stages, it matures and lives through the stages of sustaining and conservation. The study also describes the conditions, prerequisites and constraints to pass to next stages. Marmer et al. (2011b) state that skipping or speeding out one's knowledge on a previous stage will lead to (business) failure at later stages and that this inconsistency is the most important single reason for startup failure.

The Genome model seems to fit into the dominating stream of recent process model development for SME growth as it underlines the dynamism, reciprocity and iterations (Ingley, Khlif and Karoui, 2017; Torres, Kunc and O'brien 2017) and thus offers a potential categorization for the time axis of models shedding light on technology SMEs' growth. Grönlund et al. (2010) remind that "each activity is undertaken in parallel with others so as to enhance speed to market." Stage-based models (like other linear process models) are unable to support the iterations and collaborations over company boundaries that characterize development efforts today, whereas hybrid processes that combine elements of agile and stage-gate models offer more viable options (Sommer, Hedegaard, Dukovska-Popovska and Steger-Jensen, 2015). KM models need to capture iterations and loops of action and decision making, since problems lead to solution attempts, which are then tested or assessed and possibly rejected thus leading to return to the problem where the accumulated knowledge has changed the setting (de Barros Campos, 2008).

2.3.5 Change in technology-based SMEs

As technology-based SMEs seek growth and act within dynamic and volatile environments and systems, they can be seen as systems that need to continuously change and adapt (West and Meyer, 1998). There are differing views on how this change happens: Are entrepreneurial change processes manifestations of emergence, effectuation or causation? Emergence view puts weight on the non-linearity (Lichtenstein 2000, 2009; Lichtenstein, Dooley and Lumpkin, 2006; Goldstein, Hazy and Lichtenstein, 2010).

There are two distinct drivers of emergence: (1) Far-from-equilibrium dynamics that trigger order creation, and (2) adaptive tension, which pushes a system toward instability, leading to a new order emerging. (Lichtenstein, 2000). As Lichtenstein puts it conceptually (2009): "In the far-from-equilibrium approach, the entire system moves into a regime that is away from equilibrium;

this far-from-equilibrium organizing leads to non-linearity, adaptive tensions, and ultimately to perturbations of novelty. Under continuing far-from-equilibrium conditions, new order will emerge." A pragmatic example of emergence in new business development is the spread of smartphones in the early 2000s: The industry moved to a state where each manufacturer had their competing solutions and features. In terms of Abernathy and Utterback (1978) and Utterback and Suaréz (1993) the dominant design had not emerged, i.e. what was missing was a specific path, which would have established dominance among competing design solution paths. Twenty years later the smartphones are interchangeable for most customers and compatible across brands.

Effectuation viewpoint stands for taking "an active and agentic stance toward resources" (Sarasvathy, Kumar, York and Bhagavatula, 2014) and considers value as inherent in the notion of "resources". Effectuation proposes that resources are not stable but develop during effectual processes over the course of exploration by a firm and its network (Villani, Linder and Grimaldi, 2018). Effectuating firms do not aim at predicting the future, but rather on seeking to control it by developing partnerships and pre-commitments from various stakeholders in the value systems of their business (Dew, Read, Sarasvathy and Wiltbank, 2009; Chandler, DeTienne, McKelvie and Mumford; 2011). Business practitioners effectuate by participating in standardization, joint research and coordination efforts on value systems as e.g. in various smart grid consortia combining electricity system stakeholders, industry or national level.

Causation model describes a process in which an entrepreneurs and firms decide on a predetermined goal and then assess and select available ways of achieving that goal. Central to this approach is the concept of intentionality (Katz and Gartner, 1988; Shane and Venkataraman, 2000; Sarasvathy, 2001; Delmar and Shane, 2003). In practice these processes in technology-based firms may relate e.g. to supplier choices for outsourced operations, where the firm is able to give a specification of the targeted outcome of the process and compare the means of reaching them. However, causation may mislead a company, since relying on (information and control) systems and focus on compliance with pre-decided goals and objectives may not necessarily yield longer term organisational competences in the dynamic business environments (Suikki, Tromstedt and Haapasalo, 2006).

The three basic paradigms of change for an entrepreneurial firm are not mutually exclusive, even though momentarily one of them may overshadow others. It is realistic to assume that there are periods of goal clarity and resulting planning-based views, whereas at times changes in the environment force a reconfiguration in the way a form operates. No system is absolutely free form temporal changes and anomalies.

Change is inbuilt into the nature of technology based SMEs, yet it sets its own demands for knowledge for the firm and its stakeholders. These knowledge needs are volatile and different states within the growth process need specific sets of knowledge and capabilities. Koryak et al. (2015) identified two broad forms of capabilities related to growth: substantive capabilities that enable firms to compete in its markets on a daily basis; and dynamic capabilities, which

enable extending, modifying or creating new substantive capabilities. These capabilities are acquired differently in SME settings than a general firm level, due to limited resources. The technological dimension also sets the demands for fast development and change cycle times in technology-based SMEs apart from the mainstream of SME companies. Table 4 summarizes the core findings on time-bound moderation in technology SME development

TABLE 4 Time-dependent elements affecting technology-based firm´s development and KM

Core tenets and contribution to this study	Key sources
Time-dependence of technology business performance: Time-to-market and fast development cycles (=agility) are of increased importance	Griffin (1997); Afonso et al. (2008); Abrahamsson et al. (2002; 2003)
Growth as an inbuilt phenomenon in current economic system and in technology business	Coad (2009); Colwell and Mowday (2011)
Companies grow and develop via dynamic states and iterate between these states in their trajectory	de Barros Campos (2008); Levie and Lichtenstein (2010); Marmer et al. (2011a, 2011b); Ingley et al. (2017); Torres et al., (2017)
Change as a constant phenomenon in technology business; Constant flux between periods/states of emergence, exploration and intentionality.	Lichtenstein (2000;2009), Shane and Venkataram (2000); Villani et al. (2018)
Temporal (=time-related) ambidexterity: Firms run different exploration and exploitation processes on knowledge, with different time spans and narrowing vs. widening funnels = planning vs scanning horizons	Kuusi et al. (2015); Yan et al. (2016): Wang et al. (2019)
Anticipation is a KM process to interpret potential futures into present action to exploit opportunities	Dufva and Ahlqvist (2014); Poli (2014)
Knowledge capabilities serve for a) current performance (substantive capabilities) b) future performance in altered conditions (the substantive capabilities have become developed i.e. made dynamic)	Koryak et. al (2015)

2.4 Research gaps and initial framework for the study

Earlier, Section 1.3 presented the scope of this study – technology-based SMEs. Section 2.4.1 summarizes the earlier research done on the knowledge management modelling in this scope as well as highlights the areas that have been uncovered and thus justify this study. Section 2.4.2 presents the initial framework for the study that the researcher set to elaborate on, listing also the main sources of prior literature that have contributed to the creation of the initial framework.

2.4.1 Earlier research and gaps in it on knowledge management in technology-based SMEs

Despite the scarcity of research implications and resulting models for technology-based SME context, some outlines and elements that would contribute to strategies of coping with knowledge dynamics in entrepreneurial context have been established. Ching-Yung (2018) described the essence of one type of knowledge artefacts - intellectual property rights (IPR) - that they are for a SME "like water that floats or overturns SMEs", but also that "it's impossible for SMEs to invest all items of IPRs due to limited resource." (ibid.) Earlier research has identified the difference KM typically embodies in SMEs in comparison with larger corporate entities (e.g. McAdam and Reid, 2001).

The shortcomings in SME knowledge management cannot however be pinpointed to resources alone. Anand, Kant and Singh (2013) identified two key main barriers to knowledge sharing in SMES: 1) lack of managerial commitment to sharing and 2) poor or wrong understanding of the knowledge management itself. In short, SMEs would need more knowledge about knowledge to be able to act on it. How that would happen has not been elaborated on in larger volume. Anand, Csepregi and Bodgány (2018) concluded that several publications have dealt with knowledge creation in larger organizations, but creating knowledge still was unexplored in SMEs.

Instead of depicting comprehensive KM models/frameworks for SMES prior research has either modelled sub-processes of KM, e.g. design knowledge absorption (Acklin, 2013), innovation transfer (Caputo, Cucchiella, Fratocchi, Pelagagge and Scacchia, 2002) intellectual capital (IC) measurement and KM implementation (Montequín, Fernández, Cabal and Gutierrez, 2006) or then given overall recommendations for SME management for improved KM. Most papers on SME-contextualized knowledge management discuss the needs and processes with a cross-sectional view instead of a time-dependent evolutionary approach. As Birchall and Tovstiga (2002) claim: "Many firms, particularly smaller and medium enterprises, have still not translated a concern for improved knowledge management into even the most rudimentary analysis". The reason can be a combination of resources but also in the lack of tools needed.

Earlier KM studies with foci in SMEs (e.g. Lee and Lan, 2011; Yew Wong and Aspinwall, 2005; Martìnez-Conesa, Soto-Acosta and Carayannis, 2017) propose generic knowledge management models and processes for SMEs independent of their type. There are some studies focusing on technology- and knowledge intensive SMEs, but they (Olander, Hurmelinna-Laukkanen and Mähönen, 2009; Soto-Acosta, Popa and Palacios-Marquéz 2017) typically take a specific action within knowledge management under study, like the three examples above elaborate on Intellectual Asset Protection, Web Knowledge Sharing and Technology Transfer sharing, respectively.

The most recent overall views of knowledge management processes in knowledge-intensive SMEs are from Babtista Nunes et al. in 2006 and Alegre et al. in 2013, so an updated view may be of need. Baptista Nunes, Annansingh, Eaglestone and Wakefield (2006) pointed out the underlying potential of KM by

stating that "SMEs, including knowledge intensive ones, acknowledge that adequately capturing, storing, sharing and disseminating knowledge can lead to greater innovation and productivity". The gap between what could be and how shows in the way"…their (SMEs) managers are not prepared to invest the relatively high effort on long term knowledge management goals for which they have difficulty in establishing the added value" (Baptista Nunes et al., 2006).

2.4.2 Initial framework for the study and its main sources

This study aims at creation of a new integrative framework of dynamic knowledge management in technology-based SMEs and prospective practical instantiations of the framework depicting the phenomenon under study for both theory development and pragmatic usage. To build on the existing knowledge, a study needs the initial or baseline framework to elaborate on. The essence and anatomy of a framework can be understood e.g. via the definition by Miles and Huberman (1999), who claim a framework for a researcher being a mechanism that aids a researcher to decide the most relevant variables of which data should be collected and analyzed. The framework can thus be looked from the researcher angle, but it may also have validity in more pragmatic point of view. Fisher (2007) coins framework as a description of causes and relationship between the identified key elements of the framework. Element identification of the baseline framework can be based on earlier literature, and the new knowledge created is likely to lead a new version of the framework, with additional factors and new relationships indicated by the results of empirical study.

This study in its different phases addresses many of the potential purposes aligned by Schwarz, Mehta, Johnson and Chin (2009) as it integrates the previous research and provides a new focus in the research stream. This study also facilitates future research by findings of the separate articles and summary of the primary empirical contributions from the articles. Additionally this thesis synthesizes research to an actionable way for practitioners by establishing new integrative framework and its instantiations. Table 5 summarizes the core tenets of the theoretical base that the initial framework is derived from.

The initial framework for this study (Figure 7) is based on the research setting and findings of earlier literature as a source of baseline models for knowledge management and of the potential elements to be included to an improved framework. The framework in itself do not present the knowledge base of the study, but it depicts the most important issue areas to be included and their relations to each other and to the whole. It is a framework for the study and guides the researcher in his search for more detailed knowledge on the phenomenon via empirical studies.

TABLE 5 Key contributing constructs to the initial framework, premises for the study and their key sources

Model elements	**Construct**	**Premises**	**Section #**	**Key sources**
Change	Specificity of technology business	Increased clock speed, increased uncertainty	1.1., 3.1.	Fine (1998); Mohr et al. (2010)
Change	Specificity of Technology-based SMEs	Resource constraints in KM; Unspecified and continually transforming KM processes at SMEs	2.4.1.	Babtista Nunes et al. 2006; Ching-Yung, 2018
Actors/ Portfolio	Knowledge division: (Know) What, How, Why, Who	Artefacts, Processes and Actors in KM interact	2.1.	Zack,(1999)
Portfolio	Knowledge Portfolio	Knowledge is made of knowledge assets that interact: Knowledge contents, knowledge processes, knowledge infrastructure and knowledge culture	2.2.2.	Birchall and Tovstiga (1999; 2002)
Interaction	Knowledge as a cumulative and collaborative asset	Different organizational and inter-organizational levels and interaction within KM	2.2.2	Hedlund (1994); Mentzas et al. (2001)
Change Actors Interaction	Knowledge Management transformations over time	The (relative) resources of KM stakeholders shift over time.	2.2.2	Hedlund (1994); Aime et al. (2014)
Growth	Growth as a moderating factor to KM	Companies grow and develop via dynamic states and iterate between these states in their trajectory	2.3.4.	de Barros Campos (2008)¸Levie and Lichtenstein (2010); Marmer et al. (2011); Ingley et al. (2017); Torres et al., (2017)
Change	Change as a moderating factor in KM	Change as a constant phenomenon in technology business; Constant flux between periods/states of emergence, exploration and intentionality.	2.3.5	West and Meyer (1998); Lichtenstein (2000;2009), Shane and Venkataram (2000); Villani et al. (2018)
Anticipation	Anticipation as a moderating factor of KM	Anticipation is a KM process to interpret potential futures into present action to exploit opportunities	2.3.3.	Dufva and Ahlqvist (2014); Poli (2014)

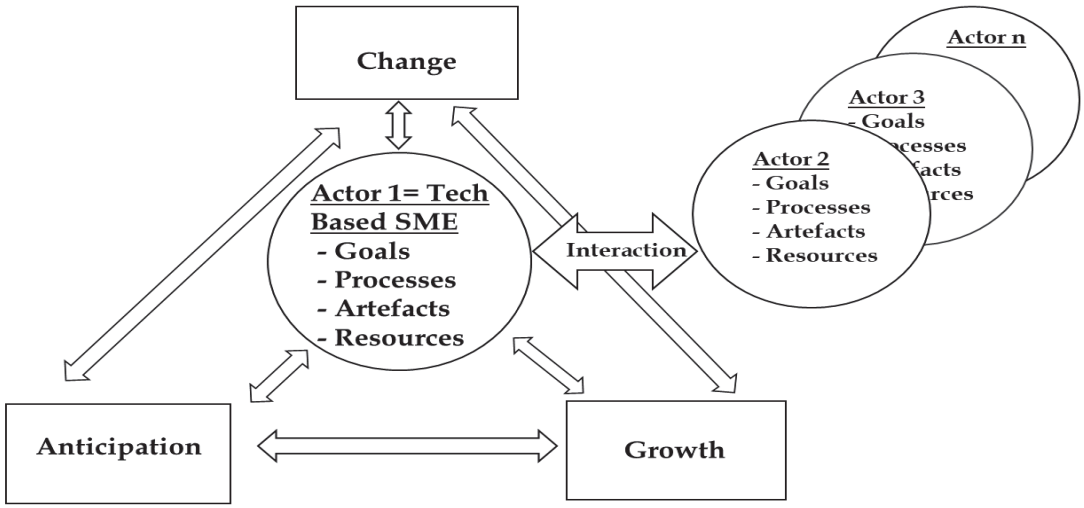

FIGURE 7 Initial theoretical framework: Dynamic knowledge management in technology-based SMEs

Actor 1 in the initial framework is the unit of the analysis of the study, a technology-based SME that has its portfolio of knowledge assets (processes, artefacts, resources) and goals of knowledge management. These assets a SME sets to develop in interaction with other actors i.e. stakeholders. Both the internal assets and goals of the SMEs as well as the ones of the other stakeholders – and as a result their interaction- are likely to be transformed over time when the elements of change, growth and anticipation that start moderating KM. The underlying assumption is that a technology-based SME (as well as its interaction counterparts) possesses not only one process or one set of artifacts that serve for all KM purposes of the company, but it rather manages a portfolio containing knowledge assets that call for variety of actions on them.

Despite the fact that the initial framework recognizes the impact of time as a moderating element on KM in a technology-based SME, it is still a static model as it cannot illustrate how the KM will change over time in regards of the goals, processes, artefacts and resources. In that sense the model cannot be seen to present a framework of dynamic knowledge management but a cross-sectional, static view of KM, that admits the presence of time-dependent moderators for KM. In addition, the knowledge and knowledge management are in the model not depicted as uniform, indivisible entity. The initial framework builds on the view that a modern company possesses and acts on multiple knowledge assets simultaneously. The concept of knowledge portfolio is thus also included in the initial framework.

3 RESEARCH SCOPE, DESIGN AND IMPLEMENTATION

This chapter summarizes the scope of the research and philosophical position of the researcher describing and justifying the multiple methods used. Data collection and analyses are described and finally the author reflects the work done on quality criteria for qualitative research that the study relies upon.

3.1 Research scope – technology-based SMEs

The unit of analysis for this study is a technology-based SME and its knowledge management process(es). As the name of the cohort of companies labelled as Technology-based companies - whether big or small - implies, their *raison d'être* and success of a firm is dependent on possessing and making operational some specific knowledge. Ambiguity on what we talk about when we talk about technology had already prevailed since 1970s (Hansen and Froelich, 1994). NCTM (2015) claims that technology is made up of physical and digital tools. This broad definition clearly would make most of the firms in modern era to be technology companies.

To avoid the complex concept of technology, some scholars have replaced the technology angle with a knowledge one. Most of the modern firms would claim to be knowledge-based ones, since without some kind of knowledge possessed they would not survive. According to Puentes, Ortiz and Rodriguez (2016) a technology-based firm (TBF) contains following typical characteristics:

- TBF is an SME company with intensive knowledge and immersion to high-tech sector, based on the intensity of Research, Development and Innovation
- TBFs produce goods and services through systematic application of technical and scientific knowledge, typically working in a project mode.

- Mostly, TBFs have an academic beginning and have linkage to collaborators such as incubators, research centers and universities for support and infrastructure.

Mohr, Sengupta and Slater (2010) define technology-based firms as ones operating in an environment characterized by 1) technology uncertainty 2) market uncertainty 3) competitive volatility. These all refer to the dynamic nature of the operating environment and address the firms´ adaptive capacity in order to survive and grow. The other characteristics typical to technology-based firms by Mohr et al (ibid.) put emphasis on issues on scalability and potential of the spread of their solutions (economies of scale, increasing demand-side returns, knowledge spillover etc.). Technology entrepreneurship can emerge where developments in science or engineering make core elements of the opportunity that enables the emergence of a venture, market, cluster, or industry as well as potentially new business models (Beckman, Eisenhardt, Kotha, Meyer and Rajagopalan, 2012).

Centobelli, Cerchione and Esposito (2017) identified three groups of SMEs that differ in the stage of adoption of knowledge management systems: 1) Companies in introduction i.e. SMEs that exploit practices and tools that are already known; 2) Companies in growth, that adopt specialist practices of knowledge management acquiring new organizational and managerial competence in the KM field; 3) Companies in maturity that invest in new technologies and acquire new competence in the field of knowledge management. The units of analysis of this study fall into all three categories of Centobelli et al. (2017), as some of the firms in the samples already have a longer tenure and firm foothold on the market than just start-ups would have. Building on Centobelli et al. (ibid.) it can also be stated that KM is a process of dynamic and evolving nature, since a SME is not likely to stay in the same category throughout its growth trajectory.

The prior literature has proposed an array of elements to be included in the definition of technology-based firms and SMEs. This study decidedly uses the concept of technology-based SMEs that contains characteristics from the aforementioned categorizations as follows.

A company can be considered a technology-based SME if it is:

- Entrepreneurial: Thy are not new ventures arms of larger corporations nor joint ventures between them but independent in making choices of action
- Based on application of specific scientific and/or technological knowledge: not just any SMEs. As a result, they are exposed to stronger uncertainties than SMEs generally (Mohr et al., 2010).
- Of different longevity: Not just new ventures or startups yet companies that may have longer history. However the companies are still under the upper SME size limit and thus are resource-constrained in comparison to large corporations acting in technology industries

3.2 Research philosophy

The research philosophy in this dissertation is inductive interpretivism. Instead of a deductive approach where the researcher would have a pre-fabricated theory to be tested and proven or refuted, an inductive method identifies the area of the enquiry and aims at developing theory, or at least a model, out of the emerging data. Inductive research moves from particulars to generalizations. The researcher is observing the occurrence of the phenomena via his interaction with respondents and then constructs a model based on observations of events and processes. The earlier theories on the issue area under study do not determine what the researcher will come up with as a result of his enquiry, though they may inform and guide the final conclusions. Induction is an ampliative form of reasoning as it adds to prior knowledge: the goal is a conclusion wider than just repetition or confirmation of earlier premises (Strauss and Corbin, 1998; Malhotra and Birks, 2005; Thomas, 2006; Ketokivi and Mantere, 2010). Collis and Hussey (2014) describe induction as a process in which relationships between meanings and actions of individuals are used as core units of observation and investigation.

One of interpretivism's main tenets is that research can never be objectively observed from the outside, but rather from inside via the direct experience of the people (Mack, 2010). Furthermore, uniformal links that are established in natural science cannot be made in the environment where different stakeholders construct meanings. Therefore, researcher´s role in the interpretive study is to "understand, explain, and demystify social reality through the eyes of different participants" (Cohen, Manion and Morrison, 2007).

Above characteristics of the interpretivist paradigm were applied in this this research that set out to explore the phenomena (knowledge and its management) in a specific context of technology-based SMEs as experienced by stakeholders involved in the issue area. An exploratory method is often chosen when the goals of the research are: (1) to scope the magnitude of a particular phenomenon and (2) to generate ideas about that phenomenon, or (3) to test the feasibility of establishing more extensive studies regarding the phenomenon (Bhattacherjee, 2012). This thesis does not have measurement in focus, but set the goals for points 2 and 3 above: to explore initial ideas of how the dynamic phenomenon could be described in form of framework and its instantiations and give the research community input for additional elaboration.

The open-ended nature of semi-structured qualitative data collection also underlines the exploratory nature of quest for knowledge in this thesis. The main purpose of exploratory research is to seek novel insights and understand what is happening in reality, as well as to ask questions and assess phenomenon or phenomena from new angles (Rahi, 2017). This type of research is usually adopted in early stages of research on issues in foci. Descriptive method of research is linked to exploration, since it "refers to the type of research that aimed at obtaining information on the current state of phenomena" (Rahi, 2017). Hungler, Beck and Polit (2001) claim that descriptive research aims to observe

and document a current phenomenon, which cannot be yet described with an objective value. In this study, the author seeks to understand and interpret a phenomenon as it has unfolded in the context of the studied companies' and their key persons' cognitive models and operations, and, finally, describe the elements and their relations to each other needed for modelling the phenomenon.

The concept of concatenated exploration refers to a process and the resulting set of studies that link together - and cumulatively leading to grounded or inductively generated theory (Stebbins, 2001). According to this principle, studies performed in the beginning of the chain of the studies on a phenomenon are likely to be predominantly exploratory in approach (ibid.). As the author of this thesis claims (see Section 2.4 for detail) that the research looking at knowledge management as a dynamic process has been low in volume. Also, the number of studies focusing on SMEs has been limited, so there is a need for concentrated research for this specific issue area.

3.3 Research methods

This study is using a combination of research approaches a.k.a. multi- or mixed methods or triangulation to reach its objectives and come to its conclusions. Generally, it has been accepted that a combination of approaches can yield advantages (e. g. Hunt, 1994; Bryman, 2006) for generating a richer picture of phenomena. It has been however discussed that since two paradigms often represent opposing ontological assumptions, attempts to incorporate both approaches would fail (Farquhar, 2002). To avoid the pitfall of contrasting paradigms, this thesis operates based on inductive reasoning via different approaches (exploration and conceptualization) and by using multiple methods (quantitative, qualitative) to foster induction (Figure 8).

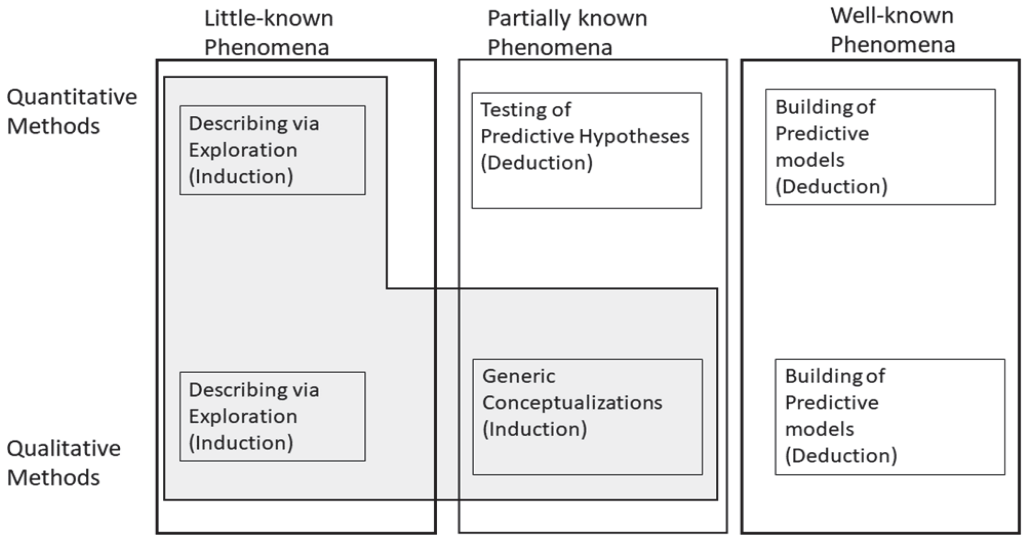

FIGURE 8 The method selection and research aims (the area in gray) for the study. Adapted from Shaffir and Stebbins (1991)

In order to benefit from the multi-method approach and avoid the potential pitfalls, the research purposefully remained in the inductive field yet using various methods to get to the inductions made in a justified way. In Figure 8 the left column can be seen to represent the dynamic i.e. temporally sensitive nature of knowledge management and knowledge management practices in technology-based SMEs, that are a little-known (by research) phenomena. Subsequently, views of general knowledge management in these SMEs and anticipation as a process can be regarded as partially known (a large number of individual studies, little agreement or combinations of them, limited volume of studies in the technology-based SME context). The study, even though consisting of six different articles did not address well-known phenomena, the column on the right. With continuing study of the phenomena and accumulation of knowledge, the topic area of the study can reach at a later stage the maturity for hypotheses building and prediction.

To be relevant the inductive process must be analytical. Analytical induction is a process in which the researcher first roughly defines an issue (Bryman and Burgess, 2002). After that, appropriate cases are examined and as a result of examination, possible explanation to answer the research problem is formulated (ibid.). This description well suits the study in hand, as the picture is created in a continuous process and new studies add angles to the formulation of the description of the phenomenon as a whole. The initial framework for the study was compiled based on earlier research. The empirical studies and data derived and analyzed from them were the inputs to the resulting proposal of the integrative framework of dynamic KM and its hypothetical practical instantiations.

3.3.1 Qualitative research methods

This dissertation consists of five articles out of six that utilized qualitative approach. Qualitative research was chosen as it is seen to be capable to "develop a complex, holistic picture of the target" (Creswell, 1998). Another justification for using qualitative approach was that the key informants, people interviewed in the studies making together this thesis, were approached in order to learn the way they construct and operationalize the issues under study. The focus of a qualitative researcher is to tap into personal and professional subjective experiences of the respondents (Daymon, Holloway and Holland, 2002). Meir Shalev has been credited with saying that "the stories we tell are more precise than the reality" (as referred by Taschner, 2017). This view stresses the importance of the perceptions by (key) people within organizations and processes to how reality unfolds for them. The cognitive maps and models of people responsible for company and function management impact the scope and performance (Calori, Johnson and Sarnin, 1994; Goodhew, Cammock and Hamilton, 2005) and thus make a relevant object to study.

Case study research is a strategy to obtain a thorough understanding of the researched phenomenon by using multiple angles. Case studies tend to feature complex and holistic descriptions (Stake, 1978). Article VI (a book chapter) in this

study includes key findings of a single case study. The case was consequently approached by using multiple stake-holder groups (owner-managers, internal experts in the firm, external experts in the industry in question, external experts in SME financing and business development) to have a variety of angles when analyzing the case. Themes included in the case study to guide the inquiry and research design were pre-planned, but they remained subordinate to the understanding of the case approached with an exploratory mind, following the principle by Stake (ibid.). Eisenhardt (1989) identifies case study research as an early part of the research continuum to understand a phenomenon: it suits new research areas for which the existing theories seem to be inadequate and thus call for amplification.

3.3.2 Quantitative research methods

In Article V, the data were collected and analyzed with a quantitative approach. The target was to find out the possible significant changes in the self-assessments of knowledge across sub-categories (strategic planning, IPRs, marketing and sales, finances etc.) of participants to an entrepreneurial coaching program. Likert-scale assessments were collected at three different points in time (pre, post, 1-year-post the program).

Survey-based collection of quantitative data from a small pool of respondents was also chosen based on data quality viewpoint. The researchers were themselves stakeholders (developers + instructors) in the entrepreneurial knowledge-building program under study, thus their involvement into qualitative data collection (e.g. via interviews) and data interpretations might have presented a bias based on social acceptability (Singleton and Straits, 2005).

3.3.3 Conceptual Research Methods

In Article III, the research approach was conceptual, not consisting of analysis of empirical data. Conceptual research is often a preliminary stage in a wider research process, used to clarify research questions and hypotheses and also used as a reference point to interpret empirical data collected. Conceptual and empirical research are thus intertwined in the creation of knowledge for objectivist researchers (Xin, Tribe and Chambers, 2013).

Creative conceptual research aims at both developing new concepts as well as reinterpreting and rearranging the existing ones. (Kothari, 2009). In this case, the new conceptual model was created to fuse together two previously separate concepts of literature of anticipation methods as well as to propose new taxonomies for anticipation methods.

3.4 Data collection and analysis

As this thesis is built on cumulative knowledge surging from six studies, the research design and approach used for each study are described in the original articles of the respective studies attached to this thesis. This section summarizes the methods used and their justification as reflected against the research scope and objectives. The datasets collected and analyzed in the articles were using samples deriving from the target population of the thesis: technology-based SMEs.

Table 6 presents the number of case companies, interviewees, survey respondents and researchers involved in data gathering and analysis in each article. The sampling of the interviewees in this study followed the principles of purposive sampling. Purposive sampling (Lincoln and Guba, 1985) is based on informational, not statistical, considerations. It aims rather to maximize information than facilitate generalization, and thus the criterion invoked to determine data collection is informational redundancy and saturation of data, not a statistical confidence level.

TABLE 6 The samples and cases in the articles for the thesis.

	Article I	**Article II**	**Article III (concep-tual)**	**Arti-cle IV**	**Article V (quantitative)**	**Article VI**
Number of companies/ startup teams	10	3		5	6	1
Number of intervie-wees/ res-pondents	10	2 + 1 studied from text sources		5	27/28/18 across differ-ent time points of measure-ment t_0, t_1, t_2	7
Number of researchers involved	2	3	2	4	4	1 (2 in the reviewed study within Article)

In Articles I, II, IV and VI a qualitative approach was applied based on data collection via semi-structured interviews. The semi-structured interview approach relies on the idea that the respondents can raise issues they consider as important even though the researcher may not have included them in the original plan. Interview as the primary mode of data collection was also suitable due to the potential lack and of a single common terminology when discussing the research topic. To avoid this pitfall and deal with individual interpretations of

questions and expressions, the interviewer can decrease research inaccuracies by explaining the core logic of questions to the interviewee (Oppenheim, 2000) and match the context of questioning and answering (Malhotra and Birks, 2005). All interviews were recorded, transcribed edited verbatim and subjected to content analysis for pattern recognition (Yin, 1989). The studies utilized either small yet relatively homogenous samples of Finnish technology-based SMEs or a single case via multiple respondents (Article VI).

The quantitative data collected in Article V was subjected to descriptive statistics and further to a Mann–Whitney U test, which was chosen by excluding other options. For example, the Wilcoxon signed-rank test would have needed the exact same number of data points from the two measurements to be compared, and the small sample did not allow a standard t test to be performed. However, as the same sample population was contactable, the quantitative analysis was applied. The descriptive statistics gave indication of achieved effects on knowledge building, so the statistical significance test was conducted to check the statistically significance of these indications.

The data analysis in this thesis follows the pattern and theme logic. Pattern theories of research are regarded to be "sensitive to and reflective of human systems" (Lincoln, 2005). Furthermore, pattern logic guides researchers to see phenomena under enquiry as elements of wider interconnected and more holistic systems. (Lincoln, 2005). To achieve the pattern, the elements of the pattern must be identified. To achieve that, themes can be identified by bundling together components of ideas or experiences, which would be often meaningless when viewed in isolation from each other (Leininger, 1985). Next, themes emerging from the informants' stories are joined together to form a comprehensive picture (Aronson, 1994). In other words, analysis used in the context of framework building is a process in which a researcher sets out bins or baskets that contain things belonging together in their essence. Next the researcher names the baskets and clarifies their relationships (Miles and Huberman, 1999).

Jain, Duin and Mao (2000) define the idea of pattern logic as a process in which one observes the environment, learns to distinguish patterns from their background and make sound and reasonable notions and conclusions about the categories of the patterns. This thesis follows the aforementioned model in summarizing the primary empirical contributions of the articles included and arranging them into an integrative framework based on the patterns recognized. The resulting framework is informed by both prior-art research of the phenomenon that is summarized in the initial framework for the study along with researcher's own empirical contributions that further develop the initial framework to a new pattern.

3.5 Reflection on research quality: Validity, Relevance, Rigor and Reflexivity

Judging the quality of qualitative research can be based on many viewpoints. Hammersley (2016) suggests that validity and relevance are essential for assessing qualitative studies, commenting however that these criteria are not straightforward to assess and, thus, require judgments. For validity improvement, Mays and Pope (2006) suggested procedures of triangulation, respondent validation, clear detailing of methods of data collection and analysis, reflexivity, attention to negative cases, and fair dealing. Hammersley (2016) adds reflexivity as an equally important measure as to relevance and validity. Reflexivity stands for adequate focus of the researcher on self-knowledge and sensitivity to better understand the role of self in the knowledge creation. This way the balance between the personal and the universal can be maintained (Berger, 2015).

What would be called (internal) validity in quantitative research design, the internal validity is also referred to as credibility in qualitative approach. According to Thomas and Magilvy (2011), achieving credibility occurs "by checking for the representativeness of the data as a whole". To establish credibility, a researcher reviews the individual transcripts, searches for similarities within and across respondent pool (ibid.). Golafshani (2003) notes that the credibility of a qualitatively constructed research depends on the capability and the effort put to the process of the researcher. One demonstration of validity according to Creswell and Miller (2000) is use of multiple methods, triangulation, validity-enhancing procedure where researchers aim at convergence between multiple sources of information to form themes in a study. Whether the term validity or credibility is adopted, the research in hand has used multiple methods (and users) to enhance the research quality. In addition, the path of reasoning from the findings in the individual articles to primary empirical and conceptual contributions (PECs and PCCs) of the study to resulting frameworks created should also do its part of proving the credibility of the study. Improvements on the validity would have been more rigorous treatment of qualitative data, though the richness of data in expression and lack of earlier studies in the context would have made creation of word and theme libraries for coding the data extremely difficult to perform without risk of loss of important larger themes.

Since the criteria of reliability is mostly out of reach in qualitative and inductive research, dimensions of relevance, rigor and reflexivity are employed. Relevance represents the level of understanding reached of individual behavior resulting in appreciation of the researcher's emerging understanding of their situation (Wilson, 2003). Benbasat and Zmud (1999) put an emphasis on rigor over relevance; their concern being establishing an academic discipline on the traditional model, rather than seeking to address the concerns of practitioners. Stige, Malterud and Midtgarden (2009) coin the term of reflexivity as a principle

of first articulating questions tacitly underlying and motivating the research and then evaluating their legitimacy and relevance.

This thesis process has demonstrated relevance for the academic community that has accepted papers addressing the topic to be published and given feedback via the events or publications they have appeared in. In addition, the practitioner community taking part in the thesis process as informants has been able to follow the question setting of the researcher(s) and contribute their views and experiences to the research process. Rigor has taken place in the way the researcher has followed the research tradition of methods chosen. This study follows the models of qualitative interpretive research but also aims at delivering relevant contribution to the practitioner community, returning the findings based on empirical findings back to practice. Reflexivity may be the quality construct hardest to assess, but the underlying questions and motivations for the research have emerged from the observed lack of research and tools in the field of the study and not of pure personal interest. The researcher has been able to approach the issue area from the quest for knowledge from a neutral angle, open-mindedly and without dependency of any party that might have harmed the fairness of the research process.

4 RESEARCH CONTRIBUTIONS

This thesis´ contribution to knowledge is an accumulation of individual studies, the results of which have been published between 2016 and 2018. This chapter provides (in Sections 4.1 to 4.6) the reader a summary of each article, its objectives, and findings summarized as primary empirical contributions (abbreviated as PECs, Articles I-II; IV-VI) or primary conceptual contribution (PCCs, Article III) to the main quest of knowledge of the thesis. After a separate treatment of each article, the PECs and PCCs are collected in a summary table in Section 4.7, which also explains the impact of PECs and PCCs to building of the frameworks. The PECs and PCCS are introduced in the order in which they appear and numbered accordingly. Section 4.8 proposes a framework for dynamic knowledge management for companies in the focus, technology-based SMEs. Figure 9 illustrates how individual articles contribute to the knowledge areas of literature review and initial framework.

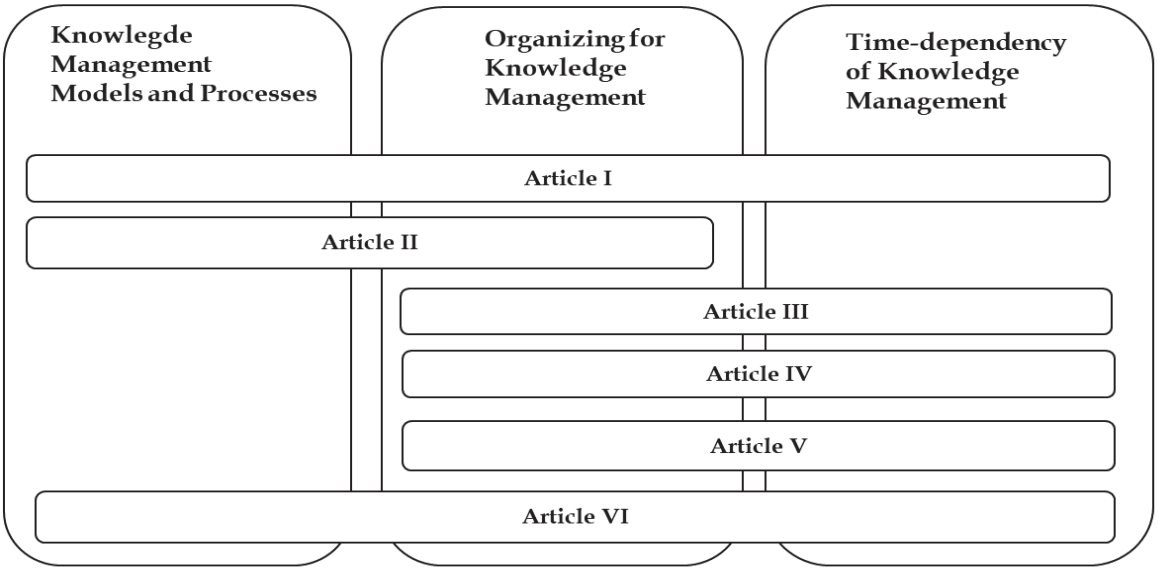

FIGURE 9 Contributions of the articles to the knowledge areas of the thesis

4.1 Article I results

Saukkonen, J., & Kreus, P. (2018). Extending the Concept of Knowledge Management into Innovation and New Business Creation. In *Proceedings of the International Conference on Creativity and Innovation 2018, September 10-12, 2018, Osaka*. Japan Creativity Society and Kindai University, pp. 11-26.

Objectives

In Article I, the authors highlight the views and strategies of SMEs in Finland in managing present and future-related knowledge in order to create and improve business value. The research approach was qualitative. Data was collected in 10 semi-structured interviews conducted in the first half of 2018 with the people responsible for KM processes in the interviewed Finnish companies that were knowledge- and/or technology-intensive. The interviews were recorded, edited verbatim and subjected to thematic content analysis for pattern recognition and typology creation. The specific interest was to identify how the use of means of knowledge protection (patents, utility models, trademarks, trade secrets, copyrights etc.) are balanced with the knowledge management processes and principles aiming at new knowledge creation and innovation and thus new business value creation. This depends on how key individuals conceptualize and operationalize KM practices in their own work and in the innovation processes within the companies.

Findings

Based on the qualitative data gathered, the authors were able to recognize two core dimensions to which knowledge management actions and processes can be categorized. This double dichotomy is built on two axes: 1) approach (getting to values of operational vs. strategic) and 2) dimension (internal vs. external).

The first axis makes a distinction in the processes that are "purely" operational vs. having a more strategic view embedded. Opportunistic/fully operational decisions are done for the current situation and with the prevailing resources, and where decisions are weakly linked to future decisions. Strategic decisions take place in somewhat predictable conditions but in a timeframe that gives an opportunity to rearrange and acquire additional resources. The second axis is concerned with whether the processes and practices are internal vs. external, the latter ones including also stakeholders outside the company.

The findings indicate that:

- The conclusions of earlier scholarly work of resource-constraint of SMEs in KM were confirmed: The interviewees had recognized needs and/or had plans to advance KM policies and practices that were in use at the time.
- Taxonomy from the interviews shows the tendency of SMEs to largely use measures that are internal in dimension and operational in approach. Active use of external parties – especially so when the action would be more

far-reaching (in time and in search for novelty) – was less practiced although the opportunities and needs for external participants were recognized
- The interviews yielded more considerations concerning knowledge protection than knowledge creation and dissemination, indicating that SMEs do not conceptualize knowledge management as broadly as the models of KM (often based on larger company context) would imply.
- The study confirmed the assertion of earlier literature that SMEs' capabilities to a certain extent, equals the roots of the company (e.g. what the spin-off firm can bring to KM from its parent company) and the key people (typically founder-owner-managers) in them – the legacies. Also, the career legacy of people responsible for KM within SMEs should be considered as a factor affecting attention to KM and choices within it. The knowledge domains that key individuals feel comfortable with and the personal mark they want to leave to the company affect choices in KM processes.
- The clarity and explicitness of KM processes evaporated over timespan. Companies have clear models and processes with organizational responsibilities to deal with imminent knowledge management needs, but as the scope moved from "now" to the future, the descriptions of the processes and policies became fuzzier or more ad hoc.

Summary and contribution to the whole

The findings showed that the dimensions/categories of KM processes, resources, impacts of legacies and time-dependent variation should be included in an integrative framework for dynamic KM in technology-based SMEs. These findings are contributions to the main expected contribution of this thesis as a whole and presented as such in Section 4.8. The study also contributed to the framework building by showing that firm- and individual-level legacies (either in a form of contributive resources or constraints) affect the way KM is conceptualized, planned and practiced within technology-based SMEs.

Article I produced the following primary empirical contributions (PECs) for building the integrative framework of dynamic knowledge management and its potential instantiations:

PEC 1: SMEs focus KM in internal (vs. involving external parties) and operational (vs. strategy-bound) action

⇨ Impacts to framework building: Company boundaries and network boundaries needed. Preference on short-term and less-strategic KM action, KM is only in part strategy-driven

PEC 2: The impact of (career) legacy of key individuals to KM in SMEs

⇨ Impacts to framework building: The challenge of cognitive bias vs. experience-based expertise in KM

4.2 Article II results

Saukkonen, J., Harju, M. & Kreus, P. (2019). Intellectual Property in the Era of Increased Clock Speed: Return of Knowhow*?* In M. Sargiacomo (Ed.), *Proceedings of the 10th European Conference on Intangibles and Intellectual Capital ECIIC 2019, University of Chieti-Pescara, Italy, 23-24 May 2019*. pp. 244–252.

Objectives

Article II investigates, through a multiple case study, how technology-based SMEs' development has been affected by two knowledge management-related trends: Modern companies are undertaking ventures in context of accelerating clock speed and in context of collaboration. The new context of speed refers to the shorter life cycle for solutions and technologies, demands for fast and lean methods of development, along with agility and adaptability to the environment in constant change. Abilities in this area and knowledge needed for it is seen to pay-off in a reduced risk of obsolescence and ability to meet the shortening window of market opportunity.

The new context of collaboration builds on the notion that innovation today is an additive and cumulative process. Novel findings typically require system-level understanding and activities where knowledge is built on knowledge. Technological advancements tend to generate knowledge spillovers that enable further advances in new areas and networks not in the original scope of development effort.

Companies establishing protectable knowledge artefacts such as Intellectual Property Rights (IPRs) see them as crucial instruments to gain freedom-to-operate, attract funding and create partnerships to widen the knowledge pool that then enables the development and market entry of the final product and solution. The current systems established for managing intellectual property of companies are mostly geared towards proprietary rather than cooperative/cumulative nature of knowledge creation and ownership. The study wanted to identify how this view complies with the context of cooperation.

Findings

The study indicates that instead of managing one action or one knowledge artefact, the current business environment requires meta-skills of knowledge management – knowledge on how to deal with altering demands and contradictory forces for knowledge under development and exploitation. The paper proposes that the concept know-how, dormant for some time in academic and professional literature, could be re-instantiated in knowledge management. These process capabilities can be seen to offer a more solid basis for survival and success than any single innovation or protected piece of proprietary knowledge, since a processual capability has potential to yield a constant flux of knowledge artefacts and the obsolescence of some artefacts is counterbalanced by longevity of others.

Article II underlines the importance of firms´ ability to comply with high-speed demands and balance that acceleration with the risk involved. The paper also points out the double-edged nature of collaboration: Knowledge sharing and dissemination exposes a firm to a loss of proprietary knowledge, especially in networks with imbalanced power positions and dependencies. The conventional means for protection of knowledge aimed at decreasing that risk are not well compatible with the new demands of higher clock speed. Article II proposes that the risk can be decreased with the deployment of contractual rather than third party granted knowledge artefacts.

Summary and contribution to the whole

Article II indicates that rather than specific and detailed knowledge on individual knowledge elements or instruments, technology SMEs should adopt a more holistic perspective. A technology-based company should recognize the speed needed for the knowledge exploitation in the market and balance that with the speed achievable in getting the needed knowledge-related artefacts in place. A technology SME needs the ability to identify the opportunities for collaboration as well as related risks and use correct means to achieve the desired outcome in a targeted timeframe.'

The PECs of Article II can be articulated as:

PEC 3: Increased demand for higher speed knowledge processes and the (partial) incompliance with instituted IP protocols

⇨ Impacts to framework building: Division to parallel processes with different speeds and for different knowledge assets

PEC 4: Increased demand for collaborative practices in KM and related risks

⇨ Impacts to framework building: Firm interfaces with the environment, mechanisms and artefacts for collaboration

PEC 5: Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts

⇨ Impacts to framework building: Process vs project/ product-related knowledge, portfolio approach

4.3 Article III results

Saukkonen, Juha & Bayiere, Abayomi. 2017. Torn between funnels: start-up entrepreneurs' dilemma of getting started and preparing for change. In J. Mitra (Ed.), *Conference Proceedings, Volume 2: Research and Reflective Papers. 15th International Entrepreneurship Forum (IEF) Conference*. Essex: University of Essex, pp. 414-433.

Objectives

The work leading to this exploratory conceptual paper can be traced back to the authors' earlier work on anticipation practices, especially in the area of technology foresight. The paper focuses on the contradictory nature of the two views related to future-orientated KM treated in the earlier literature – Innovation vs. Scenario Funnel. As technology-based companies are by nature future-oriented but time- and resource-constrained when facing the plethora of options. Both practitioners as well as the academic community would benefit from an orientation on how these two paradigms of narrowing and widening funnels could be brought together.

Findings

Article III states that two existing frameworks (funnels) are colliding conceptually especially in the mid-term timespan. The Innovation Funnel builds on the idea that when looking from the present to the future the firm is narrowing its scope and moving from a wide array of options to the final solution thus rejecting parts of available knowledge as non-relevant. The Scenario Funnel inversely suggests that the more in the future the scope is, the wider is the range of issues to be considered in the development activity of the firm. These differences of scope and mindset are also highlighted in the earlier research by proposing that the Innovation Funnel operates on the planning horizon and Scenario funnel on the scanning horizon. What the earlier theorists have not put weight on is the fact that pragmatically the two horizons are not optional, a firm needs to be able run the two funnels or horizons simultaneously.

In Article III, the authors present a model for knowledge tool/method selection in the form of two scanning and planning diamonds - following the model by Popper (2008) for futures foresight tools. The diamond 1 uses the axes of narrowing vs. widening scope of inquiry and short- vs. long-term view, whereas diamond 2 uses the axes of low vs. high company resources and individual vs. networked industry type. As typical is for a conceptual paper, the elaboration of the model at later instances is expected to improve the models for both theory building as well as for practical purposes.

Summary and contribution to the whole

Article III notes that time is a critical resource for technology companies in an increasing manner. There are forces acting for accelerated pace of development and market-entry, proposing the firm needs to make quick decisions on the exploitation of the knowledge the firm possesses and considers relevant for the window of opportunity. Simultaneously, looking at the uncertainty and volatility of knowledge, companies in the technology business need to continuously engage in scanning a wide array of potential technologies that may present a clear discontinuity to the knowledge possessed at present. Article III thus contributes to the construction of the integrative model on dynamic knowledge management by bringing the anticipation at different time spans to the core of meaningful KM in technology-based SMEs. The paper confirmed in its part the need of temporal

ambidexterity (short and long-term views combined) as a key capability for growth-seeking enterprises.

Article III contributed the following Primary Conceptual Contributions (PCCs) for the construction of the frameworks:

PCC 6: Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM

⇨ Impacts to framework building: Combination and impact of time scopes into KM process

PCC 7: Proposal for taxonomies to assist in the correct choice of planning tools and methods

⇨ Impacts to the framework building: Examples of anticipation method choices based on scope, resources and industry-type

4.4 Article IV results

Saukkonen, J., Vasamo, A. L., Ballard, S., & Levie, J. (2016). Anticipation of technology as an entrepreneurial skill. In *Proceedings of the 11th European Conference on Innovation and Entrepreneurship*. Reading: Academic Conferences and Publishing International Limited, pp. 717-725.

Objectives

Article IV aimed at exploring the approaches, strategies and practical processes that technology-based SME are applying in anticipation of technologies. The study approach was qualitative ones. Data were collected in semi-structured interviews with the key people for KM in the companies. Earlier literature had indicated that the choices of approach by the key stakeholders are both affecting the process itself but also the cognitive level: these choices have an effect on how companies view new knowledge as a whole (Boe-Lillgraven and Monterde, 2015). It has been proposed that critical futures research in commercial organizations is scarce and urgent matters tend to drive out the important ones (van der Duin, 2004).

Futures research should be done as a collaborative (network or industrywide) effort (Patton, 2004; Dufva and Ahlqvist, 2014). This might put SMEs into a weaker position, since they may lack the necessary connections for wide and deep anticipation. On the other hand, since innovations often take place at the intersection of traditional industries, SMES might even benefit from their position in the margin of existing industries and being less bound by sustaining innovation based on current business portfolio (Kostoff, Boylan and Simons, 2004). However, subsequently SMEs must then tap into the knowledge pools of various networks. These findings of resource scarcity vs. potential advantages acted as motivators for the study.

Findings

The study confirmed the relatively short timespans operationalized in anticipation. This can be understood from two different viewpoints: Either urgency overrules the longer-term relevancy or/and the SMES aim for maximum agility and act in reactive mode. One respondent coined their cognitive approach: "This flexibility and adaptability is the only true competitive approach we have when entering the markets". This confirms the earlier findings in the literature (e.g. Patton, 2004) stating that taken in account the inherent unpredictability in new technology, overly structured plans made for future may be limiting if not dangerous.

However, poorly structured approaches on anticipation, such as the one identified in the study and named "loose environmental scanning" may not serve the purpose. Instead, a well-defined and ongoing process may reveal the uncertainties and options that help the company to make the right choices early on and thus add on their agility. The other two approaches identified were: 1) Company-based technology evaluation and selection and 2) Network-based joint scenario creation demand both a process owner/driver (person or company within the value chain) as well as structured process and documentation, hence increasing the demand for structure and documentation.

Summary and contribution to the whole

The main contributions of the study are that technology-based SMEs are a heterogeneous group in what comes to the role of anticipation in KM and efforts in it. The scope of studied SMEs tends to be rather short unless they are part of the value chain of an established industry. The SMEs studied aimed at balancing the agility to adapt to volatile conditions with having views on the future directions. To decrease the risk of "betting wrong" technology SMEs studied preferred to keep many optional directions open - that leads at times to fuzzy outlooks and processes. The nature and dynamics (e.g. product life cycles) of the industry they are part of or supply to also impacts approaches on anticipation. The findings of the earlier literature highlighting the emphasis of knowledge management action extending over firm´s boundaries as well as high rate and speed of change affecting SMEs' knowledge management were supported.

Article IV provided the following PECs and resulting implications for the construction of the frameworks:

PEC 8: The large variety of scope and methods in anticipation by Technology SMEs

⇨ Impacts to framework building: No single method –path constructible, different time scopes call for different approaches and action

PEC 9: Methods of anticipation differ in their open-endedness and agility + the explicitness of the results obtained

⇨ Impacts to framework building: Dynamics in the development trajectory need different approaches. Networking for anticipation may reduce the risk but demands coordination.

4.5 Article V results

Saukkonen, J., Nukari, J., Ballard, S., & Levie, J. (2016). Start-up entrepreneurs and university students in a co-learning mode: Learning effects of a collaborative entrepreneurial coaching programme. *Industry and Higher Education*, 30(3), pp. 224-238.

Objectives

Article V is based on evaluations of impacts to self-assessed levels across entrepreneurial capability areas in a program aimed at first-time science- and technology entrepreneurs and students of university to whom this program was an optional specialization course in technology entrepreneurship. The self-efficacy was measured at three different time points – t_0 was the baseline measurement based on participants' perceived level of knowledge prior to the implantation of the program. The eight-week development program consisted of introductory lectures, exercises (done in teams made of entrepreneurial team members and students), coaching sessions and the final presentation to a panel made of professional business developers and investors. In the next assessment (t_1), the participants self-assessed their capabilities right at the end of the intensive coaching and learning period. The same sample of respondents was again approached at t_2 one year ex-post to the program.

The objectives were to study the impact of a formalized, case-sensitive (via coaching and exercising the participants' own start-up company/business idea) intensive development program: The goal was to study the impact of the program across different areas of entrepreneurial knowledge and its longevity vs. perceived deterioration over time.

Findings

The findings of the descriptive statistics analysis showed that between t_0 and t_1 (i.e. the short-term effect - self-assessment of capabilities ex-ante vs immediate ex-post) of the development program across all knowledge areas (Strategic planning, IPR and tech management, Marketing and sales, Competition and alliance knowledge, Operations, Management and staffing, Financial planning, Presentation Skills) showed that both groups (entrepreneurs and students) reported improvement in all knowledge areas treated in curriculum of the program

By applying the measure of statistical significance (Mann-Whitney U-test) the picture changed: For start-up entrepreneurs the improvement from t_0 to t_1 was significant in four out of seven knowledge capability areas, while the co-learning students showed improvement in three out of seven capability areas.

When the perceived self-efficacy on knowledge was assessed again at t_2, one-year ex-post to the program:

- the entrepreneurs reported on most knowledge areas lower values to their perceived capability that in t1

- the students participating the program reported in most continued improvement or retention of capability levels they self-assessed at t1
- the changes between t1 and t2 , however, did not have statistical significance

Looking at the longer-term effect of the organized learning to technology entrepreneurship –knowledge against time – a comparison between perceived self-efficacies between t_0 and t_2 (ex ante the program and one-year ex post):

- for entrepreneur-cohort only one knowledge area - Marketing and Sales- had been significantly (according to statistical test) improved for the longer term period
- for the student-cohort the improvements had held in a significant manner on three areas - Strategic Planning, IPR and Tech Management, Competition and Alliance Knowledge for the t1 to t2 period

Summary and contribution to the whole

The study revealed the typical characteristics of volatility and dynamism related to knowledge in technology-based SMEs set to learn and grow.

Knowledge is bound to time – when the entrepreneurial venture and entrepreneurs in it proceed, the content and level of knowledge-required changes, causing re-assessment of self-efficacy. New states of development require new solutions that the learning program could not fully anticipate and address at the time of the implementation.

The perceived level of knowledge is bound to context: The students – who did not have to put their learning into practice - reported higher levels of knowledge possessed than the entrepreneurs who need to put their knowledge into test in their business environment.

Even the core knowledge that a science- and/or technology-based company is founded on – IPR and technology management gets lower scores from the entrepreneurs one year after the formalized learning than right after it. The authors inductively interpret that the collision of the boundaries of entrepreneurs' knowledge with the real-life demands of the market – something that students did not need to live through. While the entrepreneurs' knowledge faced the reality between t_1 and t_2, the student continued their academic learning path containing additional theoretical learning of the capability areas.

On the other hand, the study showed how significant improvements can be achieved in technology-based SMEs by short intensive interventions. These interventions are likely to have a more lasting and, thus, important impact if they address knowledge areas – in this case Marketing and Sales – that is not a part of the earlier knowledge pool of entrepreneurial team.

The PECs and resulting impacts surging from Article V for the construction of the frameworks are:

PEC 10: Relativity of knowledge value possessed to real-life demands in implementation

⇨ Impacts to framework building: Iterations in KM based on the value chain and market feedback

PEC 11: (Rapid) devaluation or obsolescence of knowledge in tech business environment

⇨ Impacts to framework building: Pressure for concurrent knowledge validation and adaptation – need for personal knowledge growth and/or knowledge pool enlargement

4.6 Article VI results

Saukkonen, J. (2018). Entrepreneurs and growth: An option, obligation or obsession. In *Entrepreneurship: Development Tendencies and Empirical Approach, 1*. Zagreb: InTech Open. pp. 3-33.

Objectives

Article VI focuses on issues related to business growth as a phenomenon and growth processes within the field of entrepreneurship. Growth seems conceptually a straightforward concept, yet it is has been viewed and conceptualized in diverse ways. Article VI describes the nature of growth by looking at its rationale, dimensions, process and factors influencing it. Article VI contains an overview of a separately published single case study of a technology SME, where some of these considerations are put into a practice and empirical contributions are used to develop a conceptualization model of growth processes.

Findings

Article VI indicates how, for certain types of companies, growth is not an option but rather a pre-set condition to existence and survival. This set of growth-bound enterprises also contains the cohort of companies in the focus of this thesis, technology-based SMEs. The needs to grow surge from the funding base of such companies, invested assets demanding a steeply rising curve of returns to balance the high uncertainty. Also, there are short windows of opportunity for technologies and technology-based solutions (along with the abundance of competing solutions and technologies) which forces companies to get to the market early and obtain shares of growing markets. When doing this, technology-based companies embrace a continuous process of change often depicted in entrepreneurial research as growth processes.

Article VI points out that despite the recognized overall growth opportunity and imperative for technology SMEs, no law-like sequential models can be found in the literature that serve as a prediction of the growth trajectory of an individual firm. Modern theories and frameworks of growth have largely abandoned stage-based and sequential-only models. Rather, there are recognizable elements and dynamics states that form the part of that trajectory. The article builds and elaborates on that stream. When moving between those states SME companies

need to acquire, further develop and even abandon some knowledge related assets. Article VI proposes a new two-cyclical model where a company runs the growth processes (exploiting the knowledge acquired via Research, Development and Innovation work done) and start-up process (knowledge creation and search for new opportunities via new innovation and discovery) in parallel. The empirical single case study, shortly reviewed in Article, identified the need for evolution and change of the entrepreneur´s role, inputs and constraints in the growth trajectory.

Summary and contribution to the whole

Article VI indicates how the multifaceted nature of growth impacts the way a modern firm needs to be managed. The knowledge assets and competences in a technology-based SME both need to be exploited in a short time span as well as need to be complemented with new knowledge via strategic and structural growth. The article proposes that a relevant picture of a technology SME is an organism that runs multiple and cyclical processes that act on knowledge and impact knowledge in diverse ways.

The PECs and their effects to the building of the frameworks of Article VI are:

PEC 12: Cyclical nature of growth processes within Tech SMEs

- ⇨ Impacts to framework building: Iterative processes, need for backlogs and reverting to phases passed

PEC 13: The changing role and profile of founder-owner-managers (FOM) in the growth trajectory

- ⇨ Impacts to framework building: Layers for knowledge managements action (individual, project, enterprise) – the relative emphasis over time in the growth trajectory

PEC 14: Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)

- ⇨ Impacts to framework building: Dynamic nature of SME –cross-sectional view does not fit in the context specificities

4.7 Accumulated contributions of the study – primary empirical contributions arranged

The PECs and PCCs that surged from the articles making up the knowledge body of this thesis are presented in this section. Each article had its own main focus and contributed to a specific (in some cases more than one) element of the initial framework and/or the practical instantiaions of that framework.

The PECs in Table 7 are arranged according to the order of the articles and as they were described and analyzed in Sections 3.1-3.6 summarizing the PECs

and PCCs of each article. Next, their impact to the building of the new framework has been summarized and reflected against the findings of prior research. The last column of the table tells how the PEC has contributed in the form of theoretical and/or practical managerial contributions and thus yielded to the resulting construction of an integrative framework (Section 4.8) and its practical instantiations (Section 5.2).

TABLE 7 The Primary Empirical and Conceptual Contributions (PEC and PCCs) of the study

PEC/ PCC #	Description	Article #	Connection to RQs	Impacts for framework(s) building	Relationship to earlier research	Contribution type
1	SMEs focus KM in internal (vs. involving external parties) and operational (vs. strategy-bound) action	I	RQ	Company boundaries vs. network boundaries in the scope. Preference in short-term and less-strategic KM action.	Confirms: Tendency of urgency of actions to overrule their importance (van der Duin, 2004; CEN (2004b);Yan et al., 2016)	Practical
2	The impact of career legacy of key individuals to KM in SMEs	I	RQ RQ2	The challenge of cognitive bias vs. experience-based expertise in KM	Confirms: Impact of cognitive style of key people in KM (Sung and Choi, 2012) Enlarges: Career legacy impact on cognitive style (Goodhew et al., 2005)	Theoretical
3	Increased demand for higher speed knowledge processes and the (partial) incompliance with instituted IP protocols	II	RQ1 RQ3	Division to parallel processes with different speeds and for different knowledge artefacts	Confirms: The phenomenon of increased clock speed (Fine, 1998) Raises up: Risk vs cooperation vs speed	Practical
4	Increased demand for collaborative practices in KM and related risks	II	RQ RQ1	Firm interfaces with the environment, mechanisms and artefacts for collaboration	Confirms: The additive and cumulative nature of knowledge (Brenner and Schimke, 2015)	Theoretical Practical

PEC/ PCC #	Description	Article #	Connection to RQs	Impacts for framework(s) building	Relationship to earlier research	Contribution type
5	Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts	II	RQ RQ3	Process vs project/ product-related knowledge =>portfolio approach	Introduces: The unit of analysis? Firm/project/person/ product => confirms the Knowledge-portfolio-concept (Birchall and Tovstiga, 1998; 2002)	Theoretical Practical
6 (PCC)	Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM	III	RQ RQ2	Combination and impact of time scopes into KM process	Confirms: The temporal ambidexterity (Wang et al., 2019) Questions: The separability of planning/ scanning horizons (Kuusi et al., 2015)	Theoretical Practical
7 (PCC)	Proposal for taxonomies to assist in the correct choice of planning tools and methods	III	RQ3	Examples of anticipation method choices based on scope, resources and industry-type	Introduces: new double-dichotomies for categorizing tools and methods for KM	Practical
8	The large variety of scope and methods in anticipation by Technology SMEs	IV	RQ1	No single method –path constructible, different time scopes => different approaches and action	Confirms: The scarce and non-explicit KM practices in SMEs (CEN, 2004b; Svensson and Hedman, 2018)	Practical
9	Methods of anticipation differ in their open-endedness and agility + the explicitness of the results obtained	IV	RQ1	The dynamics in the development trajectory need different approaches Networking for anticipation may reduce the risk but demands coordination	Confirms: lack of use and structure in anticipation in SMEs (West and Meyer; 1998; Fleming and Sorenson, 2003; CEN2004b)	Practical

PEC/ PCC #	Description	Article #	Connection to RQs	Impacts for framework(s) building	Relationship to earlier research	Contribution type
10	Relativity of knowledge value possessed to real-life demands in implementation	V	RQ2	KM iterations due to the value chain and market feedback	Confirms: The iterations based on feedback and learning (Ingley et al., 2017; Torres et al., 2017)	Theoretical
11	(Rapid) devaluation or obsolescence of knowledge in tech business environment	V	RQ1 RQ2	Need of concurrent knowledge validation and adaptation – need for personal knowledge growth and knowledge pool enlargement	Confirms: Knowledge volatility and need for knowledge acquisition and enlargement from discovery-stage onwards (Kogut and Zander, 1992; Möller and Svahn, 2006)	Practical
12	Cyclical nature of growth processes within Tech SMEs	VI	RQ, RQ3	Iterative processes, need for backlogs and reverting.	Rejects: static models of KM process (Mentzas, 2004)	Theoretical Practical
13	The changing role and profile of founder-owner-managers (FOM) in the growth trajectory	VI	RQ RQ2	Layers for knowledge managements action (individual, project, enterprise) – the relative emphasis over time in the growth trajectory	Confirms: the inseparability/overlap of firm processes to owner/manager processes of growth (Calori et al., 1994)	Practical
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	VI	RQ RQ1 RQ3	Dynamic nature of SME –cross-sectional view does not fit in the context specificities	Confirms: The constant change and move between dynamic states of growth + iterations (Levie and Lichtenstein, 2010)	Theoretical Practical

4.8 Proposal for an integrative framework for dynamic Knowledge Management in technology-based SMEs

The initial framework for this study presented in Section 2.4 presents the elements likely to be needed when building a proposal for a model for dynamic knowledge management in technology-based SMEs.

The core tenants of dynamism in knowledge management – as a reminder of the theoretical base for the thesis – propose firstly that knowledge flows between stakeholders within a firm as well as between the firm and its external counterparts. Secondly, knowledge and its management are temporally dynamic, the criticality of different types of knowledge actions are bound to change as a result of the firms development and changes in its operating environment.

Building on the initial framework and elaborating on it with the outcomes of the studies reflected in the articles and summarized as PECs and PCCs, the new framework can be proposed. The framework is an evolutionary step from elements and relations that the prior-art had identified but not integrated and synchronized (these earlier findings depicted in the initial framework for this study, Figure 7). The resulting model contains the elements and relations of the initial framework augmented with the PECs and PCCs of this study.

The core premises of the framework are:

- the framework for knowledge management in technology-based SMEs can use the elements of general models of knowledge management but adapted to the specific characteristics to this cohort (theoretical base + PEC 12),
- the dynamic nature of knowledge in modern society as well as in the operating environment of technology SMEs requires the time-dimension to a framework to reflect the evolution of a SME and differing time-frames of KM action (PCC 6, PEC 12),
- a KM model cannot limit itself to describe a firm´s internal processes only, instead knowledge that the firm exchanges across its company boundaries must be included (theoretical base + (PEC 4),
- KM in technology SMEs is not a static construct, thus the framework needs to be capable of depicting the different states between which the knowledge-related action on assets changes in principles and practices (PEC 10, PEC 12),
- one construct in the model is the knowledge portfolio that is the collection of different knowledge assets (e.g. individual innovations, products or product families, processes, tacit knowledge) - that a firm aims to turn into competitive advantage and capitalize in the marketplace (PEC 5)
- presence and characteristics of key KM individuals affect the KM in technology-based SMEs (theoretical base + PEC 2),
- a model must capture the elements of iterations across and within the states of development of a knowledge asset and between different

knowledge assets within the portfolio (PEC 5, PEC 10, PEC 13). These iterations can also be called legacies, as they are informed either by a) firm´s experience of actions on the same state but with processes on earlier assets (inter-asset legacy) or b) experience of earlier attempts on the same state for the same asset (intra-asset legacy).

On the premises mentioned above, a following robust version for such a framework was created as summary of Primary Empirical Contributions joined with the findings of secondary data and prior-art frameworks of knowledge management (Figure 10).

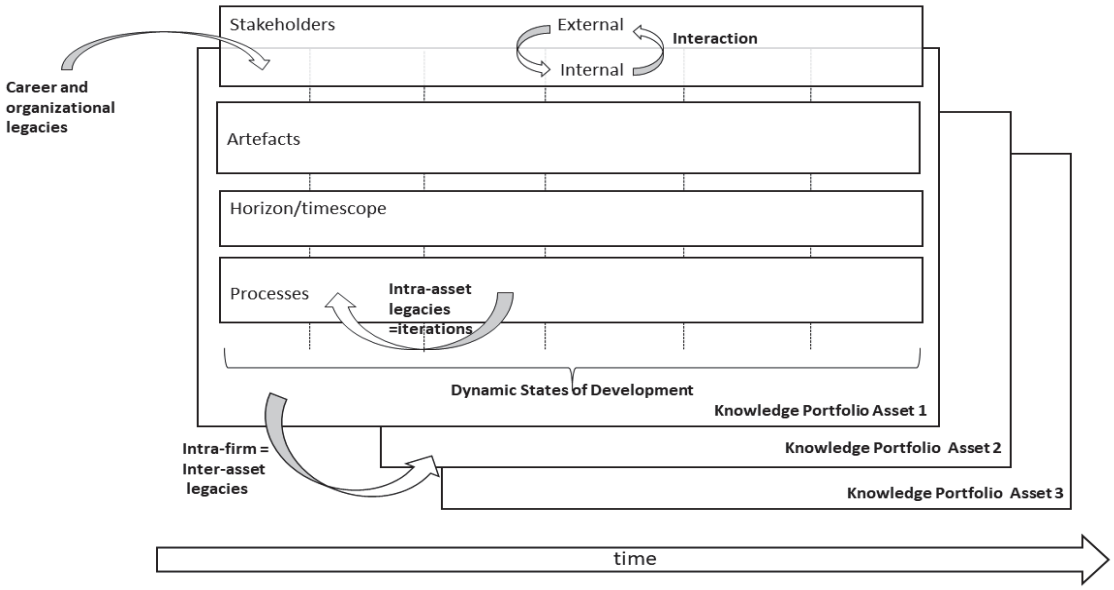

FIGURE 10 An integrative framework for dynamic knowledge management in technology-based SMEs

5 DISCUSSION

A scientific study gets motivated and justified through its attempt to broaden and deepen the knowledge of the scientific community in the researched area. It can do so by confirming the findings of the earlier research, studying and confirming the applicability of earlier theoretical constructs to new contexts, proposing improvements to earlier theories and frameworks, or even creating new theories for subsequent assessment and elaboration. In addition, theory should be applicable to practice to a certain extent. Scientific inquiry aims at capturing essential elements needed for a framework, along with the associations and relationships of those elements, and illustrating those elements and relationships in form of the frameworks. Since those constructs are derived by observations on reality via empirical research interventions, they should also be returnable back to the context of study and thus affect future action i.e. have practical implications.

This research has advanced various elements that add to the knowledge management framework and have practical implications. Those elements include: legacies of the knowledge actors, collaborative practices, time and its implications on KM, growth state relationship to KM, and implications of KM practice.

5.1 Theoretical implications

The main theoretical implication of the study is the integrative framework for dynamic KM. Table 8 summarizes the Primary Empirical Contributions that affected to the construction of the integrative framework (Figure 10).

TABLE 8 The PEC´s with theoretical contributions to integrative framework

PEC/ PCC #	Description	Article #	Connection to RQs	Impact for framework(s) building	Relationship to earlier research
2	The impact of career legacy of key individuals to KM in SMEs	1	RQ RQ2	The challenge of cognitive bias vs. experience-based expertise in KM	Confirms: Impact of cognitive style of key people in KM Enlarges: Career legacy impact on cognitive style
4	Increased demand for collaborative practices in KM and related risks	2	RQ RQ1	Firm interfaces with the environment, mechanisms and artefacts for collaboration	Confirms: The additive and cumulative nature of knowledge
5	Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts	2	RQ, RQ3	Process vs. project/product –related knowledge =>portfolio approach	Introduces: The unit of analysis? Firm/project/person/ product => confirms the Knowledge-portfolio-concept
6 (PCC)	Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM	3	RQ2	Combination and impact of time scopes into KM process	Confirms: The temporal ambidexterity Questions: The separability of planning/ scanning horizons
10	Relativity of knowledge value possessed to real-life demands in implementation	5	RQ RQ2	Iterations in KM based on the value chain and market feedback	Confirms: The iterations based on feedback and learning
12	Cyclical nature of growth processes within Tech SMEs	6	RQ RQ3	Iterative processes, need for backlogs and reverting to phases passed	Rejects: static models of KM process
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	6	RQ RQ1 RQ3	Dynamic nature of SME –cross-sectional view does not fit in the context specificities	Confirms: The constant change and move between dynamic states of growth + iterations

This study operates at the intersection of many areas of academic study. Knowledge management is a stream within management and organizational studies. The growth processes are natural foci of entrepreneurial studies, whereas considerations of anticipation are more familiar in futures research.

The study contributes to the theory building in knowledge management by introducing the time-dependent moderations (change, growth and anticipation) into the modelling of knowledge management processes. This study also highlights the specificity of technology business and especially technology-based SMEs as a unit of analysis. The study brings together the ideas of prior research on knowledge (and knowledge management) life cycles by de Barros Campos (2008) and knowledge portfolios primarily used by Birchall and Tovstiga (2002). They created framework can be seen as a bridge between two concepts previously treated individually in the literature.

Another addition to the canon of KM is the strong focus on dynamism –the impact of time-dependent elements of change, growth and anticipation in KM models. As Bono and McNamara (2011) state, many if not most research questions in management science implicitly (even when not framed that way) address the phenomena of change. There is wide agreement in the literature that organizational learning, capabilities, as well as knowledge itself should be dynamic. However, the inclusion of dynamism into knowledge management has been scarce. The concept of dynamic knowledge management has in prior research been used as a description of managerial style in regards to KM (as an alternative to 'System-orientated', 'People-orientated' and 'Passive' styles) as by Choi and Lee (2003) or as an organizational interplay between culture (motivation, people) and technology (interface, content, infrastructure) by Piorkowski, Gao, Evans and Martin (2013). Shang, Lin and Wu (2009) proposed that knowledge management can be enhanced through flow of dynamic capabilities via processes of integration, learning, and transformation. This triangle of processes was applied in a single case study (Shang et al., 2009) and thus the authors did not proceed to generalizations nor to the building of a more comprehensive model, though they comment that the implementation of the new KM system demonstrated the critical role of dynamic capabilities of knowledge management. These capabilities have the potential to transform the business processes and to create competitive advantages for the company (ibid.). The knowledge base of KM building on static cross-sectional models has thus been enriched with the model of dynamic KM, the main theoretical contribution of his study.

The research community of entrepreneurship may benefit in their studies and modelling of the development patterns of SME companies from this study that digs into growth, knowledge and its management in the dynamic framework. For startup researchers the study poses a question of the unit of analysis. Should the studies focus on products and solutions, processes, people, firms or networks as the unit of analysis to study? The findings of the study reveal some core differences in those options for scope as well as interconnections between them. The study also proposes the research community to study the development of knowledge assets and portfolios they create as a unit of analysis.

Another area impacted by this research is futures studies. Researchers in futures studies have done extensive work on developing methods and tools for foresight and anticipation. Those tools have been, as proven by earlier studies and by one of the original articles for this thesis, deployed in SMEs in modest volume. Prior studies have indicated that there is: a) a shortage of resources and systems of which SMEs suffer in looking beyond the urgent horizon, and, b) important advantages available in foresight through collaboration for SMEs (Major and Cordey-Hayes, 2000; Vishnevskiy and Egorova, 2015; Keller, Markmann and Heiko, 2015). The needs to improve the anticipation of knowledge assets in SMEs has not resulted in a larger effort to build frameworks that take into account SME specificity. Furthermore, the dilemma of scanning (long-term) and planning (short-term) scopes has been recognized by research but not elaborated on. This study assumes to have an impact on the development of model building and testing on this temporal ambidexterity. As Hassanabadi (2019) states, organizational capability in foresight provides enhancements in competitive advantage in highly uncertain environments. The framework developed in this thesis has resulted from studies focusing on technology-based SMEs who operate in aforementioned conditions.

The literature and research of knowledge management (and its dynamics) has tended to bifurcate addressing corporate-type of companies or SMEs/start-up companies. This study focuses on the latter despite utilizing many models and concepts originating from the mainstream of the KM literature, often based on studies of multinational, multidivisional and mature companies. This type of dichotomy may be outdated. Across industries big corporations are launching venture arms or acquiring young and agile companies in order to operate in a lean and agile manner like their smaller counterparts (e.g. Ries, 2017; Edison, Smørsgård, Wang and Abrahamsson, 2018).. The primary empirical and conceptual contributions (PECs and PCCs) of this study, the resulting integrative dynamic KM framework as well as the hypothetical practical instantiations of the framework based on practice-related PECs and PCCs (Section 5.2. and appendices) can potentially contribute also to the development of dynamic KM frameworks in the larger company context. This potential needs to be tested in future studies, as the research design of this thesis does not allow generalizations in that scope.

5.2 Practical implications – the framework(s) in action

Table 9 summarizes the Primary Empirical and Conceptual Contributions (PECs and PCCs) that have been used in the hypothetical practical instantiations of the integrative framework. The illustrated instantiations derived for the integrative dynamic KM framework and these PECs/PCCs are to be found in Figure 11 and appendices.

TABLE 9 The PECs and PCCs with practical managerial contributions

PEC/ PCC #	Description	Article #	Connection to RQs	Impact for framework(s) building	Relationship to earlier research
1	SME focus KM in internal (vs. involving external parties) and operational (vs. strategy-bound) action	I	RQ1	Company boundaries vs. network boundaries in the scope Preference in short-term and less-strategic KM action	Confirms: Tendency of urgency of actions to overrule their importance
3	Increased demand for higher speed knowledge processes and the (partial)incompliance with instituted IP protocols	II	RQ1, RQ3	Division to parallel processes with different speeds and for different knowledge assets	Confirms: The phenomenon of increased clock speed raises up: Risk vs cooperation vs speed
5	Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts	II	RQ RQ3	Process vs project/product-related knowledge	Introduces: The unit of analysis? Firm/project/person/ product=>confirms the Knowledge portfolio-concept
6 (PCC)	Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM	III	RQ2	Combination and impact of time scopes into KM process	Confirms: The temporal ambidexterity Questions: The separability of planning/ scanning horizons
7 (PCC)	Proposal for taxonomies to assist in the correct choice of planning tools and methods	III	RQ3	Examples of anticipation method choices based on scope, resources and industry-type	Introduces: new double-dichotomies for categorizing tools and methods for KM
8	The large variety of scope and methods in anticipation by Technology SMEs	IV	RQ1	No single method – path constructible, different time scopes call for different approaches and action	Confirms: The scarce and non-explicit KM practices in SMEs

PEC/ PCC #	Description	Article #	Connection to RQs	Impact for framework(s) building	Relationship to earlier research
9	Methods of anticipation differ in their open-endedness and agility + the explicitness of the results obtained	IV	RQ1	Dynamics in the development trajectory need different approaches. Networking for anticipation may reduce the risk but demands coordination	Confirms: lack of use and structure in anticipation in SMEs
11	(Rapid) devaluation or obsolescence of knowledge in tech business environment	V	RQ1, RQ2	Pressure for concurrent knowledge validation and adaptation – need for personal knowledge growth and/or knowledge pool enlargement	Confirms: Knowledge volatility and need for knowledge acquisition and enlargement from discovery-stage onwards
12	Cyclical nature of growth processes within Tech SMEs	VI	RQ RQ3	Iterative processes, need for backlogs and reverting to phases passed	Rejects: static models of KM process
13	The changing role and profile of founder-owner-managers (FOM) in the growth trajectory	VI	RQ2	Layers for knowledge managements action (individual, project, enterprise) – the relative emphasis over time in the growth trajectory	Confirms: the inseparability/overlap of firm processes to owner/manager processes of growth
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	VI	RQ RQ1, RQ3	Dynamic nature of SME –cross-sectional view does not fit in the context specificities	Confirms: The constant change and move between dynamic states of growth + iterations

In addition to contributing to theory development in the research area and to the accumulation of empiricist knowledge from the field, a researcher can contribute to the practitioner community by assessing and improving their strategies, processes and actions. Even though models and frameworks created in science can never grasp the full diversity and multi-dimensionality of business decisions in real life (since they are models) let alone be applicable as such for each individual case, they may help practitioners structure their thinking and provide tools to review their own practices vs. the models. In the SME cohort of companies Svensson and Hedman in their recent case study (2018) observed many knowledge processes that were not based on formulas or models. These

can be called ad-hoc KM that starts at an unpredicted point in time and forms a process as it goes (Svensson and Hedman, 2018). Frameworks may save effort in figuring out the possible directions of action as time, the firm and projects in it proceed.

In the subject area of this study, Olaisen and Revang (2018) challenged the KM research community to address in an increasing manner the need of pragmatism. They also advocated the development towards sensitizing subjective paradigms:

- The literature synthesis, primary empirical contributions of this study and the frameworks created offer the following contributions to dynamic knowledge management in technology- and knowledge-intensive SME firms - a cohort that has not been the focus in the mainstream of the knowledge management research:
- The unit of analysis and action: Is the focus in developing general firm and network capabilities on knowledge or solving knowledge issues in the project and product level?
- Is the knowledge obtained of sufficient level to proceed or is there a need for iterations (intra- and inter-asset legacies) for knowledge improvement?
- The time scope and "need for speed" in the knowledge action in question – a technology SME needs to scan and plan simultaneously
- The relationships and exchange needed to act on knowledge – balanced with risk embedded in collaborative practices
- The inherent person-based and thus potentially subjective or even biased knowledge perception and action by the key stakeholders - are the legacies of the firm and key people knowledge-enhancing or knowledge-endangering factors?

Following the idea of Garud, Kumaraswamy and Sambamurthy (2006) this study leans on the premise that organizations are designed to reconfigure themselves. This seems to hold true for the studied companies - technology-driven SMEs and more specifically, knowledge management in them as a function of time and growth. The findings of this study may facilitate such reconfigurations. The primary empirical contributions of the study should give views and guidance to the practitioners. To achieve this goal, this section aims to show how the integrative framework developed can be enriched with details. These illustrations should be regarded as instantiations of the framework. Instantiation is a term common in design science research (DSR) that typically sets out to create innovative artifacts addressing unsolved problems in organizations (Hevner and Chatterjee, 2010). The artifacts in the DSR context include among others conceptual artifacts, such as constructs, models, methods and frameworks as well system designs, guidelines and patterns (Hevner and Chatterjee, 2010; Peffers, Rothenberger, Tuunanen and Vaezi, 2012). This thesis thus complies with the core ideas of the DSR approach, and the usage of practical

instantiations is a logical step to discuss the utility of the prospective framework created.

As the framework indicates, across the states of development the core actions on knowledge, periods of the knowledge relevant and process speeds all vary. Similarly, in each state a SME is likely to find some knowledge stakeholders more relevant than others.

Figure 11 depicts how the integrative framework of dynamic knowledge management might act for the practitioner. Figure 11 is a practical instantiation of the proposed framework, as it adds pragmatic detail to the more conceptual framework. The structure follows the integrative framework and enriches it by proposing how the time-dependent change (in the form of dynamic states that a technology-based SME passes through) affects the contents of the variables (stakeholders, artefacts, goals, resources and processes). The practical instantiation in Figure 11 is of hypothetical nature, since it has not been tested as such empirically, but derives its contents from the practice-contributing PECs of this study and findings of the literature.

As the framework indicates, across the states of development questions of "who", "what", "why" and "how" get a different answer. The dynamic states selected for this hypothetical instantiation are derived from Marmer et al. (2011a) and Skok (2017) since the growth literature agrees on the principle of dynamic states but not on what the states are.

It is also worth noticing what the framework does not contain. The vivid discussion in the research on whether entrepreneurs operate on cation (decides clear goals and proceeds to them) effectuation (organizes optimal resources for the mission) or emergence (reacts to changes in operative environment) seems based on the findings of this study to be irrelevant. Technology-based companies act according to all these "settings" as they develop. The instantiation does make a notion of the altering focus between scanning for ideas and opportunities and planning for the deployment of the knowledge acquired.

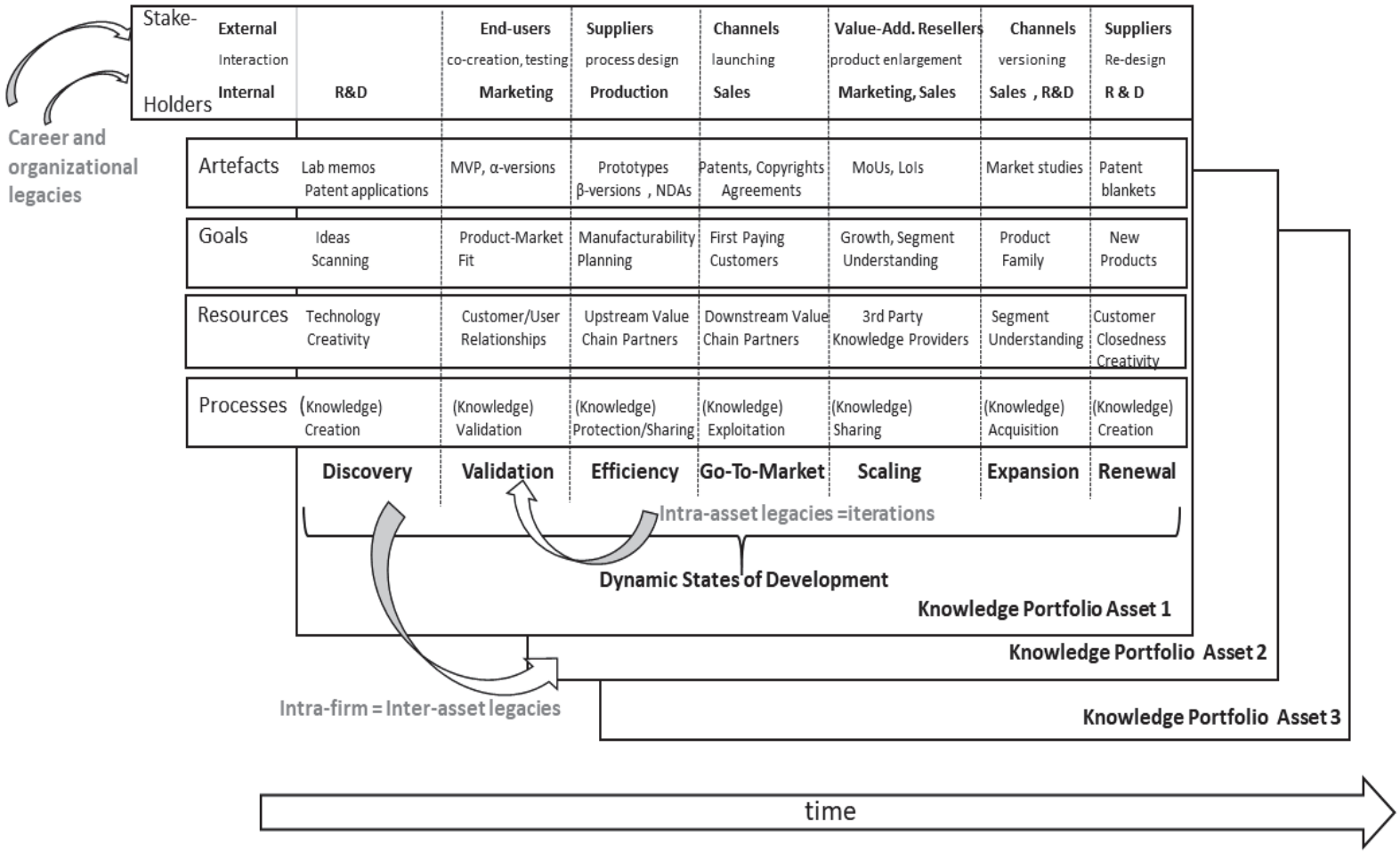

FIGURE 11 A hypothetical practical instantiation of the framework with knowledge variables across dynamic states of development

The core contributions that the instantiation proposes are:

- The framework rejects the models of growth that are linear and aim to describe how a *firm* is born and how it evolves. This rejection is based on a few premises arising from the literature and the primary empirical contributions of this study:
- A young firm is typically founded around a core innovation – new knowledge created/discovered, and subsequently the validation concerns that innovation rather than the firm as an organization or legal entity. A technology-based SME is likely to work on multiple innovations and applications of them i.e. action on a knowledge portfolio, the assets of which are in different states of development.
- The firm can utilize the knowledge it has acquired from action on knowledge assets that have been developed earlier and thus passed a state of development the new asset is entering into. These legacies can also be misleading, as the context for the new knowledge asset may have altered from the previous time a state was passed.
- From each state of development, there is potential to backtrack to earlier states in case that state does not produce viable options to proceed. As Figure 12 (Appendix 1) shows, iterations can be numerous in the development trajectory of a knowledge asset (see Appendix 1). For example if the original invention created in the discovery-state does not get response from the market in validation state, the knowledge asset needs to be returned to the discovery state for rework. Proceeding to the next state of development is naturally also possible at any point – e.g. in case the market feedback (product/market fit) is positive, the firm may move forward to the efficiency state.
- As soon as there is a wider product range or multiple markets to serve, a SME runs parallel knowledge assets that are in different states and thus operate with different participants and different contents. When superimposed (Appendix 2), these assets create a firm´s knowledge process portfolio.

When managing knowledge inside the portfolio, there are naturally issues, actions and relationships that are replicable and transferable across portfolio assets. Neither all pieces of knowledge nor processes are unique and accumulated knowledge as well as accumulated meta-knowledge - knowledge on knowledge - have potential to improve KM over time. The accumulated and enhanced knowledge can be seen to reside in knowledge legacies both external and internal to the firm. The core essence of legacy is that it is handed down to the present from the past. The dynamic nature of knowledge thus also refers to the past. The external legacies for a SME reside partly in the background of the key people for KM (their training, experiences outside the SME) as well as in the origins of the SME as an organization.

Many technology corporations have, during the last decades, tested new ideas, markets and business models in separate, smaller and more agile spin-offs or new venture arms, whose knowledge management may however contain

models (or parts of models) from the organization of origin. In the internal dimension, the knowledge accumulated from previous states is likely - and logically it should do so – to affect the states following. Knowledge is additive within firm and process/project. Another type of legacy is iteration within the growth trajectory, where the knowledge from the earlier state that the firm is forced to return or choose voluntarily to return to, is likely to inform the state performed again. Finally, in a more advanced company that is running a knowledge portfolio, as depicted earlier, the learnings of KM in a certain dynamic state can be transferred or replicated in another portfolio asset. The risk with all legacies is that if the conditions or contexts differ from the state from which the legacy is inherited, the knowledge may have become obsolete and thus it misleads new knowledge rather than eases it or speeds it up.

Not all technology SMEs are startups if the inclusion criteria to that cohort is - as in many studies - longevity up to the date of the company as a legal entity. There are technology-based SME companies with history longer than would be expected from a startup, but they operate in the same volatile (technology-, market- and competition-wise) environment as their less mature (in age) rivals. Because of that, this study has purposefully avoided the use of the word startup due to the fuzziness of the term as well as its irrelevance to the phenomena under study. However, a PEC from Article VI adds the two loop-model into a framework: A technology-based SME may possess knowledge assets that are proceeding in the states that relate to the start-up process (with potential iterations= loops) and assets that have proceeded to the growth process (Figure 14 in Appendix 3)

Additionally, this study supports the view of the earlier literature on temporal ambidexterity, where firms need to run in parallel short- and long-term focused processes. The idea of planning vs scanning horizons thus only concerns how far ahead the vision of the firm is. The question of scanning vs. planning is not an either-or issue, and they do not follow on the timeline sequentially across the time axis. Instead, a technology-based SME is likely to operate on both paradigms simultaneously, but their relative weights may alter across states through which the firm moves (Appendix 4).

6 CONCLUSION

At the outset of this study, four separate research questions derived from the objectives of the study were established. The questions are answered in a condensed format, based on the findings presented in earlier chapters, after which the quality of the process and results are assessed. To conclude the limitations of the study as well as potential future pathways to research on the topic areas of the study are discussed.

6.1 Answers to the research questions

This chapter presents the answers to the main research question (RQ) as well as sub-questions RQ1-RQ3, building on the Primary Empirical and Conceptual Contributions (PECS and PCCs) of the research relevant for each question.

RQ: How to manage knowledge in technology-based SMEs?

The main contribution of this research is the proposal for an integrative framework for dynamic knowledge management in technology-based SMEs as an answer to the main research question set. This new framework builds on PECs and PCCs relevant to the RQ as summarized in Table 10.

Instead of a cross-sectional view of what a SME's knowledge base is, the more defensible framework is to see the SME firm as an organism that operates many parallel knowledge assets of the portfolio (PEC 5, PEC 12). Those assets contain variables such as time-scope, key objectives, artefacts, tools and methods, the deployment of which depends on the dynamic state of development of the knowledge portfolio asset rather than the company as a whole (PEC 5). These states are informed and affected by internal legacies from within the firm, as well as by career legacies of key KM people. Learnings from same dynamic states from previous portfolio assets as well as intra-asset legacies surging from iterations also inform KM action on new assets (PEC 2, PEC 13).

TABLE 10 PECs, PCCs and their impacts on framework building related to the RQ

#	PEC/PCC	Impact of PEC/PCC
2	The impact of career legacy of key individuals to KM in SMEs	The challenge of cognitive bias vs. experience-based expertise in KM
4	Increased demand for collaborative practices in KM and related risks	Firm interfaces with the environment, mechanisms and artefacts for collaboration
5	Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts	Process vs. project/product –related knowledge => portfolio-approach
6	Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM	Combination and impact of time scopes into KM process
10	Relativity of knowledge value possessed to real-life demands in implementation	Iterations in KM based on the value chain and market feedback
12	Cyclical nature of growth processes within Tech SMEs	Iterative processes, need for backlogs and reverting to phases passed
13	The changing role and profile of founder-owner-managers (FOM) in the growth trajectory	Layers for knowledge managements action (individual, project, enterprise) – the relative emphasis over time in the growth trajectory
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	Dynamic nature of SME –cross-sectional view does not fit in the context specificities

Legacies can naturally be also of misleading nature. As Hargadon and Fanelli (2002) warn, at times knowledge acts as a source of organizational innovation and change, whereas at other times it can set constraints to change. A SME does not run its dynamic knowledge management in a vacuum or purely internally. The cumulative, additive nature of knowledge also requires the firm to understand the potential impacts of its networks on KM and thus the network view and actions based on it (sharing, collaboration) should be incorporated into a viable KM framework (PEC 4). Additionally, the future-oriented nature of the quest for knowledge is shown in the temporal ambidexterity. A firm is in the constant process of combining the short-term (planning) and longer-term activities (scanning), the relative role and value of which varies based on the dynamic state that the knowledge portfolio asset is in on the continuum. (PCC 6, PEC 10). The accumulated knowledge obtained from the articles – PECs and their impacts that relate to the RQ - is shown in Table 10.

Bailey and Clarke (2000) state that to be useful, ideas and models of KM need to have currency, relevance and actionability. Managerial currency of models refers to the ability to describe KM in terms of critical areas of managerial focus and practice. Model relevance should offer not only strategic relevance but also be able to reflect personal relevance by enabling the pursuit and achievement of personal goals. Actionability demands that via improved models activities of generating, communicating and exploiting that information and knowledge become practical (ibid.). The proposed integrative framework of this study and

the potential instantiations derived from it can be adapted to the particular needs of the organization, to be utilized by management and other KM actors. In addition, the changing context and firm's state of development) may require these adaptations within a firm, thus offering leeway for more current, relevant and actionable KM.

Lastly, the settings and changes of the operational environment act as a moderator of the processes described. The pressures on accelerated KM actions as well as increased volatility and resulting uncertainty have shaped and are shaping the contents and operations of KM in Technology-based SMEs.

RQ1: What are main driving forces and intervening factors to knowledge management in technology-based SMEs

The results of the study – as summarized in Table 11 for RQ1 - indicate that dynamics both as a change of KM as the function of time as well as dynamics as interchange of knowledge between KM stakeholders strongly define KM in technology-based SMEs.

TABLE 11 PECS and their impacts on framework building related to RQ1

#	PEC	Impact of PEC
1	SMEs focus KM in internal (vs. involving external parties) and operational (vs. strategy-bound) action	Company boundaries vs. network boundaries in the scope. Preference on short-term and less-strategic KM action.
3	Increased demand for higher speed knowledge processes and the (partial) incompliance with instituted IP protocols	Division to parallel processes with different speeds and for different knowledge assets
4	Increased demand for collaborative practices in KM and related risks	Firm interfaces with the environment, mechanisms and artefacts for collaboration
8	The large variety of scope and methods in anticipation by Technology SMEs	No single method –path constructible, different time scopes => different approaches and action
9	Methods of anticipation differ in their open-endedness and agility + the explicitness of the results obtained	Dynamics in the development trajectory need different approaches Networking for anticipation may reduce the risk but demands coordination
11	(Rapid) devaluation or obsolescence of knowledge in tech business environment	Need of concurrent knowledge validation and adaptation – need for personal knowledge growth and knowledge pool enlargement
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	Dynamic nature of SME –cross-sectional view does not fit in the context specificities

In more detail, the thesis research highlight the specific characteristic of the studied company cohort of technology-based SMEs: volatility and uncertainty are present when managing any knowledge a technology-based firm may possess or strive for (PEC 11). Based on the empirical contributions of the study this ambiguity of knowledge value has also resulted in loose if not vague processes on knowledge (PEC 8). Especially in the search of future-related knowledge (anticipation) this fuzziness and scarcity of practices is evident (PEC 9). The study confirms the notions of earlier research that resource scarcity and tendency of "urgent to rule over important" is clearly present (PEC 1).

The other factors that both researchers as well as practitioners of knowledge management in technology based SMEs need to take into account are increasing needs for higher process speed and constant change. Any formula created for deploying knowledge management is likely to fall out of date if not adapted as a firm proceeds on its growth trajectory – knowledge management is dynamic in time (PEC 11, PEC 12). The need to accelerate knowledge (PEC 3) – paired with the increasing need to cooperate with other knowledge stakeholders (PEC 4) poses a dilemma to companies. The more knowledge is expressed, shared and acted upon jointly, the higher is the risk for the loss of its proprietarity.

RQ2: How do the intended outcomes and contents of knowledge management process change over time in the growth trajectory of technology-based SMEs?

This research indicated growth as an inherent phenomenon that defines the context and operations of technology-based SMEs. The results – PECS and PCCs relevant for RQ2 summarized in Table 12 - indicate that the altering dynamic states of growth require altering managerial responses within knowledge management function.

TABLE 12 PECs, PCCs and their impacts on framework building related to RQ2

#	PEC/PCC	Impact of PEC
2	The impact of career legacy of key individuals to KM in SMEs	The challenge of cognitive bias vs. experience-based expertise in KM
6	Collision of scope and focus between short-term (planning) and long-term (scanning) horizons in KM	Combination and impact of time scopes into KM process
10	Relativity of knowledge value possessed to real-life demands in implementation	KM iterations due to the value chain and market feedback
11	(Rapid) devaluation or obsolescence of knowledge in tech business environment	Need of concurrent knowledge validation and adaptation – need for personal knowledge growth and knowledge pool enlargement
13	The changing role and profile of founder-owner-managers (FOM) in the growth trajectory	Layers for knowledge managements action (individual, project, enterprise) – the relative emphasis over time in the growth trajectory

Despite the wide rejection of linear-stage gate models depicting the growth of companies, growth and its impact to knowledge management can be described as a journey through dynamic states that differ from each other. This journey contains iterations and adaptation to changing demands (PEC 10, PEC 11). These variables between states are such as the time scope involved, collaboration partners relevant to the goals and also the knowledge artefacts and sub-processes operationalized (PCC 6, PEC 11).

Two important modifications to prior-art KM models seem to be of need. First, in a technology-based SME there are several knowledge processes going on simultaneously, so models of treating a firm as a one solid unity and treating the firm and its KM actions as equal units of analysis is a strong simplification of the knowledge system in a modern firm in a technology business. Rather than managing a firm´s knowledge as one, a tech SME is likely to manage a knowledge portfolio containing simultaneous yet very different actions and purposes (PEC 10, PEC 11). Second, the roles and responsibilities of key persons in the SME knowledge management have a major impact on the overall knowledge endeavor (PEC 2, PEC 13). Based on the findings their effect to the process should be recognized, the strength of positive legacies and learnings utilized but also the potential biases deriving from these legacies that prevent successful KM avoided. In entrepreneurial firms, the evolutions of KM roles over states of growth should be planned.

RQ3: What developments can be proposed for a dynamic knowledge management in technology-based SMEs?

In Section 3.8 a prospective integrated framework for knowledge dynamics in tech SMEs was presented. Compared to the earlier models by knowledge management science the model does not focus on the categorizing of knowledge actions or artefacts, but on how to build in the elements of time and collaboration as basic features of such frameworks. This study proposes to see a technology-based SME as a knowledge processing organ that is operating in volatile conditions both in what comes to its operating environment at large, as well as its networks. The outlines for such a view are based on PECs and PCCs summarized in Table 13.

This study advocates, via the frameworks developed, a model sensitive to the state of development of assets in the knowledge portfolio instead of static, company level model for KM (PEC 5, PEC 12). On the other end of the continuum, very loosely defined process may also put the company and its knowledge base at risk (derived from PEC 5). Recognizing the state of growth, the challenges but also potential avenues of action (what? how? whom?), in the current state and proceeding to next states is likely to improve the KM activity in a technology-based SME with limited resources and fast changing operative environment (PCC 7).

TABLE 13 PECs. PCCs and their impacts on framework building related to RQ3

#	PEC/PCC	Impact of PEC/PCC
3	Increased demand for higher speed knowledge processes and the (partial) incompliance with instituted IP protocols	Division to parallel processes with different speeds and for different knowledge assets
5	Request for meta-capabilities of knowledge = knowledge of knowledge more valuable than individual knowledge artefacts	Process vs project/ product-related knowledge =>portfolio approach
7	Proposal for taxonomies to assist in the correct choice of planning tools and methods	Examples of anticipation method choices based on scope, resources and industry-type
12	Cyclical nature of growth processes within Tech SMEs	Iterative processes, need for backlogs and reverting
14	Growth as an obligation for Tech SMEs + implications for different areas of growth (e.g. strategic/structural/assets)	Dynamic nature of SME –cross-sectional view does not fit in the context specificities

The changes of environment and the knowledge network are pressing a SME towards faster knowledge processes (PEC 3). The constant change is also omnipresent in the KM of technology-based SMEs. Knowledge portfolio assets are ingredients of individual projects and processes that may be in a very different phase at any point of the development trajectory - described as dynamic states of growth (PEC 12). These dynamic states do not follow each other in a linear manner, but contain many iterations (PEC 12). An entrepreneurial company may benefit from this division to plan for the changes in their operation in KM as the firm evolves.

The developed practical instantiations (figure 11 and the appendices) based on these principles and on the integrative model of dynamic KM created offer examples how a firm can identify, plan and perform their KM operations dynamically. In addition, the indication of legacies and the cumulative/additive nature of knowledge encourages practitioners to discuss and document their KM actions to best benefit from these dynamic capabilities.

6.2 Limitations of the study

As the title of this thesis indicates, knowledge and its management are dynamic as both concepts and as processes. The ways organizations and actors in them engage into knowledge management, organize and practice it have evolved over time and will continue doing so. Despite the fact that the articles making up this dissertation were published in the relatively short timeframe of 2016-2018, the picture of knowledge dynamics in SME companies is to a certain extent a cross-sectional one, since the companies in focus were not followed longitudinally. Hence, there is no data on the cases to show empirically the chain of actions taken by SME entrepreneurs and their network partners over time on the growth path. The dynamic model created via the inductive approach thus calls for testing.

The evolution of technological environments (Internet of Things, Artificial Intelligence, Machine Learning etc.) alone is likely to alter the way companies create, search for, transfer and exchange knowledge in the future. Also, the sample in the studies making the articles differed. Future researchers might be inclined to take that longitudinal case-based approach, as that would also contribute to the further development of growth models of companies. Despite the notions expressed in the theoretical part of the thesis that the growth models are (too) numerous and that they (as stated by some scholars) are "all wrong", there seems to be potential to elaborate on them from the knowledge management point of view. This suggestion can be defended from the point of view that the target population of the studies – technology-based SMEs – are both highly dependent on their ability to act on knowledge management and simultaneously resource-constrained for practicing it.

The cases selected for the studies constructing this thesis were purposefully sampled, and so there was no randomness in the selection of the KM stakeholders under study. This may create bias and limit the generalizability of findings based on the cases selected. The general limitations of the case study method in this sense prevailed: These may be related to the uniqueness of each unit under study and the resulting lack of generalizability. The researcher aimed avoiding this pitfall via method and researcher triangulation.

The main research philosophy adopted for this dissertation – the inductive approach – set another inbuilt limitation. The dilemma of inductive reasoning refers to the social process by which we generalize though we only have observed particulars. Therefore, we may proceed from "various grounds to various claims in an attempt to convince an audience" (Toulmin, 2003). The researcher has utilized the strategy of contextualization to improve the "quality of reasoning", as proposed by Ketokivi and Mantere (2010), by sticking to the cohort of companies in focus and not generalizing beyond this context.

6.3 Recommendations for further research

Despite notions that technology-based new ventures are "born global" (i.e. they enjoy a global business opportunity as well as are subjected to global competition early on), they still are, to an extent, bound to the business environment they operate in. The SME companies studied in the enclosed articles were all residing in Finland, which sets its own constraints and opportunities for SMEs. The impacts to what should be done in SMEs' knowledge management and how are impacted by socio-cultural factors as well as technological-monetary ones surrounding SMEs. A comparative study covering technology-based SMEs from various origins would shed light on the importance and impact of these contributing factors to SME development in relation to knowledge dynamics.

The view created in this thesis was loyal to its target and title focusing on technology-based SMEs. Thus, samples were somewhat homogenous and thus generalizations to all types of SMEs may be limited. However, within the scope

of technology-based SMEs, there was heterogeneity, as companies in samples operated in different industries. One approach to further the study would be to drill down to companies operating in a particular industry or product category. As an example, a SME working on physical products - with potential to access a patent - may operate differently time- and action-wise to a gaming company with at maximum copyrights and trademark achievable for protection. The latter is also likely to have an even shorter window of market opportunity. Sector-specific studies might be needed to create more targeted academic contributions on knowledge dynamics as well as to serve practitioners better in each sector in the development of their competitiveness via dynamic KM.

YHTEENVETO (SUMMARY IN FINNISH)

Pienet ja keskisuuret (pk-) yritykset ovat nyky-yhteiskunnassa keskeisessä roolissa työpaikkojen luomisessa. Niiden kyky kasvaa ja työllistää on enenevässä määrin alkanut kiinnostaa poliitikkoja, yrityskehittäjiä, sijoittajia – kuten myös tutkijoita. Pk-yrityskentän yksi sektori – teknologialähtöiset yritykset – erottuu joukosta kasvu- ja kansainvälistymispotentiaalillaan. Samanaikaisesti nämä yritykset toimivat voimakkaasti ja nopeasti muuttuvassa ympäristössä niin teknologian, markkinoiden kuin kilpailunkin suhteen. Tämän epävarmuuden kautta riski yrityksen osaamispääoman arvon nopea aleneminen on todellinen riski teknologialähtöisille pk-yrityksille. Koska osaaminen voidaan määritellä organisaation kyvykkyydeksi toimia tehokkaasti ympäristössään, yrityksen kyky johtaa osaamistaan on keskeinen henkiinjäämisen ja kasvun edellytys muuttuvassa kontekstissa.

Aiempi tutkimus on tuottanut lukuisia malleja kuvaamaan osaamisen johtamista. Luoduissa malleissa keskeisinä elementteinä ovat olleet luokittelut ja mallit, joilla osaamisen johtamista on jaettu esim. osaamisprosesseihin, osaamisen artefakteihin, osaamisen johtamisen työkaluihin tai älyllisen pääoman osatekijöihin.

Tähän saakka tutkimus on useimmiten johtanut mallinsa suurista ja etabloituneista yrityksistä kerätystä datasta, ja siten keskittynyt myös luotujen mallien soveltuvuuteen samassa kontekstissa. Pk-yritysten eivät kuitenkaan rajallisten resurssiensa vuoksi kykene soveltamaan näitä malleja sellaisenaan. Lisäksi osaamisen ja sen johtamisen mallinnusta on tehty vielä rajallisemmin teknologialähtöisten pk-yritysten tarpeisiin verrattuna yleiseen pk-yrityksiin suunnattuun tutkimukseen.

Aiempi tutkimus on pääsääntöisesti ollut tutkimusotteeltaan kuvailevaa poikittaistutkimusta, joten sen luomat mallitkin ovat olleet luonteeltaan staattisia. Luoduista osaamisen johtamisen viitekehyksistä on puuttunut teknologialähtöisten yritysten kasvupolun keskeinen piirre, muutos. Tämä ajan ja kehityksen tuoma dynamiikka koskee sekä osaamista itseään että sen johtamista. Vaikka teknologiayritykset mielletään lähtökohtaisesti tulevaisuussuuntautuneiksi, tulevaisuuden tutkimuksen käsitteet ja työkalut ovat harvoin löytäneet tietään osaamisen johtamisen malleihin. Huolimatta yleisestä näkemyksestä, jonka mukaan yhteistoiminta ja osaamisen jakaminen ovat keskeisiä tekijöitä nykyaikaisessa osaamisen johtamisessa, toimijoiden välinen dynamiikka tulisi nykyistä paremmin sisällyttää osaamisen johtamisen malleihin niin teoreettista kehitystä kuin mallien toiminnallisuuttakin varten.

Tämä tutkimus pyrkii osoittamaan, kuinka dynaaminen malli osaamisen johtamisesta voidaan rakentaa lisäämään tietämystä tutkimusalueesta ja parantamaan osaamisen johtamista yritystasolla. Tutkimus käyttää monimenetelmäistä tutkimusotetta ymmärtääkseen ja tulkitakseen tutkittavaa ilmiötä. Työn tulokset osoittavat kuinka osaamisen sisältö ja sen johtamisen toiminnot muuttuvat teknologialähtöisessä pk-yrityksessä ajan funktiona yrityksen liikkuessa dynaamisten kehitystasojen välillä. Tutkimuksen löydökset tiivistyvät luotuun

integratiiviseen malliin dynaamisesta osaamisen johtamisesta sekä siitä johdettuihin potentiaalisiin käytännön sovelluksiin. Malli on sekä kontribuutio osaamisen johtamisen ja teknologialiiketoiminnan tutkimuksen teoriakehitykseen että työkalu käytännön toimijoille, jotka haluavat tehostaa osaamisensa johtamista alati muuttuvassa toimintaympäristössä.

Keskeistä mallissa on pk-yrityksen osaamisen kuvaaminen yksittäisten osaamistekijöiden muodostamana portfoliona, jossa yksittäiset osaamiset ovat eri dynaamisissa kehitysvaiheissa, joissa kussakin on omat tavoitteensa, osaamisen johtamisen instrumentit, avainresurssit ja -prosessit kuin myös kyseiselle kehitysvaiheelle relevantit eri yhteistyötahot. Näissä vaiheissa pk-yritys voi hyödyntää niin organisaation kuin sen avainhenkilöidenkin ”perimää” kuin myös yrityksen sisäistä kokemusta niin saman osaamistekijän aiemmista vaiheista kuin myös opittuja käytänteitä aiempien osaamistekijöiden kehitysdynamiikasta.

Intergratiivisen mallin yhtenä hypoteettisena sovelluksina tutkimus esittää kaksisyklisen mallin, jossa yrityksen osaamistekijät kehittyvät ns. startup-vaiheesta kasvuvaiheeseen, palatakseen uusiutumisen kautta uudelleen startup-vaiheeseen. Toinen tutkimuksen liitteissä kuvallistettu hypoteettinen löydös kuvaa dynaamisesti etenevää pk-yritystä ympäristönä, jossa uusien mahdollisuuksien kartoittaminen sekä tehtyihin valintoihin pohjautuva toteuttaminen ovat molemmat yhtä aikaa läsnä, joskin näkökulman painotus riippuu kohteena olevan osaamistekijän dynaamisesta kasvuvaiheesta.

Kuten johtamisen tutkimuksen luomat mallit yleensäkin, tutkimuksessa luotu malli on tarkoitettu edelleen kehitettäväksi. Intregatiivisesta mallista johdettujen hypoteettisten käytännön sovellusten testaaminen käytännön toimijoiden tasolla tulee antamaan viitteitä mallin toimivuudesta ja kehitystarpeista. Nyt luotu malli ja sen johdannaiset tulisi nähdä varhaisina vaiheina tutkimuksessa, joka tähtää tiedon luomiseen aiemmassa tutkimuksessa aliedustetusta kohderyhmästä. Käytännön toimijoita mallit palvelevat työkaluina, jotka auttavat teknologialähtöisiä pk-yrityksiä tunnistamaan osaamisportfolionsa osatekijät ja niiden kehitysvaiheet. Mallit myös auttavat toimijoita suunnittelemaan ja toteuttamaan osaamisen johtamisen käytäntöjä, jotka tehostavat osaamisen luomista, suojaamista, jakamista ja hyödyntämistä.

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APPENDICES

Appendix 1: A hypothetical instantiation (1) of the framework

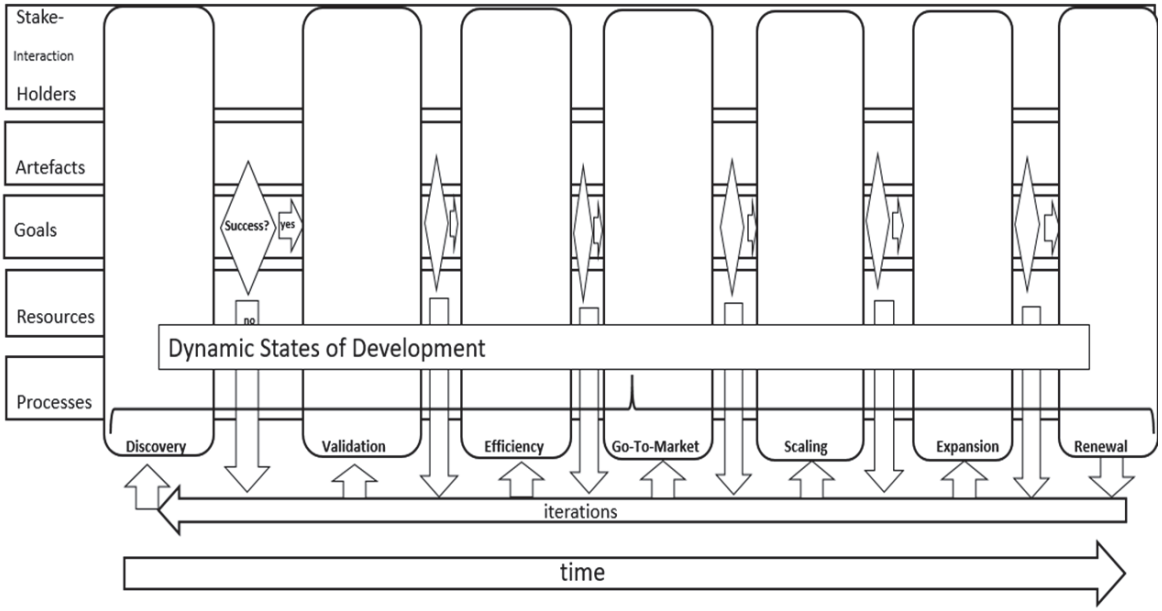

FIGURE 12 The iterations within the framework

Appendix 2: A hypothetical instantiation (2) of the framework: The knowledge portfolio

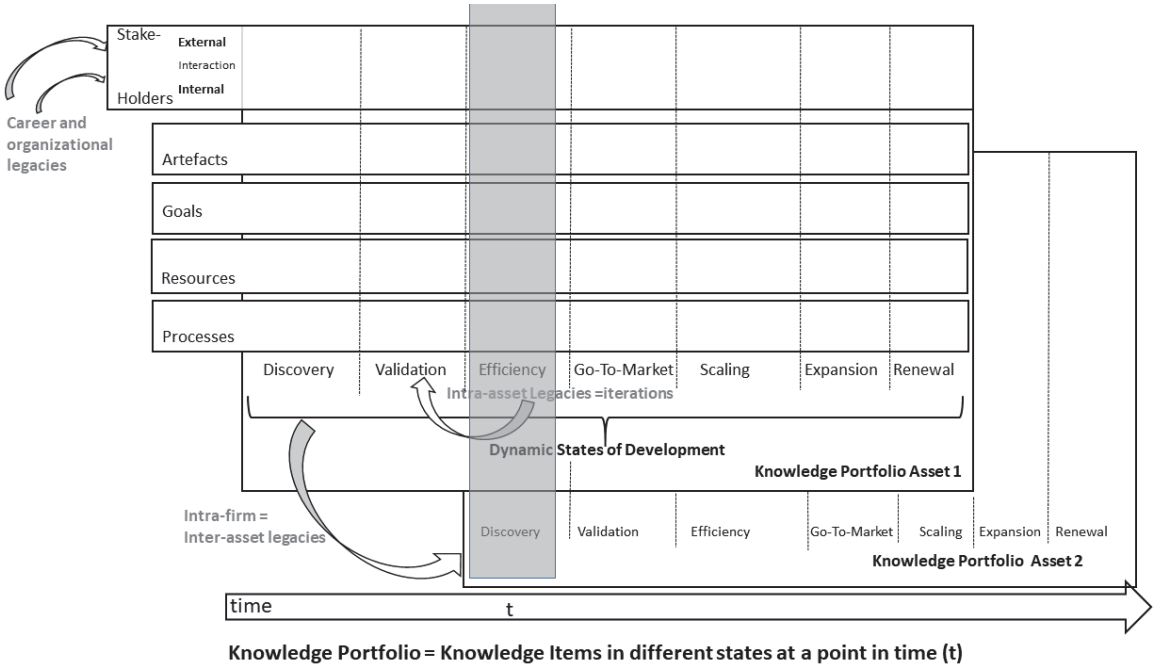

FIGURE 13 Knowledge portfolio assets in different states of development

Appendix 3: A hypothetical instantiation (3) of the framework: Start-up and growth loops across states of development

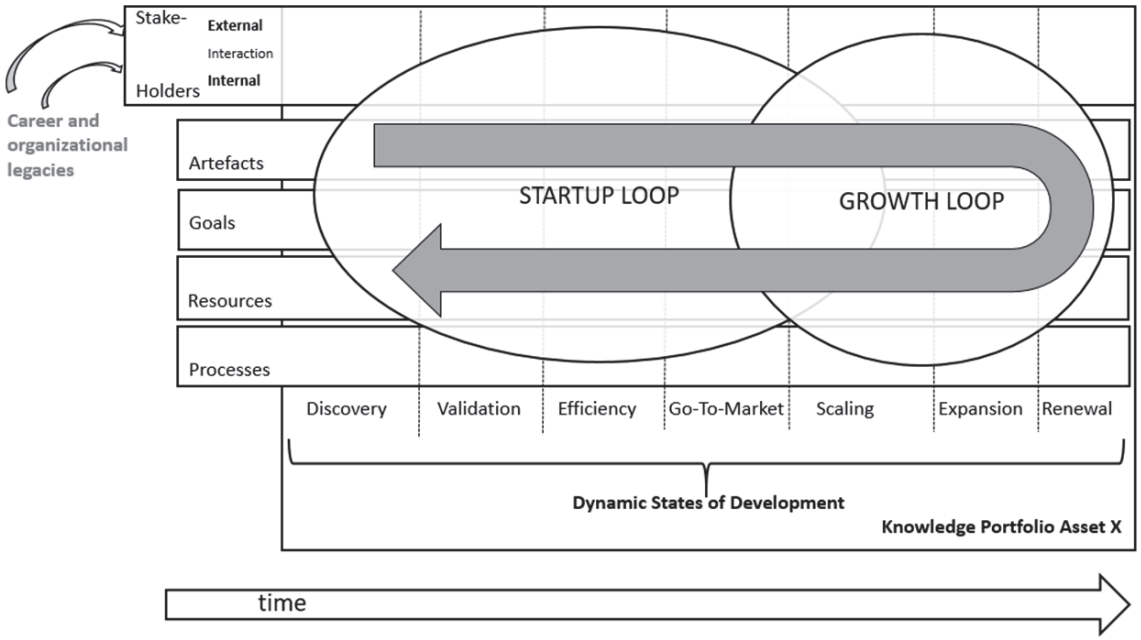

FIGURE 14 The two-loop model of start-up and growth

Appendix 4: A hypothetical instantiation (4) of the framework: Scanning and planning paradigms

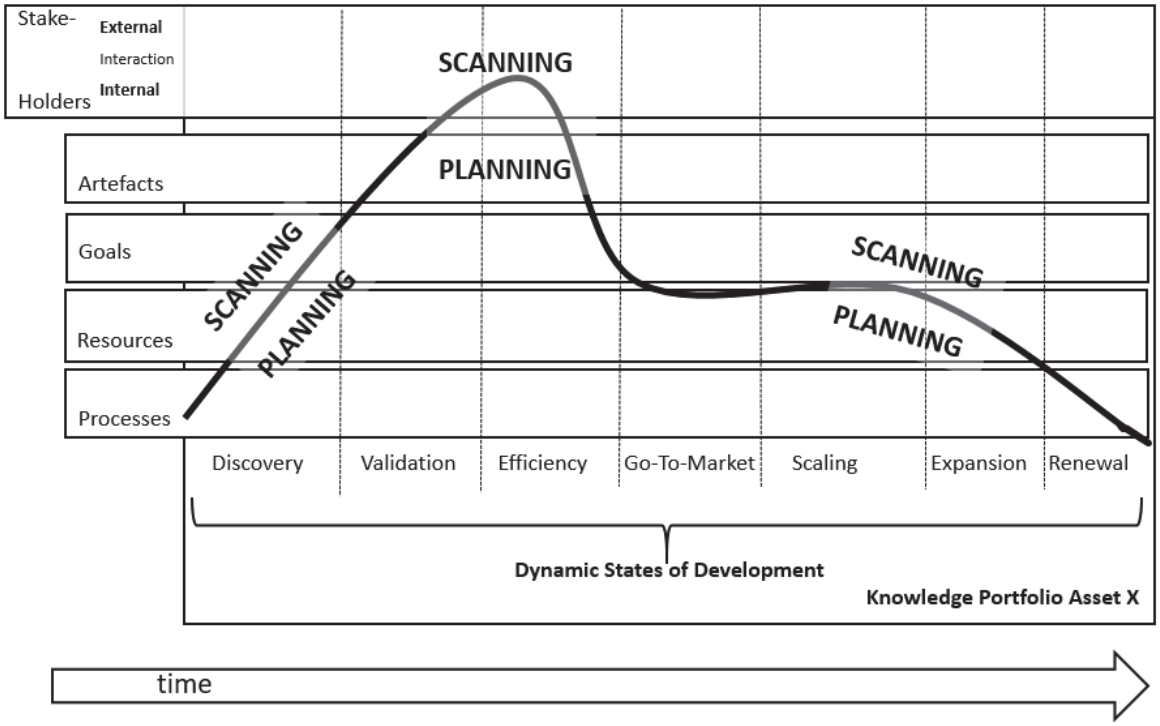

FIGURE 15 The temporal ambidexterity – concurrency and alteration of focus on scanning and planning horizons

ORIGINAL PAPERS

I

EXTENDING THE CONCEPT OF KNOWLEDGE MANAGEMENT INTO INNOVATION AND NEW BUSINESS CREATION

by

Juha Saukkonen and Pia Kreus, 2018

Proceedings of the International Conference on Creativity and Innovation 2018, September 10-12, 2018, Osaka. Japan Creativity Society and Kindai University, pp. 11-26

The International Conference on Creativity and Innovation 2018

From the Perspective of Interdisciplinary Research and Practice

September 10-12, 2018 Osaka, Japan

Category: 3: Creativity and Innovation

Title of paper: EXTENDING THE CONCEPT OF KNOWLEDGE MANAGEMENT INTO INNOVATION AND NEW BUSINESS CREATION

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Keywords (up to 5):

knowledge, anticipation, IPR, creativity, innovation

1. ABSTRACT

Knowledge management (KM) is a widely-used term in management science of 2000's. The key essence of KM can be coined e.g. as a *"purposeful management of activities and processes for leveraging knowledge to keep and improve competitive positioning by using well individual and collective knowledge resources of the firm and its stakeholders"* (CEN, 2004).

Majority of the KM discussion and research has focused on recognition, expression and dissemination of knowledge as it manifests itself in the present day of an organization. Research has focused on tangible knowledge artefacts such as Patents, Utility models, Trademarks, Licenses. The processes of creation and maintenance of knowledge are used more often by companies as protective measures rather than as dynamic tools for new value creation. Furthermore, the concepts and practices of futures research and anticipation are rarely studied as vital parts of KM.

The paper at hand studies the views and strategies of Small- and Medium-sized companies in Finland in their reach for managing present and future-related knowledge by means of qualitative research. The authors propose a double-dichotomy framework of alternative approaches and dimensions for KM. The framework is derived from the analysis of material collected by semi-structured interviews with the people responsible for KM processes in 10 companies. Authors also point out the needs for further research on the field.

Keywords: innovation, knowledge, anticipation, foresight, value creation

2. Introduction

Success and survival companies is largely dependent on their capability to innovate new products, services and business models (Hurley, Hult, and Knight, 2005; Siguaw, Simpson, and Enz, 2006). The pace of change is increasing, as noted e.g. by Fine (1999) with the concept of “increased clockspeed”, underlining the importance for swift action on knowledge. New knowledge often manifests itself in the form of new technologies, and this urges companies to develop new business models to fully benefit from the novel knowledge (McInnes, 2005).

As a response to these challenges the concept of Knowledge Management (KM) has emerged. Wiig (2000) suggested that “as for other management directions, it is expected that KM will be integrated into the basket of effective management tools, and hence disappear as a separate effort”. To a certain extent the widespread adoption of KM *concept* has taken place, but gaps exist between the theory and practice of Knowledge Management (Hung et al., 2011). Thus, further development and testing of models is necessary. Hung et al. (ibid.) proposed that instead of a holistic activity KM should be regarded as a process that can be divided into sub-processes. The sub-processes are; knowledge creation, knowledge storage, knowledge sharing, and knowledge application. A major part of literature and research on KM has been focusing on development and testing of firms’ maturity in their KM models. Nowacki and Bashnik (2016) concluded that firms show very little innovativeness in the way they manage knowledge. This implies that there is a risk of routinizing the KM activity, instead of using KM as a search method for improved competitive advantage.

The KM models, tasks, roles and responsibilities have been mostly designed for large companies with ample HR and data management resources. As Cerchione and Esposito (2017) noted, SMEs are entities without a strategy of their own for processes of knowledge management, and it is not that clear what knowledge management systems they apply. SMEs also have various ways in organizing for KM, both within company as well as with the network of the firm. Holzinger et al. (2014) state that to stimulate fresh ideas and encourage multidisciplinarity domain experts from diverse areas should be brought together for an impactful KM work.

Also the futures dimension - the tools and practices of futures research and anticipation - are rarely integrated systematically into KM. Hines and Gold (2015) make a remark that the integration of foresight work embedded into corporate culture and work processes is still relatively rare, despite its potential to create an impact and add value. As a solution Hines and Gold (ibid.) propose creation of a separate “futurist” role into the organization, to ensure foresight is included in the KM. However, SMEs are not likely to afford a separate function for foresight-task, it should rather be integrated into general KM work.

This paper starts with the assumptions that SMES have a variety of ways of performing both KM, and also foresight as an element of KM. They also have various ways in organizing KM, both within company as well as with the network of the firm. At start the researchers also assumed that certain typologies of current practices and suggestions for integration and improvement of KM processes can be proposed based on research findings.

The paper is organized as follows: After abstract and introduction (chapters 1 and 2), Chapter 3 presents the objectives set for the research and research questions. Chapter 4 (Literature review) introduces the main concepts and processes of KM and foresight as expressed in earlier research. Chapter 5 describes the methodological choices and implementation of the empirical research, the results of which are presented in Chapter 6. Chapters 7 to 9 discuss the research process and quality as well as points out implications of the study and directions for further research.

3. Research objectives

This research set out to explore the knowledge management practices in knowledge- and technology-based growth-aspiring SMEs. The research also aimed at shedding light on justification the people responsible for KM give to their choices.

In addition the research aimed at contributing to the prior-art knowledge of SMEs performing knowledge management. The aim was to find out whether there is something specific in this cohort of companies that would add to the knowledge pool of the KM phenomenon. These findings and emerging frameworks could potentially be used to improve knowledge management process in SMEs.

Since the earlier practice, research and publications of the two researchers is a combination of IP management and futures foresight, this paper also aims at seeing how these two areas coexist inside knowledge management practice.

The research questions set for the research process were;

1. How is knowledge management conceptualized by SMEs and what are the KM trends affecting SMEs?
2. What are the actions and processes of KM performed by the growth-aspiring technology- and knowledge-based SMEs?
3. What are roles of SME´s internal functions as well as the role of external partners in KM?
4. For both questions 2 and 3; what are the reasons and forces affecting the choices made in KM practice?

4. Literature review

4.1. Knowledge – definition and related concepts

Research related to knowledge is vast and spreads into the scientific areas of philosophy, educational and organizational sciences as well as to business management. At its roots, knowledge can be defined in various ways. As an example, organizational knowledge creation theory defines knowledge in three parts, indicating that it has complementary properties. First, knowledge is justified true belief. Individuals justify the truthfulness of their beliefs based on their interactions with the world (Nonaka 1994, Nonaka et al. 2006). Second, knowledge is (i) the actuality of skillful action (we recognize that someone has knowledge through their performance of a task) and/or (ii) the potentiality of defining a situation so as to permit (skillful) action (Stehr 1992, 1994). Knowledge allows humans to define, prepare, shape, and learn to solve a task or problem (von Krogh et al. 2000). Third, knowledge is explicit and tacit along a continuum (Nonaka 1991, 1994).

An ample body of research has been built on the DIKW taxonomy (Zeleny 1987, Ackoff 1989, Baskarada and Koronios 2013, Cooper 2014) that makes a distinction between Data, Information, Knowledge and Wisdom. Rowley (2007) stated that there are many competing definitions for each of these constituents and it can also be stated that the lines between the categories blur. Rowley also added one more layer to the “knowledge pyramid” (Figure 1 below); Intelligence.

When applying the DIKW (or DIKIW) model, it is vital to note that the different layers are not fully independent. For an organization quality of work done and results achieved in one layer affects the following layers.

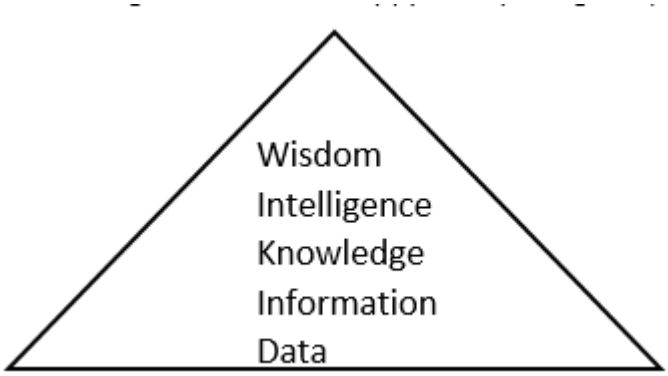

Figure 1: DIKIW-hierarchy, based on Rowley (2007)

This study uses the conceptualization of Rowley, where he defines the core essence of each category top-down as follows: (ibid., bolding by the authors of this paper) ": Wisdom is the ability to increase effectiveness**. Intelligence is the ability to increase efficiency. Knowledge is know-how, and is what makes possible the transformation of information into instructions.** Information provides answers to "who, what, where and when" questions. Data are defined as symbols that represent properties of objects, events and their environment".

In this study authors have combined the intelligence and knowledge categories of Rowley. For this study the knowledge management means *the practices and tools used to turn achieved information into action to improve efficiency for the future success in business*. The layer of Information in the framework is not limited only to interpretation of facts based on recorded data of the past and present – but following the ideas of de Jouvenel (1967) these *facta* should be expanded with *futura*, images of mind (of potential future facts) that can also be labelled as anticipation.

4.2. Knowledge Management as a process

Knowledge management, as discussed above, is a concept of many competing definitions. The conceptualization of KM naturally does not suffice to a practitioner, as concepts need to get implemented. For that purpose, research has proposed models of KM process. Shahzad et al. (2016) concluded that 1) there is a significant positive impact of system-oriented KM systems strategy on KM process capabilities, creativity and organizational performance. 2) KM processes have significant impact on organizational creativity and performance. 3) Organizational creativity has also been identified as having a strong significant impact on organizational performance.

Knowledge management process models are not of short supply, and the differences in the content and scope of the models come from many variables. One dimension studied is whether the knowledge being managed is from internal (to the firm) or external sources. Menon and Pfeffer

(2003) reported tendency of organizational members to more likely value knowledge from external rather than internal sources. A potential reason for that is that valuation of externally sourced knowledge eliminates the members' status to the information evaluation i.e. positions of power within the organization. On the other hand, Darr et al. (1995) concluded that knowledge coming from units of the same organization transfers and improves the performance of a unit studied more likely than knowledge coming from external sources (Darr et al. 1995). The applicability of the knowledge might be more straight-forward as it is coming from people and units who share the same business scope. However, this may lead to ignorance of novel ideas and new angles for future success that an independent external source might provide. This dilemma is especially relevant for SMEs to consider, as their own resource scarcity forces them to rely a lot to external sources of knowledge.

4.3 Foresight and anticipation as knowledge processes

Foresight is a theme that pertains to a wider concept of futures research. For Kuusi et al. (2015) *futures research* means those studies that are set for pragmatically valid knowledge concerning possible, potential futures. The sub-concept of *future foresight* by Kuusi et al. (ibid.) covers the more pragmatic side of future studies: method-based debates and analyses of different futures. Foresight practices and processes add value to the strategy formulation. Dufva and Ahlqvist (2014) claim that a foresight process is an effort where different stakeholders jointly explore futures and interpret them to formulate actions in present tense. To facilitate knowledge-to-action process, tools such as technology roadmapping (TRM), radical technology inquirer (RTI) and technology radar (TR) have been developed.

In wider sense an organization engaged in quest for knowledge of potential futures is incorporating *anticipation*. Anticipation serves as an umbrella term that covers different processes and practices. Poli (ibid.) summarized the key components for the discipline of anticipation implemented across sciences as follows:

1) In anticipation one will be faced with calculable risks and incalculable uncertainties
2) There is a difference between the distant future and future in the present, the latter one referring to the future as projection of the past and former one to “proper” anticipation, allowing also discontinuities
3) There are continuous and discontinuous/ruptured futures
4) Systems and organizations vary in their capability to use futures
5) Anticipations take place in many layers (e.g.. social and psychological) and are of different types - like explicit and implicit.

This paper focuses especially in the points 2 and 4 in Poli's list of components and tries to shed light on intensity, processes and capabilities that SMEs possess in including anticipation-related elements to their KM function.

Future change is often but not solely caused by technological advancement. It also affects more functions within a company than just technology. Anticipation of technology is used across industries and by organizations of different sizes and development stages. Prior-art research on technology anticipation is SMEs indicates there is a lot of unused potential. Boghani et al. (2008) pointed out that nascent ventures who learn and apply technology anticipation processes generate stronger R&D proposals and increase their odds to get funding. On the other hand, a research in UK by Farukh et al. (2001) indicated that only 10 % of manufacturing firms studied were applying the most common technique - technology roadmapping - and even that did not always take place in a repetitive and continuous process. Even the more engaged ones reported they have challenges in starting anticipation processes and keeping the processes alive. These findings underline the need for conceptual and practical development of technology foresight deployment in SMES.

Anticipation is a process that deals with high amount and magnitude of uncertainty. The negative aspect of that fact is that some of the findings of anticipative work and ideas built on those will have no use in the future that will unfold. The multitude of options and high uncertainty have been traditionally linked to the beginning of the innovation process, coined e.g. to the term of "fuzzy front end of innovation" (Thanasopon et al., 2015). Adoption of anticipatory/foresight practices to KM means that the fuzziness and open-endedness is present across different stages of research and development processes where new and unique knowledge and solutions are sought (Saukkonen & Bayiere, 2017). Sung and Choi (2012) found out that the positive effects of knowledge utilization where stronger when teams were exposed to high environmental uncertainty.

The need to combine elements of knowledge management on the existing knowledge and reaching for new knowledge is a topic addressed in the scholarly writings from the very early era of knowledge management literature. Back in 1990, Cohen and Levinthal defined an approach that they call absorptive capacity that would allow an enterprise to fully utilize their knowledge potential. According to Cohen and Levinthal (ibid.) firms must "leverage their existing knowledge and create new knowledge that favorably positions them in their chosen markets. In order to accomplish this, firms must develop an "absorptive capacity" - the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities".

4.4. Specific context of the study: knowledge- and technology-based SMEs

SMEs are recognized as the most important engine of net job growth in most economies. Most often their ability to employ is fueled by the growth achieved. Their continuous growth requires expansion to international markets. In countries with limited size of domestic markets such as Denmark, Estonia and Portugal the share of total exports generated by micro- to small-sized companies of 1 to 49 employees is as high as 30 % (Eurostat, 2014).

Both the source of competitive advantage (knowledge and technology) as well the nature of a global market opportunity and competition require measures in KM. Different stage models of company growth (e.g. Greiner, 1972; Marmer et al., 2011) confirm the view that in order to grow and evolve companies' strengths related to their knowledge vary across stages. During the growth trajectory there are needs both for knowledge protection as well as knowledge dissemination within the company. Also the knowledge management action with members within the business ecosystem a company is a needed.

The need of managing uncertainty by acquiring and transforming knowledge becomes evident in the definitions given to startups i.e. young companies with potential to fast and scalable growth. Blank (2010) and Ries (2011) underline the concepts of novelty, uncertainty and search as fundamental characteristics of these firms. Most of the companies in the sample of the empirical part of this study fall into the start-up category of SMEs, highly dependent on successful KM that includes creation of new knowledge.

5. Research methodology

For this study the qualitative, explotatory approach was chosen as the issue area studied was presumed to be complex and rich. Also the sheer amount of different concepts and frameworks used for KM concept studied requested data gathering by live discussions with respondents. This in order to ensure shared interpretations of the questions and terms in the data gathering phase. In this type of study it is not a viable option to define processes in variables expressed in numerical measures. As Black (1994) state: "Unlike quantitative research, qualitative approach seeks to answer the "what" question, not the "how often" one." Also "…qualitative methods take a holistic perspective which preserves the complexities of human behavior" (ibid.).

The research target was partly conceptual. Authors aimed at understanding the phenomenon and derive typologies and propose new frameworks for further study. Young (1995) proposed that an important parameter of conceptual research is an attempt to systematically give clarity to concepts. Conceptual research is used to either develop new concepts or alternatively to reinterpret existing ones (Kothari, 2008, Leuzinger-Bohleber and Fischmann, 2006). Thus conceptual research take the concepts themselves as a research object. Conceptual researchers investigate e.g. the origins, meanings and usage of concepts. The researchers aimed at shedding light on how practitioners in

SMEs have internalized the KM concept and processes, what factors have affected their ideas of related concepts and how the concepts, tasks and roles of KM have been externalized within the company and with its network partners.

The researchers collected the data via in-depth interviews with 10 Finnish SME-companies, all of which can be categorized to knowledge/technology-based companies. All interviews were recorded, transcribed and subjected to content analysis. In the analysis the principle of researcher triangulation to enhance the research process (Kitto et al., 2008) was used. The two authors first independently reviewed the material collected and rearranged, formulated their own conclusions from the data, that were then synthesized for a joint view.

6. Findings

6.1. The changing landscape of knowledge

What might be the new conceptualization of knowledge and its relation to other concepts in a modern context? Based on the study in the era of digitalization the sheer amount and availability of data creates a potentially wider base for the original DIKIW hierarchy pyramid than the one presented in the literature review (see Figure 1). However, this abundance of data that can be retrieved and rearranged across various information systems of the company and its stakeholders can cause a problem in itself. The defining “3 V´s “ characteristic of the modern concept of Big Data (e.g. Sagiroglu and Senanc, 2013) remind that in what comes to data we live in the era of volume, variety and velocity. The size of data can be too massive, have too much variety of format and b etoo fluctuating to be correctly acted upon. This abundance may also harm the ability of a firm to move into the higher levels of the hierarchy. This new context of massive data would need capabilities of information and knowledge capabilities that have been outspeeded by the hypergrowth of data. The modern DIWIK model illustration has the shape shown in Figure 2. Due to the width and depth of the data only part of it can be used and acted upon. Even more importantly, only a part of it is useful for the future-related decision-making, development and creativity, in other words some of the expanded data is waste. The imbalance between amount of data and capabilities/resources for its use can also lead some important data ending up in unwanted waste, thus hurting the future knowledge capacity of the SME firm.

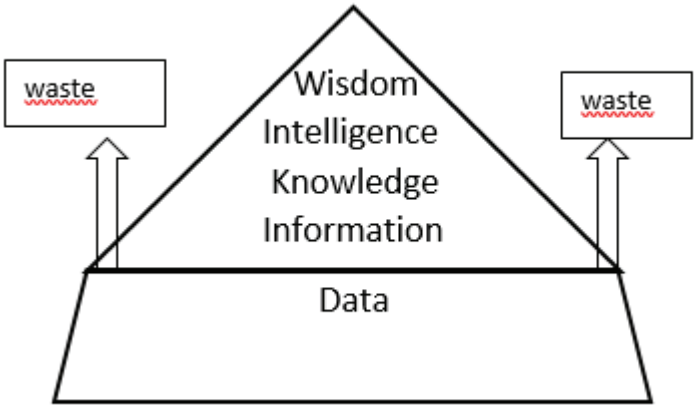

Figure 2. The new hierarchy of DIKIW? (by authors)

Especially when reaching out for future knowledge, the widened time horizon opens up a growing array of options of future development (market trends, technologies). The product and service development in companies typically aims at narrowing the options and making choices of the technologies and features to be included to the products and services rolled out. This idea of narrowing down has been described as “innovation funnel” (Dunphy et al., 1996). The evaluation of relevant knowledge happens inside the “planning horizon” of the companies (Kuusi et al., 2015). On the contrary, the future-oriented knowledge search happens on the “scanning horizon” (Kuusi et al., ibid.) and has the shape of a widening funnel. As stated by Saukkonen and Bayiere (2017), a firm has a dilemma of operating within two funnels that act in a contradictory way in what comes to narrowing vs. widening the options. This a major challenge for technology and knowledge based SMEs. Just like the data describing the past actions of the company and markets has “waste” in it, so does the scanning of futures produce future-informed data that proves to be waste first at some later stage. Either the envisioned future does not happen, or proves to be irrelevant to the company at that point of time when it occurs.

As a summary of finding from empirical study it can be stated, that companies and people responsible of KM in them do identify the challenges of data accumulation vs. usage, but are short of fast and cost-efficient enough methods to work on the growing sets of data. This confirms the researcher´s conceptual proposal of reshaped pyramid of DIKIW-model.

6.2. Knowledge management processes and their use in SMEs

The content analysis of the primary data collected with qualitative method both gave view on 1) what are the KM processes identified by actors in SMEs and 2) how common their use is in the SME sample.

The interviewees described both the processes taking place at the moment as well as reflected the processes thought over, discussed and planned for the future in their organizations.

The researchers conclude that the processes identified can be categorized using two axis, where one axis concerns whether the process is done internally in the company or does it also include external actors as stakeholders (axis of dimension). The other axis makes a distinction in the processes that are “purely” operational/opportunistic) vs. having more of a strategic view inbuilt into them (axis of approach). The difference between the two may be best described using Mintzberg’s framework where management contains decisions that are a) opportunistic/fully operational i.e. decisions on current situation and with the prevailing knowledge and recourses, and where decisions have a weak linkage to future decisions, at least by the time they are made and b) strategic decision-making that happens still in somewhat predictable conditions but in a timeframe that allows rearranging and acquisition of (some) additional resources.

The findings placed to the framework consisting of this double-dichotomy (Figure 3), indicates that SMEs tend to act in KM is mostly in internal and operational layers. The companies have identified and were planning processes with more strategic and outreaching nature, but they were rarely taken in use. Despite the view that internal and operational KM creates a solid base for future innovations (Olander et al., 2014), the linkages between operational and strategic knowledge management processes were not strong. Also Olander et al. (ibid.) in earlier research identified this need to move in KM beyond protective measures such as patenting and data security, but that good operational governance works as a foundation that should help in dealing with future uncertainties. So the cohesion between layers would be needed.

The findings also reveal the tendency to act on the protective side of knowledge management compared to the dissemination of knowledge. However, most companies expressed intention to more externally focused actions in KM and more strategic view to be added to the KM. This in order to enhance the organization’s (and its network’s) capabilities to keep innovating and creating new value in the future. However, these recognized needs had in just a few occasions turned into action. The reasons for the inertia included lack of time and personnel as well as lack of clarity in role division between different parties when acting in KM. In one occasion the co-creative approach had even led to a loss of IPR to a customer, so the realistic answer to “protect or disseminate” question is a combination of both solutions.

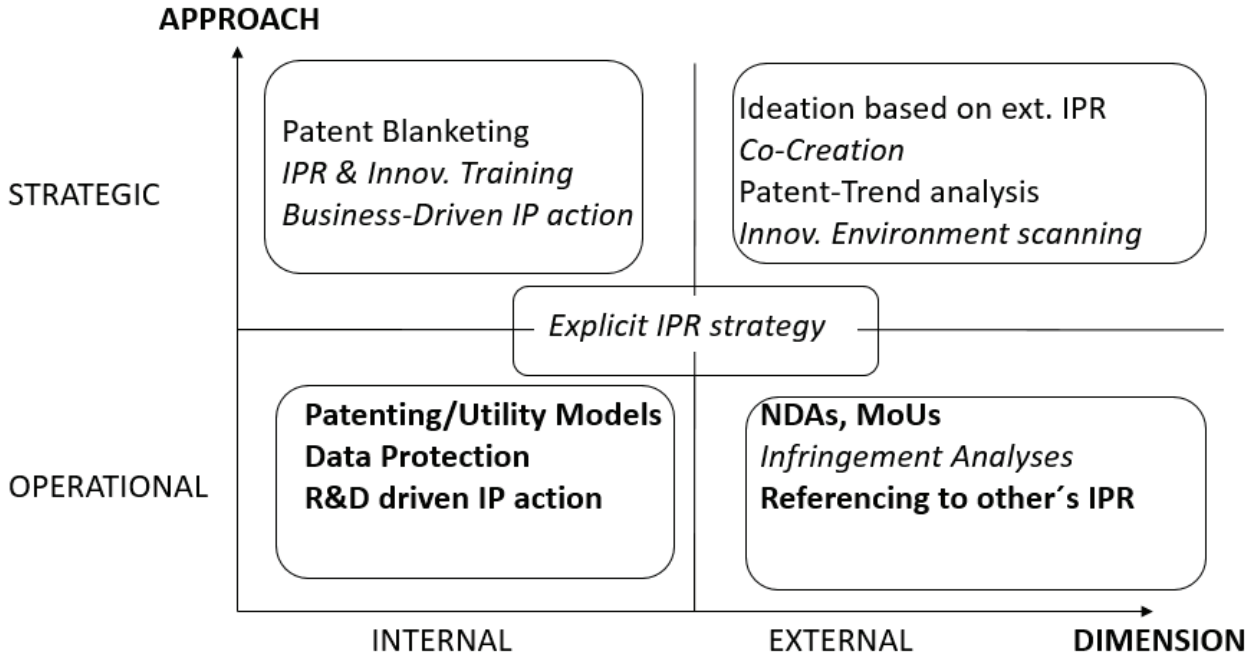

Figure 3: Taxonomy and width of usage of KM processes in the sample (Legend: **Bold font** = commonly used; *Italic font* = used by some; plain font = identified but not yet in use)

When interpreting the taxonomy it is vital to notice that the different quadrants are not alternatives. A holistic KM strategy and action can and should include elements of all sections, like is the case with many successful firms.

6.3. Factors affecting the KM concepts and processes in SMEs

Another interesting question was: Where do the choices of KM processes come from? Is there a clear view not only on *what* is done in KM in SMEs but also *why* just these processes take place? The study also aimed at finding out *what are the future plans for enhancing KM* and *why just those development steps* are in discussion or making?

The researchers identified a pattern that has been discussed in earlier research, the impact of the key persons inside the SMEs. They have a personal effect on KM and innovation processes taken in use and also in the way these processes are performed. Churchill and Lewis (1983) noted that in the life-cycle of a company in the early stages the owner-founders´ abilities were crucial, but subjected to go lower in importance over time. Hauschildt and Schewe (2000) described the role of key persons to be the ones of gatekeepers and/or promotors, but did not link the role of key persons to the time dimension.

This research revealed that a) key person´s effect in KM scope and practice in SMEs is crucial and b) the KM choices and actions by them are largely based on *legacy*. As Xie et al (2018) put it, spin-offs carry the legacy of their parent firms. This was clearly seen in teams that had spun off from larger entities to start a personal entrepreneurial endeavor as well as SMEs that had started as a

new venture arm of a bigger corporate entity. The *organizational legacy* clearly has an impact on KM in SMEs.

Another type of legacy is related to the individual that is central to KM process in an SME. Their *career legacy* – the motivation that drives them and the impact they most aim at having (Hinds et al., 2015) affects what the SME will focus on. Their strengths and weaknesses become the ones of the company. This legacy is a combination of their education, work history and knowledge possessed. Naturally this can act in favor of an SME. In some of the cases in the sample the core team members came from a strong research institute background, so they bought the KM practices that go beyond an average SME level with the. This phenomenon at the same time makes SMEs vulnerable as changes in personnel can mean sudden loss of KM and innovation capabilities. The role of the key persons' career legacy can also mean myopia – distant objects seem too blurry whereas nearby objects are seen well and they are easier to cope with. This ignorance of new knowledge that does not pertain to the area of the person's legacy area can be the negative KM effect of legacy.

Other dimensions of knowledge management that arise from the research data is the formality/informality as well as explicit/implicit nature of the processes of KM. Typically SMEs have a relatively high degree of formality and explicitness in the processes that focus on the protection and maintenance of firm´s own and existing knowledge. Processes and principles most often exist for internal and operational issues related to the known. There are process descriptions and procedures for knowledge that is clearly definable and thus can be said to enjoy a certain level of certainty (i.e. "facta"). The more uncertain the knowledge is e.g. when it is of an external source, is future- and upcoming innovation –related (i.e. "futura"), the more informal the KM processes are.. Also more implicit are the processes to the people acting with that knowledge. Researchers identified processes and core ideas for acting with uncertain type of knowledge – that often acts as an important spark for innovation and new value creation – but they resided in minds of just a few people in organization. Most respondents expressed intention or at least interest to formalize the processes and move forward towards more externally-linked and strategic action in KM. This enhanced role of external partners was expressed to take place in both knowledge protection as well as in the quest for new knowledge. Action taken to those identified directions was however scarce.

External partners were used in many cases to assess a new product or functionality in what comes to knowledge artefacts (like evaluation of patentability and writing process for a patent/utility). This move to the external dimension may however miss some of its potential if the KM action is only focused on individual and operational knowledge item. So, controversially, using external resources and thus enlarging the pool of people working on firm's knowledge may even be counterproductive for innovation, if the external resources are not used also to act on uncertain

and future-related action. The external members and their knowledge should be brought in to serve also the strategic dimension of KM.

7. Discussion

This research contributes to the earlier findings in the literature of knowledge management, SMEs' growth and innovation. The findings support the earlier views that SMEs fall short in their knowledge management processes in comparison with larger and more mature companies. The SMEs in the sample recognized the needs to improve KM processes to better serve their ongoing creativity and innovation. Due to lack of resources many of the identified development steps were not yet taken.

The dilemma of modern management of overwhelming, volatile and fast-changing data became evident when studying the sample population of growth-aspiring technology- and knowledge-based SMEs. The abundance in sources and amount of knowledge that potentially would serve for innovation and competitiveness is exceeding the capabilities of the organization to handle it. Even more so when acting with external and future-related knowledge is in scope.

The challenges of KM for SMEs in a modern context are at least threefold: 1) SME's ability to act on knowledge depends heavily on its core people. They make the choices on what and how to act upon in KM. The rationale of their choices is often based on the organizational and career legacy that may not be relevant to the current environment. 2) When KM processes get outsourced to company partners in SME's network, the accumulation of knowledge and knowledge –related capabilities and/or proprietorship of knowledge may get negatively affected 3) Volatile nature of knowledge and increased uncertainty of knowledge may lead SME companies to settle in vaguely defined and communicated KM processes. This in its turn may harm the strategic and operational cohesion of the firm's internal resources in KM. This together with a fact that SMEs by definition are resource-scarce created a major challenge for SMEs in KM.

The research confirmed also the earlier findings of KM transforming towards a function that is strategically oriented and bound to external network members. There still is a gap between the intentions to implementation in this respect.

8. Implications (for learning, research policy, practice, for networking)

The research in hand pointed out both the current solutions of KM in growth-aspiring SMEs as well as challenges in it. The results propose that the challenges of full-scale and high-impact KM (that

serves for both protection, utilization, dissemination and further development of knowledge) seem to be growing at higher rate than the resources for them in SMEs. The authors were able to recognize the following streams of further research and development needs both to practitioners of KM as well as to researchers and scholars of it.

- Processes and tools for screening and choosing relevant items from a growing pool of data (present and future-oriented data) are needed
- SMEs knowledge management processes with more of a strategic undercurrent than the current operational/opportunistic actions is needed. This would allow SMEs to direct and synchronize the scarce resources to best serve for creativity and innovation leading to improved future competitiveness
- There is a lack of approachable models for the interplay between a SME and its network partners. These models would include models of choice of partners and criteria for it; roles, right and responsibilities of each party. These models are needed to maintain the correct balance between sharing and proprietorship of knowledge.

To reach these aims the authors of this paper suggest both conceptual and processual development to take place, as well as case-based research to test the appropriateness of the new models developed.

9. Concluding Observations

This research set out with and exploratory approach most focusing on the conceptualizations, processes and development directions of KM as part of creativity and innovation management in SMEs. The study did not set to test any prior models, as they were inductively created as a result from the primary data from the empirical qualitative research. Further research could study e.g. more in detail any of the four quadrants of the Focus-Dimension typology in Figure 3: Operational-Internal, Operational-External, Strategic-Internal, Strategic-External or address more specifically one or more of the above-mentioned development needs: 1) Tools for screening and choice of KM process alternatives 2) Alignment, articulation and communication of a cohesive KM strategy 3) Networked operations in KM.

The sample of this research consisted of Finnish SMEs with a knowledge- and technology-base. These type of companies operate typically in international market environment with international competition. Therefore it may be justified to conclude that the key findings would repeat in other contexts for same kind and size of companies. To confirm this it would be recommendable to repeat the study either in other context or study more specifically companies in one or two fields of industry. This would shed light on whether to there are some business-specific issues in KM and its relation to innovativeness and creativity that this research could not reveal.

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II

INTELLECTUAL PROPERTY IN THE ERA OF INCREASED CLOCK SPEED: RETURN OF KNOWHOW?

by

Juha Saukkonen, Mauno Harju & Pia Kreus, 2019

In *Proceedings of the 10th European Conference on Intangibles and Intellectual Capital ECIIC 2019*, *University of Chieti-Pescara*, *Italy*, *23-24 May 2019*. Reading: Academic Conferences and Publishing International (ACPI) Ltd., pp. 244–252

Intellectual Property in the Era of Increased Clock Speed: Return of Knowhow?

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Abstract: Growth-aspiring companies with a technological edge operate in an environment of ever-increasing clock speed. The life cycles of solutions have shortened. Virtualisation and digitalisation further increase the pace of product and service development. This trend requires agile development. Companies have to manage the speed requirements and increased uncertainty. New concepts like customer development (Blank, 2008), lean start-up (Ries, 2011) and minimum viable product (MVP) are common in new venture development. The new processes partly contradict the idea of proprietary knowledge, in which a company needs to rigorously keep track of knowledge creation, protection, development and dissemination. To achieve the freedom to operate, a firm needs knowledge artefacts such as patents, design rights and copyrights. The distinctive knowledge protected by IPRs is a fundamental element in the foundation of a new company and its resourcing. However, IPR processes tend to be heavy, they require a lot of time and resources compared to the plethora of solutions on which companies work. They are also 'heavy' with respect to the speed which is required from innovation process. New knowledge is often born in a multi-party and loose network relationship, where the ownership of knowledge is potentially unclear. This conceptual paper draws together prior research on the forces affecting IP approaches and processes in the new operating environment. We also discuss the existing implications and potential continuum of recent development. The cases highlight the theoretical findings of new knowledge dynamics for firms. Focusing on process rather than product knowledge – close to the "dormant" concept of knowhow – seems again to be of value.

Keywords: IPRs, protection, competitive advantage, growth, innovation

1. Introduction

The business environment for innovative companies contains elements and forces that are seemingly contradictory to each other. Demands of shorter time-to-market as well as agile and collaborative development need to be fitted with the creation and protection of unique knowledge that acts as a basis of differentiation and furthers the maximisation of the *competitive advantage gap* (Moore et al, 2000).

Simultaneously, a firm must seek ways to extend the *competitive advantage period*, i.e. the time it can preserve this uniqueness. The ways of achieving the latter target include e.g. the creation of systemic products, customer-lock-ins built into a business model and establishing intellectual property rights (ibid.).

This paper summarises the recent research on the new environment for innovation practices and resulting IP actions. We aim to contribute to the understanding of knowledge dynamics especially in the context of growth-aspiring knowledge and technology-based companies. Through cases, we also aim at offering the practitioners within innovative companies an indication of development issues that would allow them to better cope with the new landscape of innovation and IP.

Chapter 2 reviews the prior research in the subject, highlighting the two major forces affecting innovation in our era: Increased speed and uncertainty. We also discuss the answer to those calls; the shift towards collaboration, process view and contractual approach on innovation. Chapter 3 presents business cases that the authors have been involved in or followed from a close distance. Chapter 4 summarises the paper's contributions and proposes direction for further research.

2. Literature review

2.1 The new context of speed

In 1998, Charles Fine introduced the idea of increased clock speed. Even the oldest innovation theories like Schumpeter's recognise the waves of change that shake companies and industries. The idea of the increased clock speed states that these waves happen with increased density and unpredictability (Fine, ibid.). One effect concerns the life cycles of individual technologies and innovative products. From the upstream of the value chain, research & development and productisation, the produced goods nowadays are unique or custom-

designed, the competition is global and the goods produced in smaller quantities (Slusarczyk and Golnik, 2015; Kovacs and Kot, 2016; Gereffi, 2011). Companies have shorter development lead times and reduced costs, but these are balanced with shorter lifespans of the individual products, thus squeezing the window of revenue creation. Innovative products are prone to technological and/or functional obsolescence. A product becomes out of date because consumers turn their interest towards products with improved performance and better technology (Rai and Terpenny, 2008; Rivera and Lallmahomed, 2016). The uncertainties and volatilities are not only related to the technology and the products based on it, but also to the market size and behaviour. Also the intensity and tactics of the competition is volatile. (Mohr et al, 2010).

In dealing with the new demands for innovation processes, the rise of new technologies, business processes and global supply chains has been one answer (Gereffi, 2011). This, however, has been a double-edged sword, since, as Sandborn remarks, technology-centric products contain physical parts, software and materials whose procurement lives end before the product they are in reaches the end of its life cycle (Sandborn, 2017). Solving the puzzle of one´s risk by added technologies only adds to the complexity, yet provides no real solutions.. Technologies do add functionality and value, yet fast-moving technologies make products obsolete more quickly (Rai and Terpenny, 2008). The current business environment requires a *reduced total cost of development and shorter time-to-market* to cope with the uncertainties that are built in to the market dynamics.

To keep their competitive edge, technology firms and knowledge-intensive businesses need not only to deliver radically new *products* but also deliver them by radically different *processes*. According to Banu Goktan and Miles (2011), "radical product innovation development was not negatively related to innovation speed. Results revealed a significant relationship between radical product innovation and innovation speed" (p. 533). They claim that improved processes may be the key constituent to dynamic capabilities, enabling the creation of radical innovations in a timely manner. Firms have put increased emphasis into improving development cycle times (Akroyd et al., 2009) in order to deliver products to the market quickly and be early movers in their industries and market (Akroyd et al., ibid.; Karlsson and Ahlstrom, 1999). Hairman and Clarysse (2007) suggest that time-consuming product development is also money-consuming (in accumulated development cost) for organisations. Naturally, an extreme cost associated with not hitting the timely window of market opportunity is losing said market. Afonso et al. (2008) warn of the flip side of the speed coin: When time-to-market is seen as the key to profitability, development managers have no time nor attention span to consider alternatives. Instead of finding the best solution, the aim is to find at least one solution.

2.2 The new context of cooperation

Innovation in our era is a cumulative and additive phenomenon. Accumulation of knowledge is a dominant feature of modern innovation (Schankerman, 2016). Revolutionary findings require system-level activities where knowledge is built on knowledge (McKenna et al., 2018). The novel steps in technology generate knowledge spillovers that enable further advances. This may lead to knowledge strategies where the firms turn their focus towards innovation and IPs held by others to avoid the risks of obsolete development efforts of their own. This dilemma of whether a company should 'focus,' i.e. invest their effort and resources on the utilisation of knowledge vs. creation and exploration of new knowledge, is inevitable. Working in both extremes is likely to lead either to exaggerated cost vs. future value (in case of exploration-focus) or to loss of differentiation and thus future opportunities for value creation (in case of utilisation-focus). The sweet spot is somewhere along the continuum where the two approaches merge (Simone, 2011).

To exploit the cumulative nature of technological development, companies need to collaborate and integrate their development targets and processes. The mode of collaboration called supplier integration refers to processes where suppliers are involved in organisations' innovation processes and the execution of holistic innovation tasks. Research has redefined supplier integration into two dimensions: 1) product integration, where suppliers carry out product engineering and design activities on behalf of the customer (Koufteros et al., 2005) and 2) process integration, where the supplier is engaged in the development of processes that can be effectively integrated with the design (Koufteros et al., 2007). Logically, knowledge management research has identified *relationship capital* as a knowledge asset for firms (Edvinsson and Malone, 1997; Nahapiet and Ghoshal, 1998). The other elements of a wide view on Intellectual Capital (IC) are *human capital and structural capital* (Kianto et al., 2014). Other subsegments of IC are *renewal capital* in terms of innovative solutions, products and services available (e.g. Kianto, 2008), *trust capital* in terms of the trust embedded in its internal and external relationships (e.g. Mayer et al., 1995) and *entrepreneurial capital* in terms of capabilities and

mindset for entrepreneurial activities (e.g. Erikson, 2002). These areas of intellectual capital are not mutually exclusive; for example the collaboration of separate corporate entities has the potential to impact most if not all of the elements mentioned. The effect on IC can also be negative. Collaboration naturally poses challenge of proprietariness on the innovations and may even put the competitive advantage at risk, since the efforts can and will be partly utilised outside firm itself. Dutta and Hora (2017) state that partnerships in the upstream layer of value chains have a positive impact on invention success (novel solutions) but no significant impact on commercialisation success. This indicates that the return on relationship capital can in many is low. On the other hand, the effect of downstream partners is positive for both invention and commercialisation success (ibid.), Thus, collaborative practices can improve the firm´s knowledge exploitation despite the risks associated.

2.3 State of IP systems in the high clock speed era and proposed improvements

The most visible and unified IP process for today´s innovative companies is that of patenting. Patent systems have, however, long been debated. Scholars, researchers and practitioners propagate both for and against the current patent framework, its support vs. prohibition of advance and its suitability for the modern era (see chapters 2.1. and 2.2. above).

Technological innovation is an uncertain endeavour. One estimate states that 3,000 raw ideas produce one substantially new product and business success (Stevens and Burley, 1997). Naturally, not all of these ideas will move from firms' internal processes to patent application procedures, let alone be granted a patent. The number of patents granted versus R&D investment in money is an often-used indicator of efficiency of innovation activity (e.g. Johansson et al., 2015). Still, the hit rate of patents granted to commercial success is low at best – estimates of mere 1-3% of patents creating commercial value over the IP process costs are published as indicators (e.g. Key, 2016). On the other hand, new approaches such as strategic patenting (Baldus and Heckmann, 2016) question this type of straightforward benefit calculation. In strategic patenting the commercial value can be contributed to patents only if they have the potential to actually hit a target, e.g. a competitor. Reflecting this phenomenon, the knowledge ownership gets challenged increasingly often. Both in the UK and US the number of patent litigation cases has grown over 100 % between 2005 and 2015 (WIPO, 2018), In the same time span, number of patents and applications went up by some 60%. Every fifth patent application is filed by an SME (WIPO, 2018) that typically has resource limitations in their innovation and IP process.

The above-mentioned statistical indicators, when paired with the risk of knowledge leakage via non-disclosure pose a set of questions to innovative companies: 1) Is the engagement to formal IP processes a correct choice ? 2) If yes, what inventions are worth it when balancing the time and cost with the needs of market entry time and market value of the invention? 3) Are there options that solve the needs of a growth-seeking company better than the current IP practices? The decision of which technological option(s) to bet on carries a risk for a firm. For example, ICT market research and consultancy firm Gartner targets strategic planning and innovation by highlighting a set of technologies that will have broad-ranging impact across the business (Fenn, 2011).

Whereas the aggregate hype cycle contains some 50 technologies (or better: technology areas), their current development stage and expected timeline to full market presence, there are altogether close to 2,000 individual technologies on Gartner's radar. In addition to uncertainty on technology, the market and competition are also highly uncertain for new technology companies, multiplying the risk of failure (Mohr et al., 2011).

Supporters of strong patent systems with lengthy process times but also with long protection provided point out the impact on innovation activity and progress of science. IP is a core element in firms' ability to extract value and gain resources from market and investors. Successful development of new technologies is a costly and risky process that typically requires financial backing and assistance from third parties, to whom the assessment of future value is difficult (Hsu and Ziedonis, 2008). The mechanisms that shape outsiders' expectations include e.g. entrepreneurial lineage, founder backgrounds (Eisenhardt and Schoonhaven, 1990; Burton et al., 2002) and affiliations with reputable venture capitalists (Hsu and Ziedonis, 2008). Those value a firm by estimating the probability of a firm to succeed, given a set of characteristics of the organisation (Stuart et al., 1999) such as the presence of IP quality indicated by knowledge recognised by the patent system. Hus and Ziedonis (ibid.) found out that patenting can positively affect investors' perceptions of start-up quality across multiple stages as measured through intermediate venture valuations and the likelihood of an IPO

(initial public offering). Hsu and Ziedonis see this result as consistent and confirming with the earlier views of patents providing a vehicle for avoiding early-stage disclosure problems in the market of ideas (Arora et al., 2001; Gans et al., 2002). Ferri at al. (2019) found that the number of patents (in academic spin-offs) is a positive driver of performance, whilst a patent's age has no significant impact on growth. Despite the cumulative nature of innovation discussed earlier, the market opportunity for an individual invention is constrained by time. Patents assist trade by protecting buyers against the expropriation of the idea and by easing and increasing information sharing during negotiations through the publication of details (De Rassenfosse et al., 2016). However, there seems to be a lack of academic research on the profitability or efficiency measure rate per filed patent applications.

There are also critical notions on the current IP systems. Innovators and IP holders often fail to profit from innovations (Teece, 1986). Innovators often fail to possess the necessary assets and complementary skills beyond their own IPR and ability to move down the value chain (Lamin and Ramos, 2016). Some successful firms started as ''copycats'' (Williamson and Yin, 2014) or "imovators" (Shankar, 2010) and later transformed to be innovative on their own. De Braak and Deleersnyder (2018) learned that copycat followers (in form of private label versions) outperformed original innovators when measured as growth of market share of a product category. These tendencies indicate that innovation processes need to be improved with organisational routines to properly deploy IP (Steensma, Chari and Heidl, 2016). Scuotto and Shukla (2018) provide a suggestion to scholars to extend their analysis from imitation and/or innovation strategy to a combination of both views.

Chesbrough (2006) claimed that firms developing new technologies mostly pursue protective measures on innovation, seeking freedom to operate in the market. By their nature, patent systems restrict public access to inventions, but it may actually harm future technological progress by impeding firms from building on prior knowledge (Scotchmer, 2004). Conversely, if the patent system offers too little protection, the public not only loses just one invention, but also its future offspring. According to Roin (2013), providing enough protection to motivate innovation activity is critical, but providing too much protection will lead to stifling of innovation.

One of the potential solutions to the identified challenges has included tailored patent awards (Roin, 2013) that would shorten the innovator's time of operational freedom but still grant enough of a timeframe for the innovator to profit from the innovation - while letting others build on the original innovation in a meaningful way. This approach, however, builds on the idea that future value is assessable early on, which is judgement difficult to make.Another stream of development is the shift from the 'products of innovation process' to the process itself. Blank and Newell (2017) propose that organisations need a self-regulating, evidence-based innovation pipeline, a process that operates with speed and urgency, and that helps innovators and other stakeholders elaborate on and prioritise ideas and technologies. *Open innovation* built on multiparty sharing of knowledge is one such process. This view builds on the concept of the Innovation Funnel (Dunphy et al, 1996), in which a company moves from a vast number of opportunities to a limited number of launched/rolled-out features and products (see Figure 1).

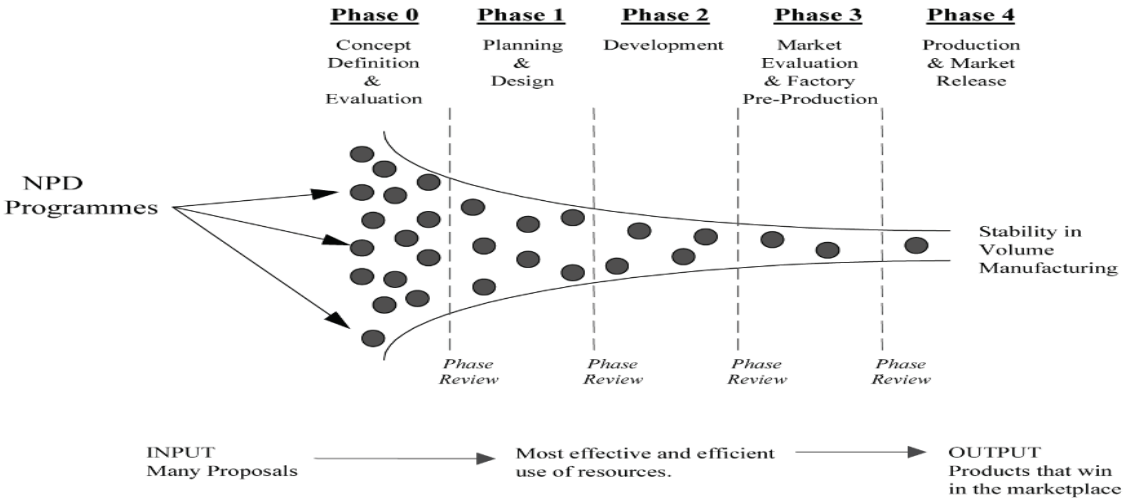

Figure 1: Innovation Funnel (Anthony & McKay, 1992)

The internal New Product Development model can be widened to the external environment (Figure 2). The company collaborates with its environment across company boundaries through stages of development.

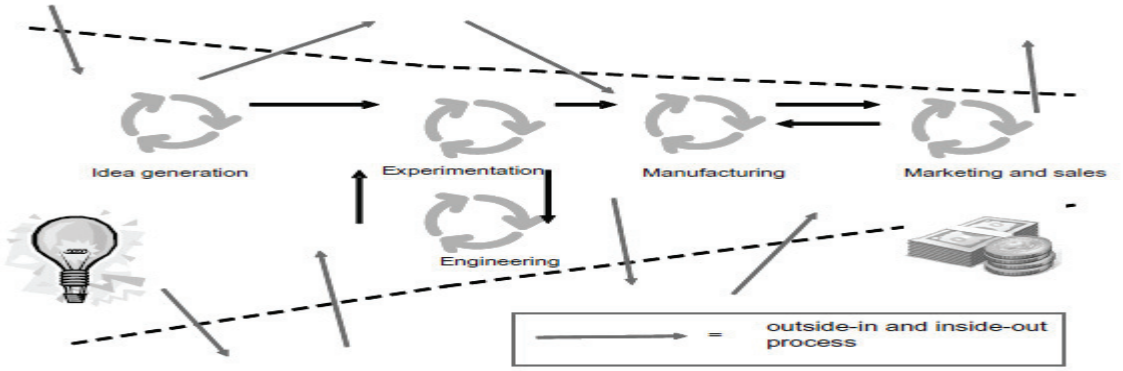

Figure 2: The New Product Development Model (Phillips, 2011)

Another development area has been a compromise between closed and open innovation (see above) that could be called *selectively open process controlled by mutual agreements*, where a company uses broadly described conditions for cooperation and co-development with selected counterparts. The parties involved agree to reveal some and protect other parts of their IP during the cooperation. The Letters of Intent can e.g. present plans for preserving and improving current capabilities, jointly meeting the challenges and taking advantage of operating critical resources (e.g. Atlas, 2012). Witek (2000) noted that letters of intent (LOIs), memorandums of understanding (MOUs) and similar documents were in the past used rather sparingly and in narrow transactional circumstances. Nowadays, LOIs are a common element in transactions such as software licenses, joint development agreements, manufacturing services agreements, intellectual property licenses, etc. LOIs and MOUs are used to set some form of managerial frame to undefined outcomes of joint processes.

3. Recent phenomena of focus shift – a multiple case analysis

3.1 Case 1: Pace of market opportunity opening vs. IP process

The IP creator, a Finnish institute of Higher Education, started a "Research into Business" project based on the invention of a novel solution for safety systems in vehicles. The project was assigned public funding for 16 months of duration, with the aim of charting its market opportunities and value chain structure for the future market launch. In this case the activities were divided into four sections that proceeded in parallel: 1) IPR = Patent application preparation, 2) Laboratory and field work to test the solution and understand potential use contexts, 3) Performing (via desk study and purchased research reports) market analysis, and 4) In one-to-one encounters with recognised value chain actors.

The process of getting IPR artefacts in place (patent application and resulting national priority date) lasted to the very end of the 16-month process. Since the invention did not enjoy any degree of protection, section 1 as a result did not provide support to stages 3 and 4. In practice, the early market studies (section 3) revealed the key players and their relative importance, even down to key individuals in those companies as well as events in which to meet them. However, the contacts were unable to take any stance or point at a suitable pathway without knowing some basic details of the innovation. This was not possible, as the discussion on the core innovation would have provided direction to competing research by the value chain actors. The length of the IPR process was thus incompatible with go-to-market plans. The need for higher process speed was further underlined by the fact (revealed in work done in section 3: market analysis) that one of the largest overseas markets was renewing its legislation related to the product category in just 2.5 years´ time from the start of the project. The delayed industry contacts meant that the solution misses the first wave of market adoption.

To avoid these pitfalls, the party possessing the proprietary knowledge could have potentially tried to safeguard the unique knowledge by contractual means (letter of intent, memorandum of understanding, non-disclosure agreement, etc.).

3.2 Case 2: Loss of IPR due to overtrust, i.e. jumping over process steps in knowledge creation

The supplier of components to the specialised working machine/vehicle industry was engaged in a longer-term development project with their main customer. To their surprise, when the supplier began the internal

preparation for the patenting process and started screening for competing solutions, a patent application had already been filed for the jointly developed invention, in the sole name of the customer. Claiming a fair share of the paternity rights for the innovation was not possible without putting the key customer relationship for the main product line of the company under serious strain. So for now, the supplier's knowledge is applicable only to a part of its market potential.

This case underlines the role of early involvement in the process with agreements and clear guidelines when working with external knowledge resources. Even when acting in an Open (or Joint) Innovation environment, the ownership can't be a free catch to the most agile party. All in all, there is a powerful case to be made for strong contractual framework on knowledge creation, dissemination and protection.

3.3 Case 3: Value of meta capabilities – knowledge on knowledge and innovation on innovation – corporate acquisitions of innovation process expertise providers

A recent phenomenon related to innovativeness and innovation capabilities has been the wave of corporate acquisitions by major ICT technology providers and consulting companies, in which they have fortified their innovation process knowledge capabilities. In 2016, an Indian ICT giant acquired a Danish innovation champion at a price that was threefold to the sales revenue of the acquired company. The acquired company has 9 patents (as retrieved from the Espacenet database 8.2.2019) in their own name, but those patents have little to do with the core business of the acquirer. The French ICT/concluding conglomerate GapGemini, in its turn, acquired the Finnish-originated innovation process champion Idean Enterprises at an estimated price of 75 million euros, which equals about tenfold the sales revenue of the latter (Talouselämä ("Business Life"), 2018).

Though Idean has just 2 patents granted in its name, it possesses innovation and design process expertise with a global customer base.

The rationale of the latter acquisition was according to the buying party that "customer demand is shifting; service providers who bring digital design, creativity, and agility to redefine the customer experience are developing a strategic dialogue with their clients, driving uniquely differentiated outcomes" (CapGemini, 2018).

3.4 Summary of the case examples

The cases presented and analysed above differ in the industries where they occur and in the size of the companies involved. Still, they point out the same dilemmas as the literature review (Chapter 2), namely that the balance of closing vs. disclosing information and the practical action to maintain that balance is a delicate act. Overtrusting the fairness of innovation partners can lead to the loss of IPR and hurt future business value. On the other hand, fear, lack of trust and/or lack of contractual and practical ways to allow a certain level of information disclosure in business relationships can lead to missing the market opportunity entirely and render the knowledge obsolete. The focus on innovation processes instead of their tangible results is also gaining increasing interest and business value.

In the three unique cases happening during a one year timespan inside one local innovation environment in Finland, both similarities and differences in presence and impact of different Intellectual Capital consituents and driving forces got demonstrated, as the summary table 1 below shows.

source and impact / cases	Knowledge asset driving the case originally	Knowledge asset impacted by the case development	Impact of IP process to the case (magintude)	Impact of IP Process to the case (qualitative)	Correlation to the New Context of Speed	Correlation to the New Context of Collaboration
Case 1: Missing time-to-market for not having IP´s in place	• Entrepreneurial Capital • Renewal Capital	• Relationship Capital • Structural Capital	High	Short-term: Negative Long-term: Positive	High	High
Case 2: Loss of jointly developed IP to a key customer	• Relationship Capital • Trust capital	• Relationship Capital • Trust Capital	High	Short-term: Negative (for the case company) Long term: n/a	Low	High
Case 3: Acquisition of an Innovation Process – concept owner	• Human capital • Relationship Capital	• Human capital • Structural Capital	Low	Neutral	High	High

Table 1: Summary of the case analysis

4. Conclusions and discussion

This paper highlights the shift happening in the sphere of knowledge management. The new innovation environment requires fresh angles to firms´ innovation capabilities and practices. Current development is an extension to the continuum where the *success probabilities for individual innovations are low, competition for a market-capable solution is intense* and shifts both in customer demands (pull) and supplier´s capabilities (push) are frequent and *change speeds are accelerating*. The current clock speed of evolution and the components contributing to it (technological advance, hypercompetition and shortening windows of opportunity) are causing challenges to especially novel and resource-constrained firms to engage into formal IP processes. They need to seriously assess their resources and capabilities as well as the business viability of the traditional formal IP processes with long lead times and high uncertainty.

In the new paradigm, the *modus operandi* leans towards at least two directions that appear to be partial resurrections of old practices. The first direction is a step back from the widely popularised philosophy and practice of open innovation. In his stream of development firms deploy policies and practices where, by means of contractual knowledge artefacts such as MoUs and LoIs, the process leaves room for joint, continuous and, to a certain extent, non-destined innovation. Simultaneously, the process safeguards each parties' proprietary rights for IP and input to the multiparty process.

Secondly, the importance of innovation processes *per se*, a constant flux of new ideas subjected to testing and analyses, is highly valued. The concept of *knowhow* has been dormant for some time – the number of scholarly articles containing the word 'knowhow' in the title has been just 5-15 annually throughout the 2000s. Partly, this may be due to the evolution of new terms such as process knowledge. Another reason may be a further division of the original term to new concepts such as know-who, know-where, etc. (Simone, 2011). Based on our observations, knowhow seems to be regaining strength back from the 'know-what' mindset of innovation management. The modern knowhow is seen as an internally and externally joint effort. However, the advantages of knowledge pooling with partners need to be balanced with the risks on proprietariness of knowledge.

We propose that firms need to operate on multiple fronts of intellectual capital in order to fully exploit their knowledge assets. The levels on which a company is in different subareas of intellectual capital (IC) have an effect on operational modes it can apply. And reciprocally, the different IP actions performed have a differing impact on IC. The current formal IP processes are still an option (with their advantages and disadvantages) for growth-seeking innovative companies, but companies search and practice already alternative ways.

This paper aimed to present a conceptual overview with cases chosen as examples to link the conceptual considerations closer to practice. Further research with a wider sample, deeper data and a unified practice of

approaching cases is needed. In business, everything boils down to business viability, i.e. long-term value creation. To achieve that, research should also longitudinally approach the topic to see the full business effect of different strategies in IP policies and processes.

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III

TORN BETWEEN FUNNELS: START-UP ENTREPRENEURS' DILEMMA OF GETTING STARTED AND PREPARING FOR CHANGE

by

Juha Saukkonen & Abayomi Bayiere, 2017

In J. Mitra (Ed.), *Conference Proceedings, Volume 2: Research and Reflective Papers. 15th International Entrepreneurship Forum (IEF) Conference*. Essex: University of Essex, pp. 414-433.

Reference 30

Torn between funnels – Start-up entrepreneurs´ dilemma of getting started and preparing for change

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Keywords*: Innovation, Start-up, Time, Future, Value Network*

Abstract:

Start-up entrepreneurs operate in an environment that has special time-related dynamics. As earlier research has indicated, the speed of change or "clockspeed" of industries has been and keeps accelerating. That implies that the speed of market entry to hit the window of opportunity is crucial for all businesses. For startup companies, nascent ventures that offer novel solutions based on advances in knowledge and technology with limited resources, this time constraint of getting to the market and start making revenue is even more crucial than for mainstream established companies.

For certain types of investors and industries, the revenue from operations has to be generated already before investment is considered and done (e.g. Cohen, 2016). This means the company has to do quick solutions of product configuration and technologies applied. This process of narrowing the vast landscape of opportunities identified form internal and external sources to a much more limited number of solutions brought to the market is often described utilizing the schema known as *Innovation Funnel* (e.g. Dunphy et al, 1996). Simultaneously the companies need to show from 3- up to 5-year projections of revenue. Earlier research (e.g. Saukkonen et al., 2016) has shown that e.g. in ICT-intensive industries the predicted lifetime of individual technologies is 2-3 years. This means that inside the planning horizon of 5 years there is a widening array of potential technologies, some of them to be implemented by the firm doing the planning. The core idea of the widening field of alternatives is coined e.g. by Kuusi et al. (2015) as *Scenario Funnel.*

This conceptual paper discusses the challenges and demands that the firm´s internal development needs as well as external forces and stakeholders set for a start-up company moving between the planning (narrowing the first funnel) and scanning horizons (the second funnel: widening range of opportunities and challenges). The paper also discusses potential solutions derivable from earlier literature applicable to new venture context, relying on the joint effort of the value network(s) that the new venture is a part of. We also the concept of *futures mix* as a toolset for new venture development. To conclude the paper points out need and direction for further research.

2.Introduction

It is often stated that we live in the fast-paced environment and where the speed of change – also called clockspeed (e.g. Fine, 1998; Nadkarni & Naranyan, 2007; Schimmer & Patel, 2015) is accelerating. This new order of sudden changes in the operating environment and quick responses such as shortened development cycles for new products and services is seen to favour new ventures – start-ups firms with little to none legacy of previous operations hindering their agility to move where the market is going to. E.g. Christensen 2013), based on evidence derived from various industries, made a remark that there are some fundamental reasons why "great companies fail", opening door to the marketplace to newcomers.

The dynamics related to new ventures, also often called entrepreneurial firms or start-ups, do not always seem to prove that point. Evolution of new technologies and firms betting their future on them tend to be slower than originally expected, leading to drought in resources and inability to keep up with changes and necessary evolution steps in the turbulent environment. This then leads to investor deception in the time and magnitude in which they can make an exit and get revenue for their initial investment.

There are multiple methods and tools developed and used by the business community and researchers to help companies to both foresee the opportunities arising and in an agile and smart way to act on opportunities and risks of the future. However, the tools have been developed independently and their sheer number (e.g. one of the classics of Future Foresight, Futures Research Methodology 2.0. by Glenn and Gordon lists 23 main methods of futures research, some of which fall depending on their implementation into any of 4 categories of foresight – or multiple to all categories simultaneously: Qualitative, Qualitative, Normative, Exploratory).

It is clear the field is rich with options for an entrepreneurial firm to choose from, but much less of available criteria and guidance when and how to use them. This paper aims at drawing an overall picture of frameworks and tools of future-oriented action, demonstrate the gaps of knowledge (or abundance of it in certain terms) and point out direction for further research and development.

3.Objectives

The objectives set for this study were two-fold. Firstly, the authors wanted to draw a aggregate picture of the time-related contradictions that start-up entrepreneurs face in their business development as well have an overlook at the tools proposed by earlier scholars to overcome the challenges set by time. Based on these findings, the aim was thus to find out if there are important needs of improvement discipline, practices and tools. Secondly, the authors aim at proposing direction to further development and research on the field, creating stronger links between the science and art of futures foresight and entrepreneurship.

4. Method

This research was designed to be a conceptual enquiry, and was also performed as such. Following the ideas of Kothari (2004) it can be stated that conceptual research is about creating new theories or re-interpreting existing ones, without yet observing real-life representation of them (experimental research design) and collecting data to test and prove theories.

The objective of this paper was not to create a new theory or framework for anticipation efforts, opportunity scanning and operational planning for entrepreneurial firms, but rather study and make explicit the possible dilemmas and incompatibility of existing approaches (methods and tools) that new ventures face. The researchers have in their earlier work (Saukkonen et al., 2016) observed real-life manifestation of the issues handled in this paper, and the identified lack of common frameworks on practitioner-level of business has been the spark for this enquiry.

The data collection has happened via literature review of prior research, approaching the topic from two angles, that of a) new business development b) future foresight. These two angles do not commonly meet in research, but would still both be necessary parts of a thorough strategic development in an entrepreneurial firm.

5. Literature review

Nature of start-up companies and entrepreneurial effort is that they need cope with multiple options, high level of uncertainty as well as with constant willingness and ability to develop and change. The often used definitions of start-up companies by Ries (2011) and Blank (2010) stress the very nature of start-up entrepreneurship. Blank coined conceptually that start-ups are fundamentally different to established companies: “A start-up is an organization formed to search for a repeatable and scalable business model”, and along the same lines Ries (2011) stated that “a start-up is a human organization designed create a new product or service under conditions of extreme uncertainty”.

These forces and characteristics have gained in magnitude in the era of fast development and volatility in business and technology environment. the accelerating pace of change referred e.g. as “increased clockspeed” (Fine, 2002) and the increase in the amount of potentially transformative and often intertwined technologies has made technology anticipation a resource-demanding and wide exercise for firms aiming at “seeing what is next?”. How many and which technologies to include to anticipation processes and which ones not? One of the leading ICT consulting firms Gartner has for years published their “Hype Cycle curves” of emerging technology areas and particular technologies. As the representative of Gartner, J. Fenn (2011) coined the purpose of their approach: “Hype Cycle for Emerging Technologies targets strategic planning, innovation and emerging technology professionals by highlighting a set of technologies that will have broad-ranging impact across the business. It is the broadest aggregate Gartner Hype Cycle, featuring technologies that are the focus of attention because of particularly high levels of hype, or those that may not be broadly acknowledged but that Gartner believes have the potential for significant impact." Fenn refers to the “general” ICT –hype cycle, but in addition to that Gartner publishes on a yearly basis separate Hype Cycles for specific technology areas such as cloud computing or social software. There are close to 2000 individual technologies under Gartner radar (ibid.). These listing and graphical presentations offer potential technologies that the companies pursuing technology anticipation can alter to their processes. In other words, they are (one of) potential sources from technologies to be followed.

A brief analysis (both of the stage that the listed technologies are assessed to be at the time of curve publication as well as the expected time that it will take for a technology to be mainstream adopted) of the Gartner´s broadest aggregate Hype Cycle curves over a span of 5 years (2010-2014, compiled from various online-sources) clearly indicates the complexity of the field for individuals and companies that aim at engaging to technology anticipation processes (tables 1 and 2 below).

Table 1: Gartner Main ICT Hype Cycle curve 2011-2014: average time to mainstream adoption - analysis

Time to mainstream adoption (nr of techs)	2010	2011	2012	2013	2014	total
0 - 2 years	4	5	4	3	2	18
2 - 5 years	18	15	17	10	10	70
5 - 10 years	11	16	20	21	27	95
10+ years	7	6	7	9	6	35
Obsolete before reaching adoption	1	-	-	-	-	1
total	41	42	48	43	45	219

As can be seen from the table 1 (above), the mere number of the technologies (or tech areas) in the aggregate level Gartner-curve is approaching 50 technologies. Also the expected time to mainstream adoption has seen a shift towards 5-10 years of “waiting” time before full commercialization of a technology

will take place, indicating that investment into development of those techs needs far-reaching planning with high risk involved.

Table 2: Gartner Main ICT Hype Cycle curve 2011-2014: Divisions of technologies by devel. Stage-analysis

Stage of the development of a technology	2010	2011	2012	2013	2014	total
Technology Trigger	13	12	12	14	17	68
Peak of Inflated Expectations	9	15	16	13	10	63
Through of Disillusionment	11	7	13	9	11	51
Slope of Enlightment	7	7	6	5	6	31
Plateau of Productivity	1	1	1	2	1	6
total	41	42	48	43	45	219

Table 2 shows how most (and in an increasing manner) of the detected technologies are still at the Technology Trigger-phase. That stage is defined by Gartner: “A potential technology breakthrough kicks things off. Early proof-of-concept stories and media interest trigger significant publicity. Often no usable products exist and commercial viability is unproven.” Investing money and effort to technologies in that stage sounds a risky choice. On the other hand, if a company waits until a technology reaches the stage of the slope of enlightenment “More instances of how the technology can benefit the enterprise start to crystallize and become more widely understood. Second- and third-generation products appear from technology providers. More enterprises fund pilots; conservative companies remain cautious” the competitive advantage achievable via the technology in question has vastly diminished.

5.1. Planning horizon – concept, tools and affecting forces

Henri Mintzberg (1989) categorized managerial decision-making to be divisible into 3 broad categories. The first category is that of opportunistic decision-making: Taking the best out of the prevailing situation, inside the constraints of existing resources and competences. The short time-horizon do not allow acquisition of new resources neither rearrangement of the existing resources and competences. On the other hand, the uncertainty related to the decision-making situation is low, since the decision is most often a continuation of the earlier opportunistic and strategic decisions. Timespan for truly opportunistic managerial decisions is typically anything from immediate to one year. Interestingly, Olson (1986) noted that entrepreneurs have a tendency to be opportunistic decision-makers. This might be related to the newness of the firm established, the strategic direction is still in search and also the limits in the resource base, that directs the new venture owners to focus on the short-term steps and survival, leaning little effort to strategic, let alone visionary decision-making.

Strategic decision-making (Mintzberg, ibid.), in its turn, is still based on relatively well-known environment but with additional uncertainty when compared to opportunistic scope. The relatively low level of uncertainty and lengthened timeframe (in comparison to opportunism) allows acquisition of new (identified) resources and rearrangements of the existing ones. Timeframe for strategic decision-making is seen to be of 1-3(5) years. Eisenhardt and Zbaracki (1992) point out that the managers working on the strategic decision are only “boundedly rational, that power wins the battles of choice and that chance matters.” Opportunistic and strategic decision-making paradigms allow quite detailed step-by-step approaches to the development processes of the firm, and can thus be seen to belong to the *planning horizon* of the firm – reducing the number of alternatives to choose from, choosing and executing.

Inside the planning horizon the firms are likely to bring up mostly sustaining or incremental innovations, that were defined to be based on current technologies and bringing gradual upgrades to existing products and services. According to Norman & Verganti (2014) organizations are “continually looking for niches in

a market to exploit and do so by either incrementally improving existing systems, products, and services or creating entirely new ones. Some innovations come in the form of evolutionary, incremental improvements."

The third category of decision-making, visionary management, is in its turn dealing with added uncertainties, added amount of options and is likely to bring up radical and disruptive innovations. The visionary decision-making time scope and uncertainty make detailed planning efforts unrealistic, and thus this time scope from 5 years (in today´s fast clockspeed and volatile environment often 3 years) to 10 years is referred as *scanning horizon* (Kuusi et al., 2015). The nature of scanning and practices of it are more closely presented in Chapter 5.2.

Innovation Funnel / Open Innovation

The concept of Innovation Funnel (Dunphy et al, 1996) refers to a process that a company uses to move from vast number of opportunities to a limited number of launched/rolled-out features, products and services. The schematic picture of the funnel process as typically figured out by innovation researcher community, in this case by Anthony & McKay (1992) is shown in the figure 1.

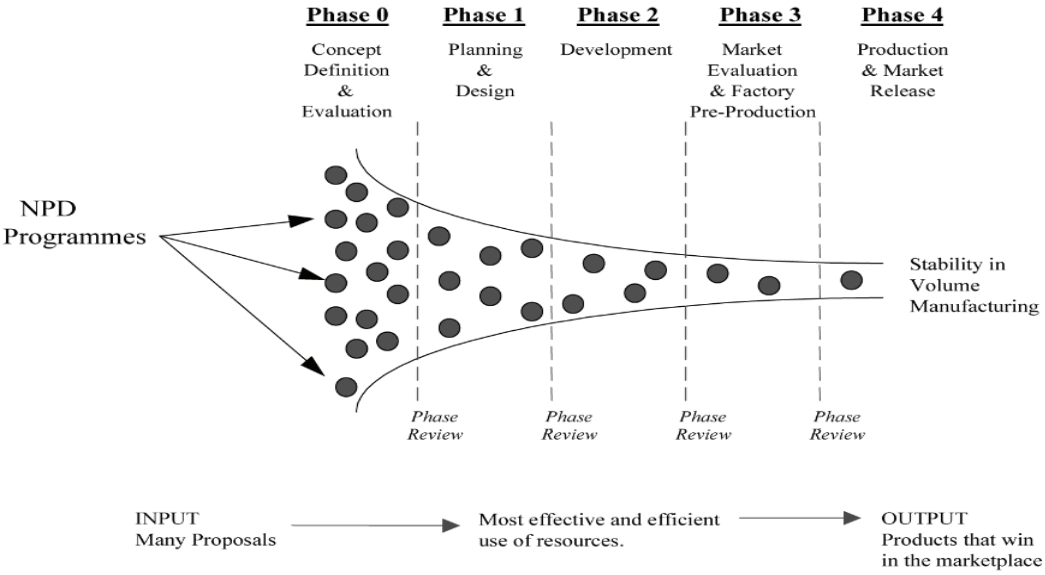

Figure 1: Innovation Funnel

Even though the model by Anthony & McKay uses the term of New Product Development (NPD) programs, that is a common term for a company´s internal R&D, most often the innovation practitioner community adds the external environment and actors to the model, like in the illustration by Phillips (2011) in Figure 2. The dotted line represents the company´s boundaries and the arrows in the figure the interaction that the company has with external actors such as partners, suppliers, customers etc. utilizing the principles of *Open Innovation*. According to Brunswicker & Vanhaverbeke (2015) the central principle of open innovation is the crossing of firm-boundaries: firms who practice it purposively "use inflows and outflows of knowledge to accelerate internal innovation, and to expand markets for external use of innovation, respectively". The "breathing" and flow of innovation can be inbound (finding ideas, knowledge, resources from external environment, or outbound (releasing or trading ideas and knowledge to the external environment (ibid.).

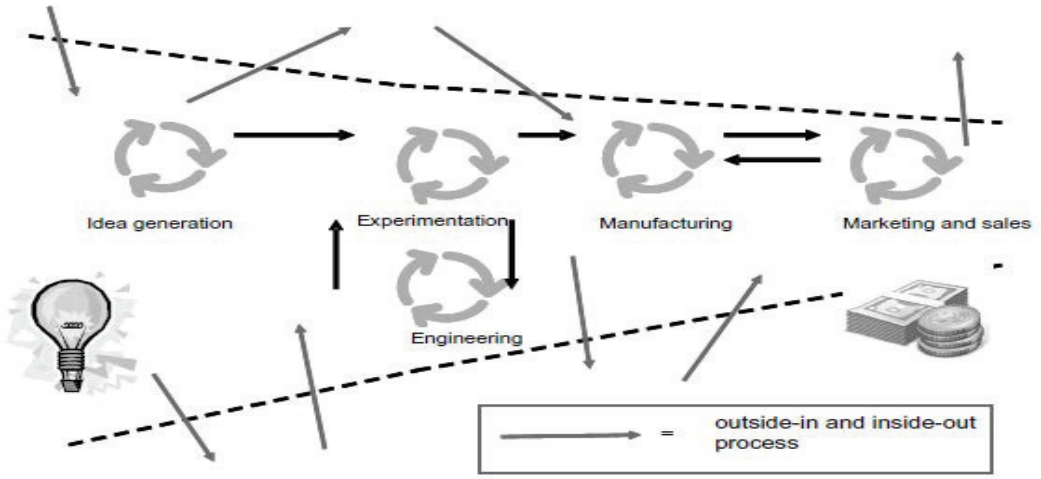

Figure 2: Steps of Innovation Funnel Process (Dunphy et al., 1996)

The loop-like symbols in the model by Dunphy et al. stress the importance of the learning process involved in NPD. Instead of linear process the trajectory from ideas to products contains iterations and returns to the earlier phases. Innovation Funnel should be seen more as an umbrella term that hosts many specific methods across its stages, like the Open Innovation-paradigm already mentioned. In the following sub-chapters some key methods related to the narrowing (with time) funnel of innovation get introduced.

Product and Technology Roadmaps

Roadmapping is a process that take many forms and concern various layers from whole industries and technologies to a single business unit inside a corporation. Roadmapping has been seen a method of (futures) research itself (Glenn & Gordon, 2003), but also as a method of processing and organizing data obtained by various means of study. Phaal et al. (2001) that have developed the "T-Plan method for (product and) technology roadmapping (TRM)" summarize the nature and purpose of TRM to be a time-based chart that consists of a number of layers that include both commercial and technological perspectives. The roadmap enables the study/anticipation of markets, products and technologies, and of the linkages between the various perspectives.

Unlike Innovation Funnel, a roadmap is more full with information at a closer timely distance to the moment of its creation, as the near-term future is more carefully planned and data of external and internal forces affecting NPD is available. Figure 3 shows the schematic picture of Product & Technology Roadmap.

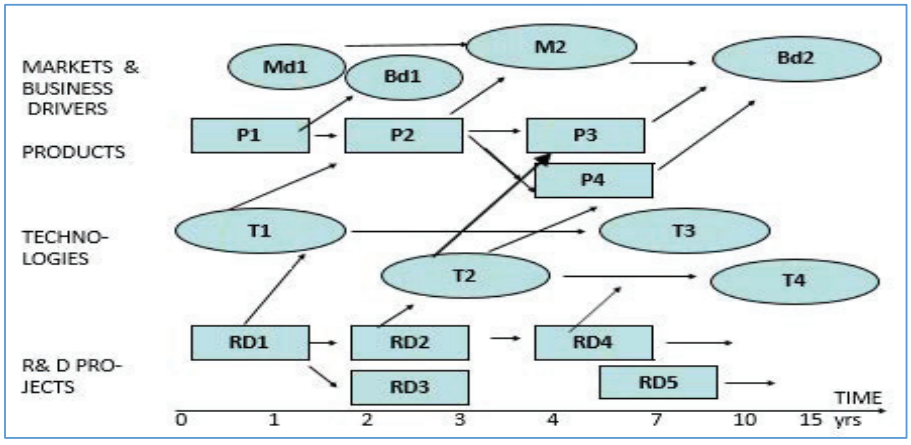

Figure 3: Product and Development Roadmap – structure

Agile Development methods

Neither Innovation Funnel nor Technology Roadmap are responses to the question “how” (the narrowing of the options to work on). T-Plan model by Phaal et al. contains a clear process of check-ups for the validity and rationale of “results” for each layer, but they can´t be known or assessed looking at the plain roadmap, that is the outcome of many processes linked to roadmapping. In the same manner, the model of Innovation Funnel does not reveal what are the practices that need to be performed in phases of (e.g.) planning and evaluation.

As a response to the harshness of roadmaps and funnels, numerous methods have been developed to support swift progress between the stages. Examples of such approaches are Lean Start-up, Design Thinking and SCRUM-methods.

The concept of *Lean Start-up* is largely based on the writings by Steve G, Blank (2010) and Eric Ries (2011) and been backed up by the research by Marmer et al. (2011a, 2011b). The core essence of Lean Start-up methodology is to replace long at linear and lengthy product and service development cycles with agile testing, experimentation and learning in interaction with the market. To highlight this market-oriented view Blank has even replaced the name of the process of product development by customer development. Key concecpts linked to Lean Start-Up are e.g. MVP (Miminum Viable Product, a product that can still be far from final solution in designs, totality of features etc. but able to demonstrate the core benefits/value to customers) and Pivoting (change of plans and direction due to feedback and learning). Marmer et al. (2001a) call the four early stages of development (before reaching maturity a.k.a. business-as-usual) Discovery, Validation, Efficieny and Scaling, and based on their 650+ start-up company data propose that iterations are needed. Marmer et al. (2011b) also state that companies who exaggerate in speeding up their development by jumping over some stages or do not spend enough effort in each stage, are proceeding and scaling prematurely, and this behavior is negatively affecting their chances of success on the market and getting funded.

According to Lockwood (2009), *design thinking* is a human-centered process aimed at innovating that emphasizes the usage of observations, collaboration, emphasized fast learning and visualization of ideas, rapid concept prototyping and also concurrent business analysis running parallel to the aforementioned more creative actions. Ben Mahmoud-Jouini et al. (2016) highlight the difference of design thinking (DT) to a more close-ended R&D process by stating that DT is a structured process that fits to exploration for problems that are ill-defined.” Liedtka (2015) states DT is best suited is best suited to decision contexts in which uncertainty and ambiguity are high and list the key principles of DT as follows (numbering by the authors of this paper) : It relies on 1) abduction and experimentation involving multiple alternative solutions that actively mediate a variety of tensions between possibilities and constraints, and 2) learning through experimentation based on 3) multiple iterations are seen as a central tasks.

SCRUM-method of development originates from software and systems development, and build on the basic principles of spiral development, where the continuous learning and creation of novel ideas within the development process are key elements of the process. The figure 4 by Schwaber (1997) shows the spiral-like process, that does not rely on random and ad-hoc iterations but on controlled and planned loops.

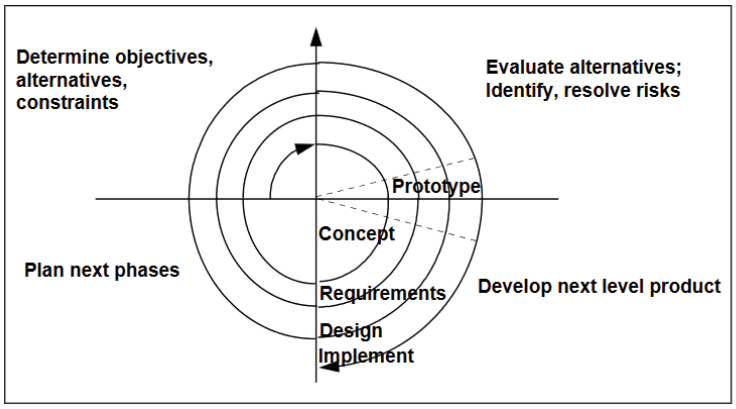

Figure 4: Spiral Method of Development (Schwaber, 1997).

SCRUM is said to enhance the team engagement (inside teams) as well as working in a controlled manner with numerous development teams that work in a reciprocal manner with each other. SCRUM is said to offer a base of joint and distributed development and mutual learning, and it is nowadays used in areas very different to its original application area, e.g. in educational processes (Kingston, 2015). This enlargement of SCRUM usage has been made a note of by Naz et al. (1986) who state that SCRUM was first defined as a flexible product development strategy by Takeuchi & Nonaka (1986), but quite soon it was elaborated further so that SCRUM is now seen as a sort of organizational knowledge creation that is working well in getting about novelty constantly and incrementally.

Despite its clear positive underpinning, the case study by Sutherland et al. (2007) proved that "distributed teams and even outsourced teams can be as productive as a small collocated team". However, to succeed with SRUM requires excellent implementation is needed along with good engineering practices. The whole set of teams must function as one unified team and with one global build repository, and e.g. with one tracking and reporting tool only. Thus, to reach the promise of SCRUM for an entrepreneur may be time and energy consuming.

5.2. Scanning horizon – concept and affecting forces

Visionary management and decision-making is typically used in the time scope of 3 (5) to 10 years from now. The time from now to the time "anticipated" in visionary management bears al lot of uncertainty, but at the same time allows the firm to respond to anticipated change by acquiring new resources and competences. The time scope allows enables the birth of radical, disruptive innovations. In spite of the vagueness of the definitions of disruptive and radical innovations brought up by Nagy et. al. (2016) – for example, what is disruptive to some organization is not disruptive to another – there is some common ground found in the literature. Various definitions stress the concept of newness. Slappendel (1996) underlines the importance of true newness, as it sets innovation apart of any change. And innovation is seen to be crucial as a motivator and success factor of new venture and entrepreneurial activity (Johannesen and Olsen, 2001). Zhou and Li (2012) coin the term of radical innovation meaning innovations that are "novel, unique, or state-of-the-art technological advance in a product category that significantly alters the consumption patterns in a market". To the concept of newness in the external dimension (market) the concept of internal newness (newness to the firm making the innovation) is often added. The newness also means that a true innovation is competence-destroying (Christensen, ibid.): Some of the capabilities behind the past success of the firm become obsolete with radical and disrupting innovations.

Because of the wide range of potential future paths of evolution (or revolution) of markets, competition and choices of the firm, Kuusi et al. (ibid.) describe the paradigm of the scanning horizon be that of the *scenario funnel.* Unlike the earlier discussed innovation funnel that attempts to narrow the range of options between now and the time of product/service launch in the *planned future,* the scenario funnel opens up towards future (see figure 5, Kosow & Gassner, 2008). The more we expand the time horizon from the present, more rich of options our view of the future gets. Following the ideas of Kuusi et al., "the basic idea of the scenario funnel is that the farther we gaze from today's standpoint towards the future the more possibilities are open". The different scenarios all start from time point of "present" and the range of the scenario paths increases with time, so after certain point the "collection of possible scenarios" spreads widely, like an opening funnel does. Scenario funnels are often drawn and described in the way that places the most probable scenario in the middle of the funnel and the (presumably) most radical scenarios to maximum distance from the "mid-scenario" for the time point in question. Scenarios, for their part can be shortly described as Khan puts it: "… hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision-points. They answer two kinds of questions: (1) precisely how might some hypothetical situation develop, step by step and (2) what alternatives exist, for each actor, at each step, for preventing, diverting, or facilitating the process." So a scenario is not just a justified estimate of future conditions at a given point, but contains "mini-scenarios" that are trends, desicions, actions and incidents on the way to the end point of the scanning horizon.

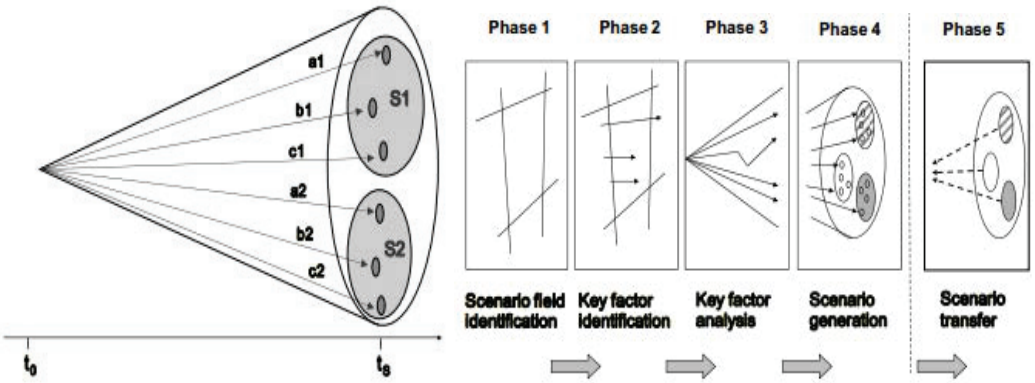

Figure 5: The schematic picture of scenario funnel and process of its creation (Kosow & Gassner, 2008)

To help the entrepreneurs to cope with increasing number and variety of options, tools for scanning have been developed to translate wide future views into selected number of issues to work on. Most often the anticipation effort is concentrating into changes in the technology landscape (the focal point of this paper), but also societal and market development could naturally be mapped as well. Both methods introduced below: Technology Radar and Radical Technology Inquirer can be seen to represent elaborated and pragmatic examples of the approach called Environmental Scanning by Glenn and Gordon (2003).

Technology Radar

Technology Radar (TRI) as a tool for future-oriented technological intelligence was originally created and first implemented at the Deutsche Telekom Laboratories´ DTAG unit and later adapted by several other companies for example Cisco (Rohrbeck et al. 2006). TR aims at offering a system for identification, selection and verification of emerging technologies, aiming at fulfilling simultaneously three purposes: 1) to identify early the technologies, trends and shocks, with potential impact to the investigating company's business 2) to raise to awareness and discussion within the company the threats and opportunities of technological development, and 3) to stimulate company´s action on innovation, streamline innovation activities within the company, and to put in motion new quest for knowledge and investments to R&D (Rohrbeck et al., 2006; Boe-Lillegraven & Monterde, 2014).

The process and outcome of the TR

The TR tool is a process that consists of four stages: technology *identification, selection, assessment* and *dissemination* (Figure 2).

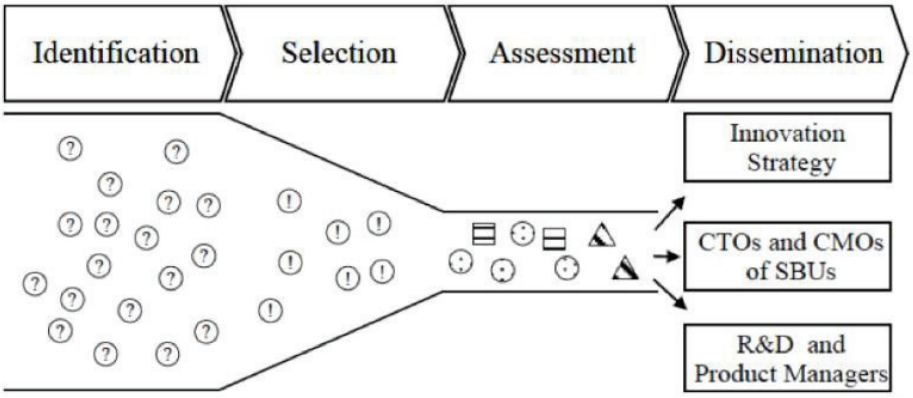

Figure 6; The Technology Radar method (Rohrbeck et al. 2006)

In the *identification* stage, technologies get identified by an international "scouting community", internal and external to the company, that will report on emerging technologies in pre-defined (to them) fields (Boe-Lillegraven & Monterde, 2014).

After identification, a panel *selects* and short-lists the most relevant technologies for further investigation. In the selection process, the technologies are put into four categories: 1) completely new technologies, 2) state of the art technologies but with recent leaps in development, 3) important improvements in complementary technologies, and 4) notable increase in the awareness of a technology and technology application (Rohrbeck et al., ibid; Boe-Lillegraven & Monterde, ibid).

Finally, the selected technologies go to an *assessment* (by a committee) for assessment - evaluation and ranking. The technologies are rated in two dimensions: 1) 'market impact' and 2) 'technological realization potential'.

Following the assessment, the findings of the process are *disseminated* to a wider internal audience. An example on how results can be visualized in Figure 3. The technological fields represent the segments, and the development stage depicted as concentric circles starting with the lowest development stage on the outside and the most developed technologies on the inner circle.

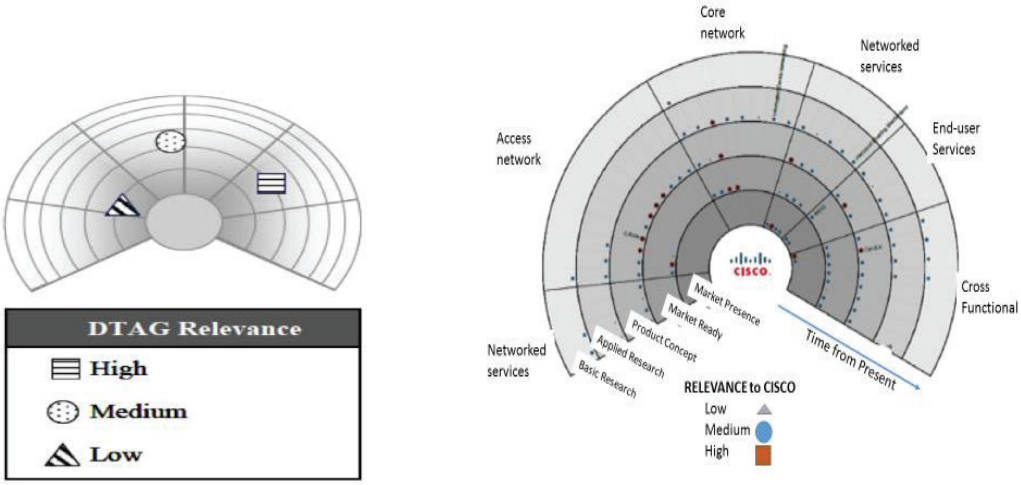

Figure 7**:** The Radar Screen of DTAG (left), and Cisco (right) (Rohrbeck et al. 2006; Boe-Lillegraven and Monterde, 2014)

Technology Radar offers to its users a way to dig into the recent and foreseeable developments in technologies that a company considers important to their business. Companies applying TR run the process most often 3-4 times per year, suggesting the tool is sufficiently light to be used in corporate context of. One obvious challenge of TR is that it only scans for technologies that have been pre-defined as important for their current business. It may be then a process that fortifies the present strategy rather than acts as a catalyst for change. As Vanamo et al. (2016) noted it may be also be a less appropriate tool for detecting unexpected but at the same time highly impactful technologies from sectors outside the scope of those technologies that have been deemed by the company and its network as important for the business. Also the knowledge base and number of actors participating to the process may limit its usage in start-up and small business contexts, that would anyway be fertile grounds for innovative action.

RTI (Radical Technology Inquirer)

The RTI tool developed by Linturi, Kuusi and Ahlqvist (2014) was originally published in 2013. The tool was originally developed for national foresight purposes, but adaptions and pilot usage in corporations have taken place since the launch of the method.

The result of the RTI development process was a collection of 100 emerging radical technologies that have been listed into an order of importance based on a calculation based on various indicators, like the maturity of the technology, existing competence in the technology and the technology's anticipated impact on the marketplace. Indeed, the purpose of the development was to offer a credible tool to create such a ranking list of emerging radical technologies and help policymakers and organizations to follow, assess and prioritize reactions and actions to the reshaping technological landscape. The tool is designed to consists of a 100 emerging technological solutions called Radical Technological Solutions (RTS) and 20 Global Value-producing Networks (GVPN) that are combinations of emerging technological possibilities and customer's needs or demands, i.e. areas of technological and societal change based on anticipation of global customer demands. The Radical Technological Solutions (RTS) refer to individual technology areas aiming at addressing a shared challenge.

The authors of first-cut RTI selected the 100 most promising technological solutions from all the creation process contributors' suggestions using a set of indicators under six categories.

Global Value-producing Networks – 20 in number - (GVPNs) were presented by describing (Vasamo et al., 2014)

- the current situation and expenses related to the network
- the anticipated new operating model with its savings
- the development of the maturity of the enabling technologies
- the challenges of the transition period to the new model
- legislative/structural barriers to change, and
- the threats of the new technologies related to the network

The100 identified Radical Technological Solutions (RTS) were presented by (Vasamo et al. 2016)

- a summary of the state-of-the-art of the solution, and its future prospects in 2020 and 2030 if the solution delivers on its promise as anticipated
- today's spearheading achievements related to the solution
- the most relevant background documents presented as Internet hyperlinks
- the most promising execution options of solution's functionality
- the most probable application areas of the solution
- an evaluation of the general maturity level of the solution
- an evaluation of global scientific interest on the solution
- an evaluation of the strength of the linkages to the Global Value-producing Networks (GVPNs)

So far, the RTI process has been conducted once in Finland and the top 100 list of most promising technologies is planned to be updated once a year or once in every parliamentary season (four years).

The pilot version of the RTI was conducted as a large crowdsourcing among stakeholders over the Internet, with hundreds of participants. This kind of an approach in terms of its size and openness may or may not be desirable for private and resource-constrained companies. The timeframe of 15 years can be also too long for companies, but as Vanamo et al. (ibid.) conclude: "…RTI could also allow companies to freely and creatively think about radically and disruptively different strategic possibilities and threats for their

business, as opposed to thinking about the mid-term, which might not allow them requisite time for major shifts in strategic direction".

6. Findings

Putting together the findings of earlier research and the compilation of the tools and models introduced across research and practitioner communities, it becomes clear that there are major concerns and difficulties for managers/owners of start-up enterprises who aim at managing time in a smart way. At first sight there seems to be abundance of

6.1. Complicated relation between startup entrepreneur and time – need for speed?

Time can be seen as one of the resources of a company. There has not been and there is not likely to be a final and complete list of all resources that a firm can have and gain competitive advantage from - or lose its competitive edge, if resources are not well managed. A typical presentation of resources is e.g. that of Penrose (1985). He presents a wide "resource approach" in which he argues that firms are administrative organizations and collections of physical, human and intangible assets. Barney (1991) gives a good overarching definition to resources: Resources are all assets, capabilities, processes, attributes of the firm, information (today: also data (authors´ remark)) and knowledge etc. that the firms controls and enable strategies leading to better results and efficiency. The well-known resource-based view (RBV) at companies suggests that firms' re-sources drive value creation via the development of competitive advantage (Ireland et al., 2003).

There also are sub-currents in resource-based research analysis of companies, e.g. Brush and Edelmann (2015) note that the emerging international entrepreneurship perspective posits that a key difference between internationalized and non-internationalized new ventures lies in their resource stocks, which includes founder attributes, organizational dimensions and social contacts. The type of the company also affected to the list of critical strategic resources in the research by Sirmon and Hitt (2003) from family firms: Human Capital, Social Capital, Patient Financial Capital, Survivibility Capital and Government Structure Capital. All these vary in time and they have an effect on the pace (action vs. time) that the firm can develop and grow.

Is time itself a resource for a firm despite the fact it rarely gets listed when creating an image of a firm? E.g. Sirmon et al. (2007) wanted to challenge the domination RBV paradigm by "linking value creation in dynamic environmental contexts to the management of firm resources". And as the definition and essential meaning of the word "dynamics" proposes it is about movement against time. So time can be seen as a sub-element of all other resources, or a meta-resource affecting the value and exploitation opportunities and challenges of all other resources.

As Wernerfelt (1984) pointed out, what is common to the firms´ view on their resources of all kinds is that "What a firm wants is to create a situation where its own resource position directly or indirectly makes it more difficult for others to catch up". Wernerfelt also states that in order to analyse a resource for a general potential for high returns, a company has to find ways in which a firm with a strong position can influence the action and returns of firms with a weaker position related to the resource in question.

If and when time is a universal resource, how can a firm act better on it than competition? Aren´t e.g. the market opportunities the same and known for all? Is having more time beneficial to a company with less time in their use, or can the time dynamics even work in a reverse manner? Time is by definition a complex issue to deal with.

There is a considerable amount of research related to time-boundedness and new business, and with drastically controversial conclusions. The line of thinking suggesting that "faster is better" was dominating the discussion in the 1980s and 1990a. In 1998 Stalk came up with the term time-based competition to highlight the importance of quick time-to-market in today's intensive competitive environment. Clark (1989) estimated that for each $10,000 car launch, any additional delay day in introducing a new model represented a $1 million loss in life-time profit for a company. A McKinsey study quoted by Cohen et al. (1996) reported that, on average, studied tech companies lost 33% of after-tax profit when they shipped

products six months late, as compared with the losses of 3.5% when they ended up overspending 50% on product development.

However, the speed - implied often by lack of resources to elaborate on things and thus leading to jump over important steps of development and learning (e.g. Marmer et al., 2011b) – may also affect a company negatively. Overly accelerated development may lead the company to launch immature technologies or launching in too much of anticipation for market opportunity, firms thus being not able a) to reach even the innovative customers, that make some 2,5 % market for tech products in both Business-to-Consumer as well as Business-to-Business spheres (according to Moore, 2002) or b) spending too much time to reach critical masses of customers in early adopter and early majority customer groups (13 and 34 % shares of total market, Moore (ibid.).

Lately, Stanko et al. (2012) in their research aimed at answering a question whether the speed-to-market is a blessing or a curse, after a wide review of earlier research proposing contrary answers to the question. The takeaway of the work and results of Stanko et al. is in its point made: The question cannot be answered without understanding the internal and external context of innovations to be launched. They state that if there is a high level of newness of the innovation to the company working on it (internal newness), additional speed in development may be value-destroying. The so-called first mover advantage suggesting quick launches of new-to-market innovations (external newness) was not supported either. When the product bears less innovation newness both internally and externally, the speed-to-market is one of the crucial elements of lifetime profitability of the innovation.

Thus, there is no single-handed answer to the question whether limited (limited by the external environment and resources or firm´s own processes) time is affecting positively or negatively to a success of a new, innovative venture. Figure 8 summarizes the findings from prior-art research and literature portraying both early and delayed launch options and the benefits of both options. It is easy to make the conclusion that time-related competence of a new business developer and entrepreneur cannot be measured in the length of time, but in a correct balancing of time between short and longer term, and being situationally and contextually sensitive is decision-making.

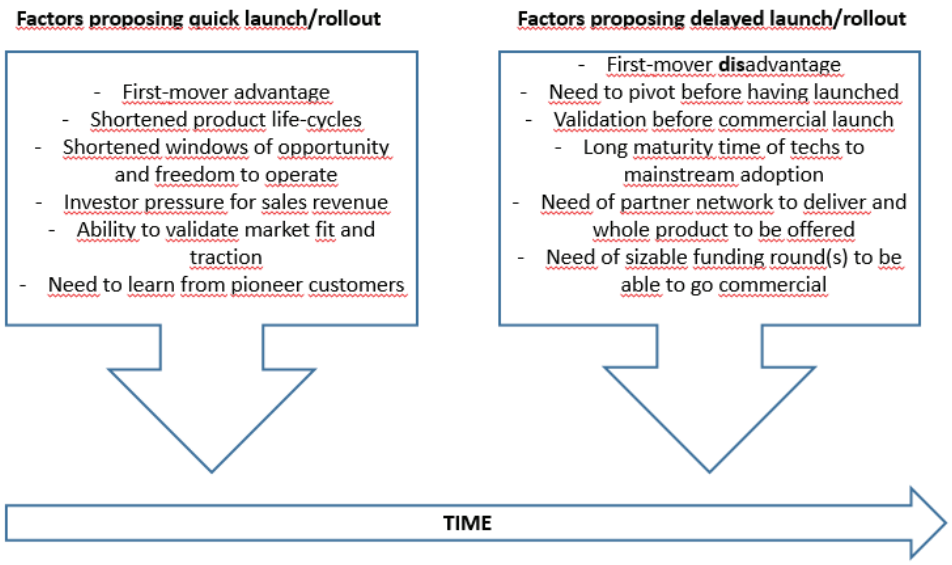

Figure 8: Controversial forces affecting the speed of launching to market

Based on the findings it is easy to enter into the conclusion that the battle of winning the marketplace for an entrepreneur is not just using the *minimum* amount of time, but use the *right* amount of time and use it widely. This mean ability to cope with multiple time horizon, act simultaneously with many time-scopes and choose and manage suitable scanning and planning tools for the needs.

6.2. Various time horizons and abundance of tools to work on them as an entrepreneurial challenge

Summarising the key essence of previous chapters, it has become obvious that the problem facing entrepreneurs willing and committed to act smartly with time is not the shortage of tools and frameworks but rather the abundance of them and unclear selection criteria and guidance on which tools to use. For each individual tool there is available literature on the process in question, studies of effects and critical success factors for planning and scanning processes.

Different time horizons are likely to require multiple tools, that can't be used (only) sequentially, but a start-up company and its owners/managers need to run many processes parallel. This complexity of time horizons that rose from the literature review is also backed by findings from the financing statistics of the main investment vehicle to start-up companies, Venture Capital industry. The average exit time for investors (based on compilation of reports on NVCA = National Venture Capital Association of US) has risen from the 3,3 years in the tech boom years of early 2000s to close to 7 years in 2015. This means that while the VC investors are expecting an early start and growth of sales revenue (suggesting the rapid time-to-market) in order to reach the reasonable level of sales that partly determines the value of the exit sale i.e. "multiple" (of sales to define the company value), they at the same time need to admit that the products and services will face major revisions between the investment and exit time.

The dilemma of dealing with various time horizons is visualized in Figure 9. A start-up company must find an agile way of narrowing its scope from ideation by selecting, testing and eventually rolling out the products and services, typically in 1-3 years' time from the idea generation. The closer to the roll-out date the "narrowing funnel" gets, more close it also gets to the "widening funnel" where new technologies and opportunities representing uncertainty.

The accumulated knowledge on how to use multiple tools and frameworks of scanning and planning has been extremely low, since the literature and research has mostly focused on studying and improving individual methods, not their integration.

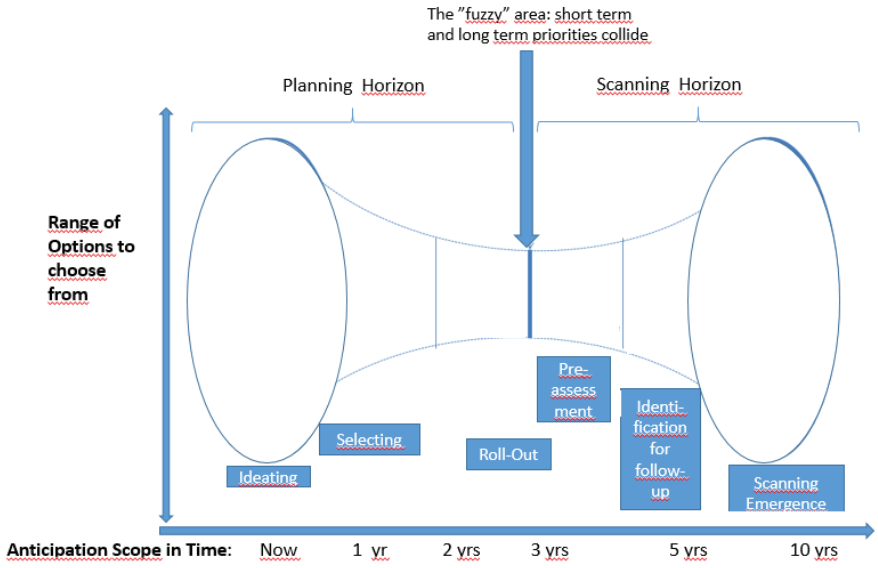

Figure 9: The competing funnels and horizons – planning vs. scanning

The accumulated knowledge on how to use multiple tools and frameworks of scanning and planning has been extremely low, since the literature and research has mostly focused on studying and improving individual methods, not their integration.

The collected data of existing concepts and their relations in the prior-art research show that choosing the correct (= relevant to the business demands and resources available) methods of planning and scanning

and especially combining them is a difficult task to any organisation. Popper (2008) introduced Foresight Diamond (see Figure 10), that is looking at different methods of foresight with three dimensions in mind:

- The main source of the knowledge used: Creativity vs. Evidence
- The type of process and roles used in the process: Expert-based vs. Interaction
- The type of data used: Qualitative vs. Quantitative (and in-between)

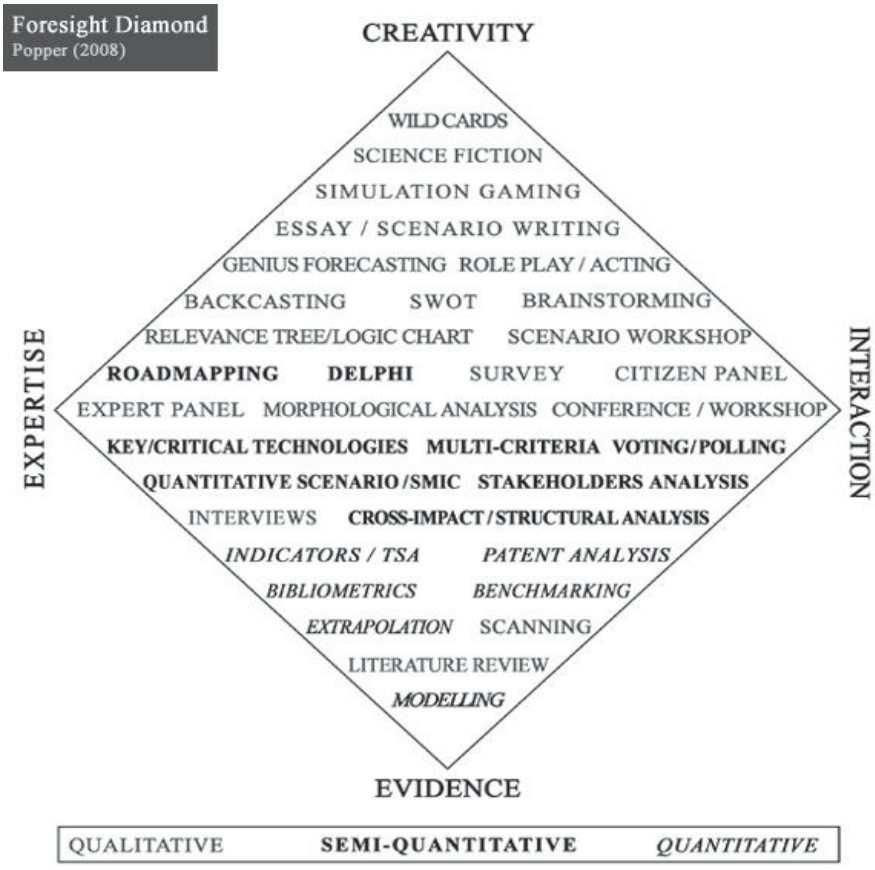

Figure 10: Foresight Diamond (Popper, 2008)

As can be seen, Popper´s Diamond hosts 30+ methods, that can be combined in a myriad of ways to create a foresight process for an organisation. Also the concepts such as “expertise” and “evidence” are at their heart fuzzy, and someone might want to place e.g. weak signals to evidence-end of spectrum whereas one would say the data is at the point of assessment scarce, so working on changes hinted by weak signals in more of creative nature. Also one can state that expertise and interaction are not opposite end of a same continuum.

The model by Popper has its value to a professional futures researcher - but does not resonate that well in the context of resource- and time-limited SMEs and start-up firms, to whom foresight processes are done alongside other duties.

And yet, the model can´t give an answer to questions to “Why?” and “How?”.

Why-questions are of the nature: “What is the goal of the anticipation process at hand: To scan a vast number of opportunities or narrow the potential directions to go to?”

> How-questions ask issues such as: “Whom to involve in the process, what are their roles?” and “Given the resources (financial, human and time resources

We propose the research and practitioner community to work on two fronts to improve the management of time in enterprises, namely those of:

- developing advanced knowledge on the selection criteria for the tools and processes to use
- looking for ways of integrating individual tools to create coherent managerial processes that serve for both the short-term and long-term good for the company engaging into planning and scanning activity.

In the following figures (11 and 12) the authors show examples (following to a certain extent the model of Popper) of usage of dimensions that might facilitate the choice of the correct method(s) to be used. More diamonds could naturally be drawn by combining the dimension (x- and y-axis of the diamonds) in a new way.

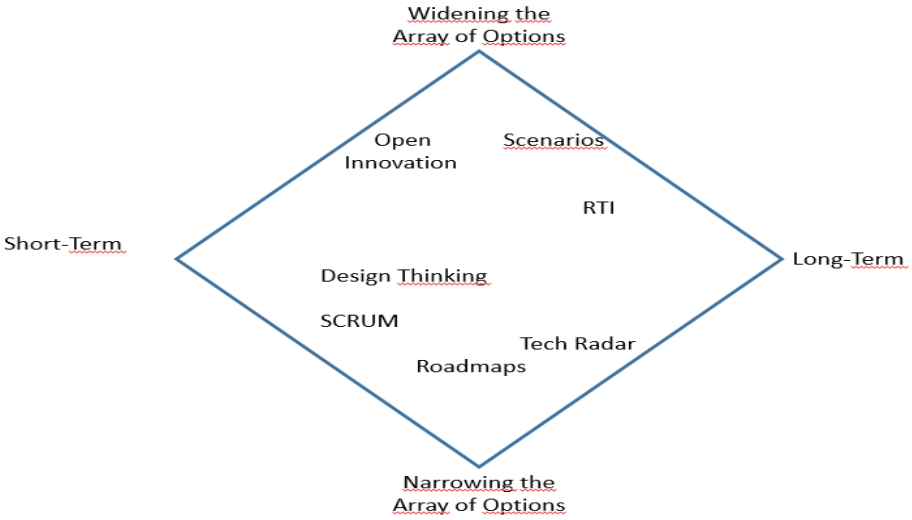

Figure 11: Scanning and Planning Method "Diamond" based on time and focus (narrowing or widening the views) –dimensions

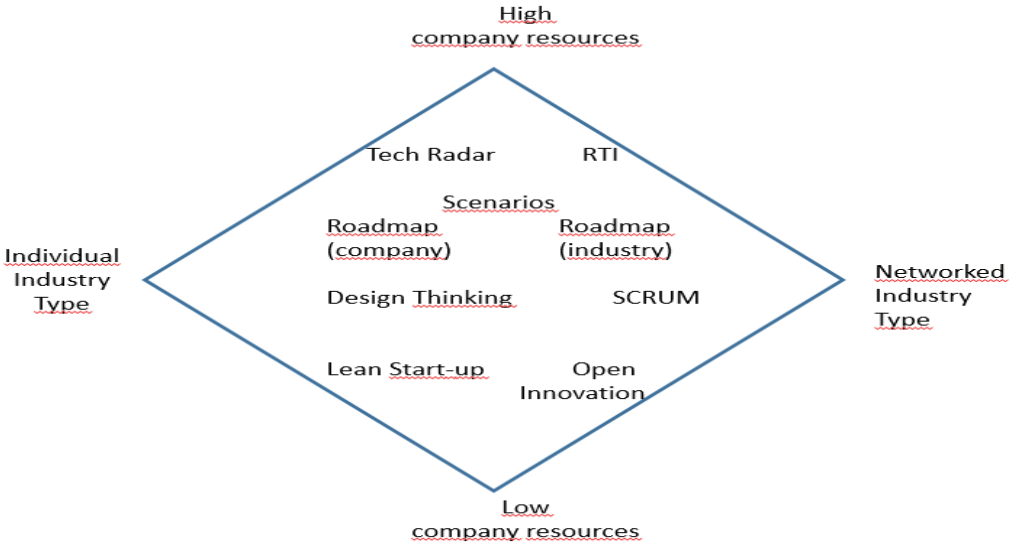

Figure 12: Scanning and Planning "Diamond" based on company resources and network interaction-type

In the last figure (13) the authors show andexample of how for an individual company the methods could be combined and feed each other in content. Case studies where these integrations are taken in use would be a natural step forward in adding to the knowledge and practicality of this concept-based modelling.

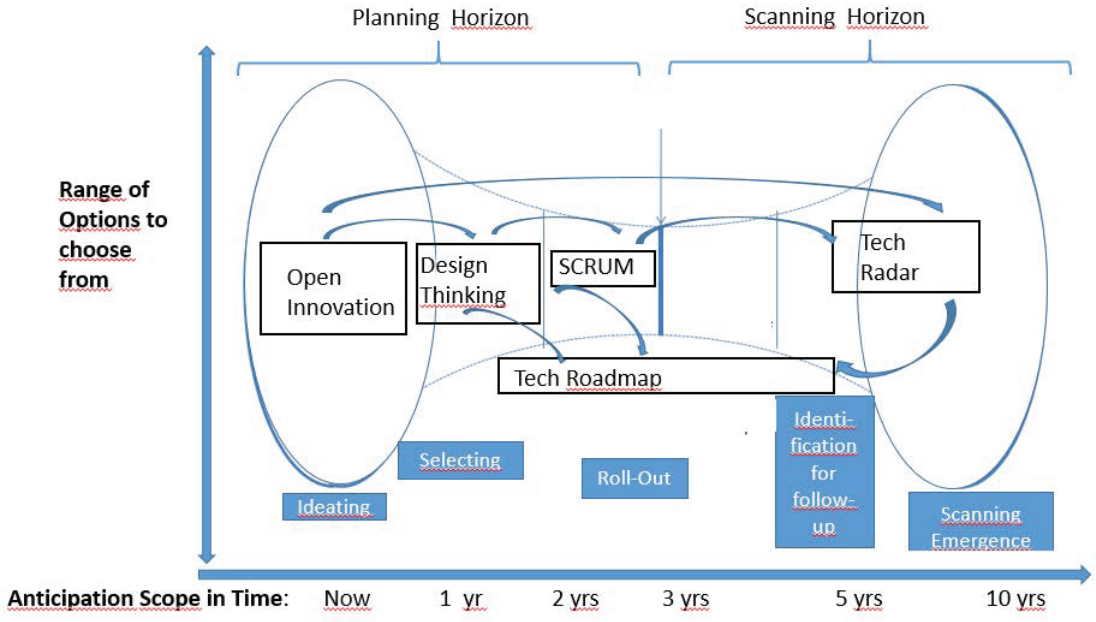

Figure 13: Potential interactions between time-horizons and methods related to them

Despite the fact that the figure above does not contain all available methods, it is capable of illustrating the synergy potential of the methods: e.g. some findings from the open innovation process can be directed to the concept configuration via design thinking and further to product configuration via SCRUM-method, but some may demand that much technological advance from the present that they need time to elaborate, and it might even be wise from the company not to invest own resources to it yet, but follow the evolution via active work with Technology Radar. Also the SCRUM method - that originally is designed for agile development with short NPD (new Product Development Development) cycle time – can spin off new ideas that will be followed and worked on over longer period of time.

7. Discussion

The findings of this research cannot be stated to present the whole spectrum of potential efforts and tools available for scanning and planning for opportunities that there are available to an entrepreneurial context. The authors relied in their choice of concepts and tools to their own earlier (conceptual and empirical) research (E.g. Vasamo et al., 2016; Saukkonen et al.,2016) as well reviewed widely the scholarly discussion and publications on the subject.

In spite of having to limit the total number of approaches treated in this paper, the main dilemmas related to entrepreneurial firms and time as well as clarity in the choice and implementation of approaches to use became clearly demonstrated.

8. Implications

The findings of this research create a relatively wide look at the anticipation (scanning and planning) practices in an organisational context. It seems obvious that there is on general level an abundance of practices, yet same time there are “missing links” in the totality of options in what comes to the main aim of practices, time frame of anticipation and resources usable for the anticipation effort. The classifications

of different tools may serve for an entrepreneur to be able to choose the "correct" (= relevant and realistic) tool/method for the purpose. What is typical to future-oriented research – triangulation a.k.a. multi-method (or mixed method) approach – where more than one method is used in order to improve the results and process itself, is somewhat more complicated issue. Where a research community may look at contrasting findings and methods as a richness and a result itself (or as a spark to a new research), enterprises and entrepreneurs cannot act based on ambiguity, they need a solid and unified process, where either one process is dominating the support of strategic development or – if many processes are run – these process fit together and give meaningful feeds to each other to make the multiple method process workable.

This latter target is – based on the finding of this study – a target that is at the moment a far reach.

9. Concluding Observations

The authors of this paper strongly propose additional research on time and entrepreneurship –relationship – research that would not be limited to the futures research community but also have a high input from the strategic, business and project development spheres, as well as from the key actors in business development process - entrepreneurs (and the researchers of them). The search for potential new tools and/or combinations of earlier tools and models should be kept in focus is such effort. The authors themselves aim at developing their own understanding of the phenomenon by case studies among technology- and knowledge-based start-up enterprises as well as mirror those practices against processes and frameworks in established technology/knowledge-intensive firms.

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What kind of companies are in our scope?

Start-Ups/New Ventures

2 classical definitions

Eric Ries (2011):

"A start-up is any organization aimed at creating new product or service in the conditions of extreme uncertainty"

Steve Blank (2010):

" A start-up is a temporary organisation searching for a scalable and repeatable business model. "

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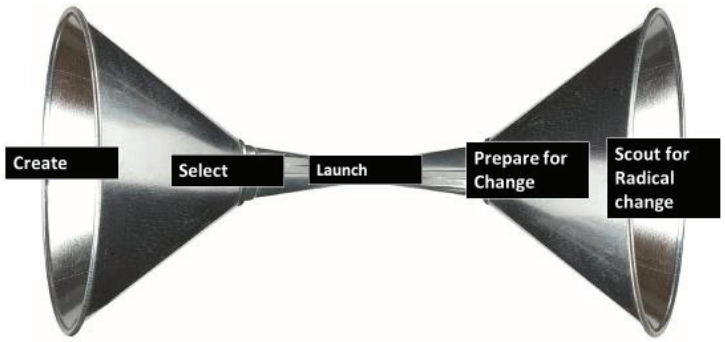
Torn between funnels – what do we mean?



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How does this show in the practice for a start-up entrepreneur?

THE CUSTOMER DEVELOPMENT
[MANIFESTO]

A STARTUP IS A TEMPORARY ORGANIZATION DESIGNED TO SEARCH FOR A SCALABLE AND REPEATABLE BUSINESS MODEL

There **are no facts inside** your building, so get outside Pair Customer Development with Agile Development Failure is an integral part of the search **If you are afraid to fail you are destined to do so** Iterations/pivots are driven by **insight** from continuous "pass/fail" **tests** [Success begins with buy-in from investors, and co-founders] **No business plan survives** first contact with customers Validate hypotheses with customer experiments [Not all start-ups are alike] **Agree on Market Type** it changes everything Start-up metrics differ from those in existing companies [Track progress converting hypotheses into facts] **Fast & fearless** decision-making, cycle time, [speed and tempo] A startup **without** driven, **passionate** people **is dead** the day it opens Startup functions/titles are different from companies Preserve cash while searching for the business model **After** it's found, **spend** [Communicate & share learning] Startups demand **comfort with uncertainty, chaos** and change

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The starting postulates

- Time is one of the key resources for any company
  - in addition to finance, human capital , technology, capacity
- Time is a simple concept on the surface – but complex to deal with in business practice
- (Start-up) Entrepreneurs have potential to act smartly with time compared to establsihed companies – agility – but have a lack of processes and knowledge how to do it
- Time lost or wrongly used is different to recapture for entrepreneurial efforts

=> There is need for knowledge about time and for time

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TO START WITH: THE MAIN DILEMMA

- **"You can´t out<u>SLOW</u> your competition "**
  - Timo Elliott, SAP
  Chief Innovation Evangelist, Helsinki 15.11.16

⇒Need for Speed ?

- **But you can out<u>SPEED</u> your resources and learning**
  - Authors of this paper

= > How to out<u>SMART</u> your competition ?
- via planning and scanning...

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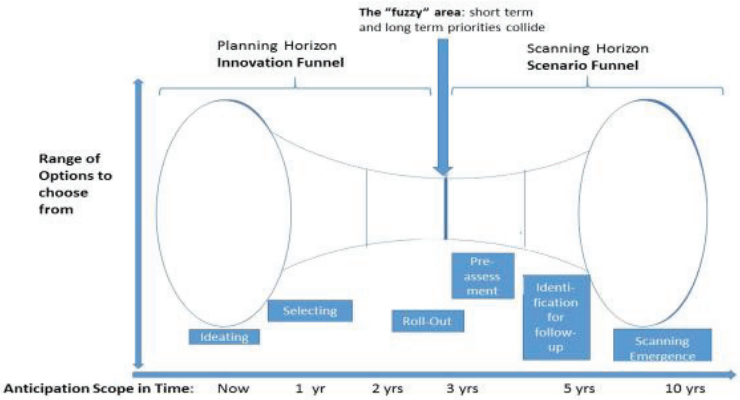
The time-related schitzofrenia



Processes on-going simultaneously 1) in many timescopes 2) with different tools and individual toolkits jamk.fi

Some key market data & findings of earlier research (1)

- Shipping your product ½ year too late (to the window of market opportunity) can cost a firm 1/3 of the lifetime profits of the product (Cohen et al.,1996)

- In global industries like automotive, any additional delay day of launching can cost 1 mill USD in profits (Clark et al, 1989)

And Now:

- The clockspeed of industries and markets is increasing (Fine, 1998)

  => the speed of change is accelerating

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Some key market data & findings of earlier research (2)

BUT:

- Too fast development – stepping over stages of evolution (a.k.a. inconsistent growth) will affect negatively to market success and odds of getting investment (Marmer et al, 2011)

- If the innovation has a high degree of newness to the firm working on it (internal newness), the high speed of developmentcan be value- destroying (Stanko et al., 2012)

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Some key market data & findings of earlier research (3)

- Technology is abundant = e.g. Gartner (a leading ICT research and consultancy) says to be following 1600 individual technologies – yet the time of mainstream adoption is long (typically 5-10 years)

- The exit time = time when the original entrepreneurs and early investors can csah in the growth (NCVA reports) has grown to 7 years

⇒The company and its technologies yielding products and services never settles

⇒Companies need to master constant and even radical and cannibalizing changes

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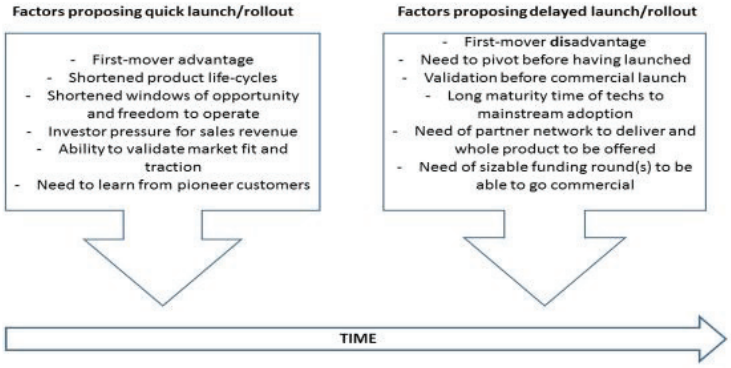
The forces tearing an entrepreneur



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Present methods in use for different stages

- Scenarios
- Technology Radar
- Radical Technology Inquirer
- Lean Start-up
- Open Innovation
- Design Thinking
- Roadmapping
- SCRUM –development

.. With a low degree of integaration to each other…

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Present aid in selecting the fitting methods?

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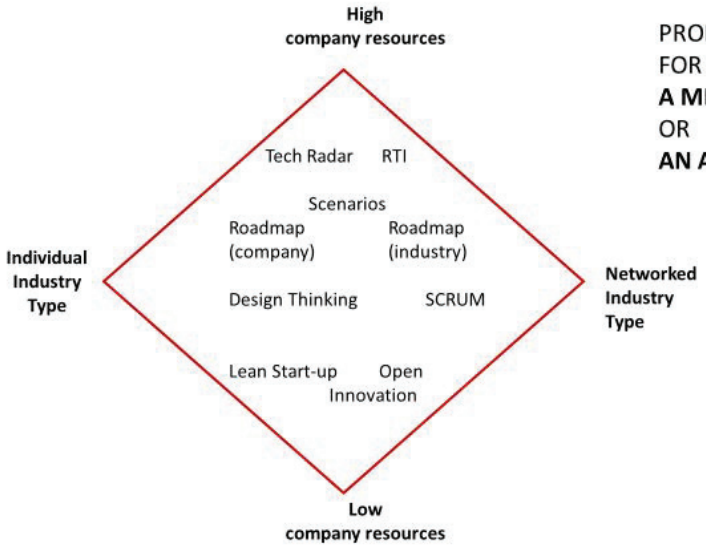

PROPOSAL (1)
FOR A TOOL FOR CHOOSING
A METHOD
OR
AN ANTICIPATION MIX

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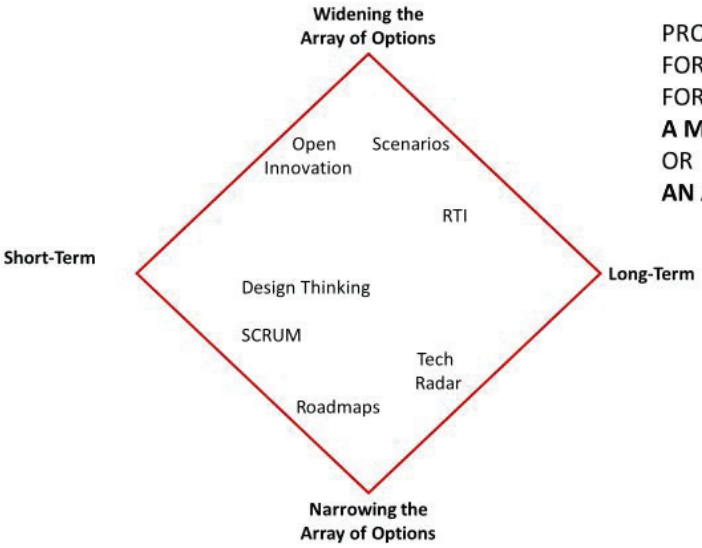

PROPOSAL (2)
FOR A TOOL
FOR CHOOSING
A METHOD
OR
AN ANTICIPATION MIX

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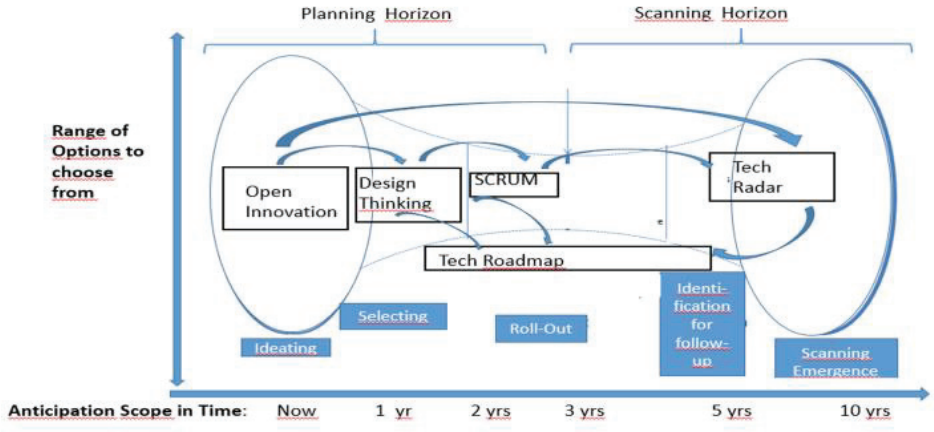
HOW TO MAKE THE METHODS TO "MEET & FEED" EACH OTHER



The road ahead

For The authors of this paper:

- Want to learn more of the phenomenon by studying **cases** of various industries and companies: does the framework offer an **ease for the choice** of methods
- Will apply **method combination(s)** in real-life cases to study more their **complementary vs. supplementary nature**
- Work on in developing the concept of **"anticipation mix"**

The Scientific and entrepreneurial community

- To Join us (the authors) to turn the gained knowledge into action – with both conceptual and pragmatic goals in mind

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TO CONCLUDE:

Fast-paced
Environment and Operations

need

Fast-paced solutions
to make right
Short & long-term decisions

We need them soon !

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IV

ANTICIPATION OF TECHNOLOGY AS AN ENTREPRENEURIAL SKILL

by

Juha Saukkonen, Anna-Leena Vasamo, Sharon Ballard and Jonathan Levie, 2016

In *Proceedings of the 11th European Conference on Innovation and Entrepreneurship*. Reading: Academic Conferences and Publishing International (ACPI) Ltd. pp 717-725.

Anticipation of Technology as an Entrepreneurial Skill

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Abstract: Anticipation of technological change is crucial for startup companies and entrepreneurs to survive and grow in the volatile environment. The concepts, processes and tools have mainly been developed in and for larger corporations with ample resources that can run the often lengthy and slow processes of technology anticipation (TA). The dilemma facing TA in entrepreneurial startup companies is that they need to build and commercialize their first technology and prepare simultaneously to its disruption – to anticipate. This paper studies the rationale of TA and the different TA approaches utilized in technology-based young and evolving companies and proposes a framework – a taxonomy of TA approaches in entrepreneurial context for further study.

Keywords: technology, foresight, anticipation, roadmapping, disruption, innovation, entrepreneurship

1. Introduction

Every day, early-stage entrepreneurs face three main uncertainties: technological uncertainties, market uncertainties, and competitive volatility (Mohr et al., 2010). In this paper, we explore how early-stage entrepreneurs can deal with technological uncertainties to assure themselves and their stakeholders that the path they are on will not be destroyed by a surprise attack from a different technological solution.

While the traditional advice to investors of capital is to diversify a portfolio to offset uncertainty, Andrew Carnegie urged entrepreneurs to deal with uncertainty by adopting a focused strategy: ”Concentrate your energies, your thoughts, and your capital. The wise man puts all his eggs in one basket and watches the basket.” The risk with a focused strategy, as Don Moyer (2008) has pointed out, “is that no matter how attentive and focused you are, the basket you're watching is simply the wrong one.” In this paper, we show how entrepreneurs can adopt a focused strategy while still ensuring they are not watching “the wrong basket”.

Because many technologies experience significant inflection points in the pace of their development and because there is often more than one potential technological solution to a problem, technology anticipation is a crucial skill for entrepreneurs. Yet technology anticipation rarely features in entrepreneurship research or education.

According to Lee at al. (2011) technological intelligence consists of practices for capturing information of emerging technologies and delivering it in a usable form to decision making. Technology anticipation is a risk management practice as well as an opportunity recognition practice (Brown and O’Hare 2001; Fowler and Hammell 2011; Lopez-Ortega et al. 2006; Mortara et al. 2009; Porter et al.2007). One example of a technique commonly adopted by large companies is technology roadmapping (Kostoff and Schaller, 2001. Large firms also have their own specialized resources and connections inside and across industries enabling technology anticipation. In contrast, little is known about how entrepreneurs of new and small ventures practice technology anticipation. This paper contributes to the knowledge of foresight by presenting via a qualitative study the tools and approaches of technology anticipation used by smaller firms – startup companies and entrepreneurs dependent on technology in their business.

This paper continues as follows: Chapter 2 introduces the theoretical viewpoints of technology anticipation, its relation to the strategic planning in entrepreneurial context and some practical tools and the recent advancements and challenges in the field. Chapter 3 covers the methodology and implementation of the empirical research. Chapter 4 shows the results of the empirical research by introducing three different “modus

operandi" identified in start-up firms in technology anticipation. In chapter 5 presents conclusions and shows directions for further study.

2. Literature review

2.1 Anticipation - in the intersection of disciplines

The purpose of this paper is to contribute to the knowledge of future foresight and more specifically technology foresight also referred e.g. as "future-oriented technology analysis", as was reflected e.g. in the title of most covering conferences on the topic arranged biannually. Technology foresight is studied and practiced partly inside the domain of engineering sciences and partly inside futures research. The research in hand also adds to the knowledge pool of entrepreneurship as it studies one of the key capability areas of growth-oriented start-up companies. With some rare exceptions like the "Innovation to Context" paper by Ballard et al. (2013) there is very little bridging of these two areas - Technology Foresight and Entrepreneurship to be found. In that sense the research is of exploratory nature.

In a classical definition of strategy Mintzberg (1987) states that strategy is 1) a plan: it is preparation of actions to come and resourcing them; 2) a ploy: the continuity of one decision set leading to others; 3) a pattern: an intentional way to do things repetitively in a certain manner over time; 4) a position: it always relates to the action of the competition as well as other value chain actors; and finally it is about 5) perspective: this includes direction and vision. These five P´s of strategy illustrate well how strategic planning places itself very close to basic components of generating futures research. According to Kuusi et al. (2015) the concept of futures research should be reserved for those studies that are looking for pragmatically-valid knowledge concerning possible futures. The sub-concept of future foresight is coined by Kuusi et al. (ibid.) to cover the more pragmatic side of future studies and consists of systematic debate of different futures. As strategic planning focuses in the direction of the future, futures foresight practices and processes directly add value to the strategy formation of companies. According to Dufva and Ahlqvist (2014) a foresight process is a joint effort of stakeholders to explore futures and interpret them to present actions. This interchange of ideas and interpretations requires processes and tools such as technology roadmapping (TRM), radical technology inquirer (RTI) and technology radar (TR).

The concept of anticipation chosen to the title concept for this study originates from the recent rise of interest towards anticipation referred to e.g. by Poli (2014). Anticipation is an umbrella term, under which many different processes and practices fit in. . Poli (ibid.) summarised the key components for the discipline of anticipation after his journey through the usage of the concept across sciences: 1) Anticipation is about calculable risks and incalculable uncertainties 2) Distant future and future in the present differ, the latter one referring to the future as projection of the past and former one to "proper" anticipation 3) There are continuous and discontinuous/ruptured futures 4) Systems and organizations vary in their capability to use futures 5) Anticipations take place in many layers (e.g.. have both social and psychological factors affecting them) and can be explicit or implicit.

There is wide prior research of individual tools of technology foresight (e.g. by Rinne (2004), Boe-Lillegraven & Monterde (2015) and of results obtained by using those tools. Recently many scholars have applied tools and approaches such as Technology Roadmaps, Technology Radar and Technology Landscape in foreseeing the impacts of technological development in different economical/societal (e.g. Becker et al., 2016) and industrial (e.g. Kolominsky-Rabas et al., 2015; Stelzer et al., 2015; Rodriguez et al., 2015; Hansen et al.,2015) contexts or in a combination of an industrial and societal context (e.g. Pietrobelli & Puppato, 2015; Amer et al.,2016). However, as Boe-Lillegraven and Monterde (ibid.) point out - the foresight approach chosen also affects the way an organization seeks and interprets information - it has a cognitive effect in addition to its primary function of providing relevant knowledge to support decision-making. The research in hand aimed at shedding light on how (the approach and processes) and why (justification, usage) the sample of startup technology companies – reach for relevant information of the technological change and act upon it.

2.2 Entrepreneurial dilemma - planning vs search

Technology-based entrepreneurs face a core dilemma in developing strategy for their ventures: how to incorporate into their strategy the future evolution of both their core technology but also potential competing technologies. There is uncertainty in the direction of their core technology, and even more on technologies they are less familiar with. Large companies have technology futures officers whose job is to prepare technology

roadmaps for vast array of technologies that could compete with their core technologies. Start-up entrepreneurs do not have the resources (time, contacts) for this. They devote their time to thorough planning or thorough search, but not both. Eliminating this dilemma could greatly improve strategy making by entrepreneurs, their likelihood of acquiring resources, and their chances of success. Several sub-optimal alternatives are commonly practiced. One is a "venture flipping" model that requires a total focus on commercializing the current technology at the cost of not searching for potential competing solutions. This usually requires a short venture lifetime and early harvest if the entrepreneur is to extract any value from the business. A second is a "hedging bets" approach that spreads effort across a number of technological solutions without assessing their probability of success ex ante. The latter has been described as "shotgun sampling" (Fleming and Sorenson, 2003) and it can consume firm´s resources and energy on testing technology at the expense of building market-based expertise.

In the field of futures research and specifically to that of technology anticipation, van der Duin (2004) proposed that critical research on futures in commercial organizations is scarce, it only uses limited resources since "urgent drives out the important", and focuses on short term. To improve the practices utilized van der Duin stresses the usage of multiple background, networked foresight and usage of expert views. Especially the "search" mode would benefit from these improvements, while planning mode can be handled internally. Patton (2004) commented that the networking and thus scanning typically happens around industries. Related industries that may pose a disruptive threat to another industry are ignored. In the words of Kostoff et al. (2005): "Disruptive technologies can evolve from the confluence of seemingly diverse technologies or can be a result of an entirely new technological investigation. Existing planning processes are notoriously poor in identifying the mix of sometimes highly disparate technologies required to address the multiple performance objectives of a particular niche in the market".

Start-ups, however, often operate on the margins of an industry or on the borderlines between traditional industries; and they obviously lack the access to industry networks (and they would need to cover many industries) of this kind available for scanning, which only underlines the importance of their own anticipation processes.

2.3 The origin, development and practices of technology anticipation

Technology anticipation as a repetitive, disciplined and strategic action was started in the 1960s by major research and development organizations such as Department of Defense and National Science Foundation and NASA in USA, (Gordon, 2003) and followed by large technology corporations like Douglas and Motorola (Willyard et. al., 1987).

Today, technology anticipation is a well-known practice across industries and companies, who are applying its principles and tools in strategic planning. Looking at the main engine of net job creation across economies, the start-up firms, it has been stated by Boghani et al. (2008) that nascent ventures that learn and apply technology anticipation processes generate stronger R&D proposals and increase their odds to get funding. On the other hand, a survey done in the early 2000s in UK by Farukh et al. (2001) indicated that a mere 10 % of manufacturing firms were applying the most commonly known technique – technology roadmapping. Even the ones engaged in anticipation reported challenges related to starting anticipation processes and "keeping them alive".

The methods such as Radical Technology Inquirer (RTI), Technology Radar (TR) and Technology Roadmapping (TRM) form a part of a larger entity: Technology Management. The European Institute of Technology Management EITIM sets a framework for technology management by defining that "Technology management addresses the effective identification, selection, acquisition, development, exploitation and protection of technologies (product, process and infrastructural) needed to maintain a market position and business performance in accordance with the company's objectives."(2015)

Simultaneously, the accelerating pace of change referred e.g. as "increased clock speed" (Fine, 1998) and the increase in the amount of potentially transformative and often intertwined technologies has made technology anticipation a demanding exercise for firms. How many and which technologies to include to anticipation processes and which ones not? One of the leading ICT consulting firms Gartner has for years published their "Hype Cycle curves" of emerging technologies and technology areas .A representative of Gartner, J. Fenn (2011), coined the purpose of their approach: "Hype Cycle for Emerging Technologies targets strategic planning,

innovation and emerging technology professionals by highlighting a set of technologies that will have broad-ranging impact across the business". In addition to broad Hype Cycle, Gartner publishes separate Hype Cycles for specific technology areas s. There are close to 2000 individual technologies under Gartner's radar (ibid.).

The mere number of the technologies (in fact technology areas) in the aggregate level Gartner-curve is approaching 50 technologies. Also the expected time to mainstream adoption has seen a shift towards 5-10 years of "waiting" time before full commercialization, indicating that investment into development of those techs has a high risk involved.

Most of the detected technologies in high cycle curves are still at the Technology Trigger-phase. That stage is defined by Gartner (2016): "A potential technology breakthrough kicks things off...Often no usable products exist and commercial viability is unproven." Investing money and effort to technologies in that stage sounds a risky choice. On the other hand, if a company waits until a technology reaches the stage of the slope of enlightenment where: "More instances of how the technology can benefit the enterprise start to crystallize and become more widely understood." (ibid.) As a result, the competitive advantage obtainable has diminished.

3. The empirical study - method and implementation

To create understanding on how the concepts and practices found from literature and prior research are applied in the context of tech-based startups, the qualitative approach was chosen. As the purpose of this paper was to an extent conceptual and as the start-up companies vary so much, a quantitative survey with a representative sample was not a feasible option. The pool of informants consisted of 5 companies, all of which fulfilled the following criteria:

- The companies operate in technologically-intensive industries and the contextual factors include the components typical to technology markets
- The informants i.e. person(s) interviewed are actors in technology anticipation in the firm they operate or have operated in (in 4 out of 5 cases the interviewees also had experience of other startups or established companies).

Companies in the sample are Finnish companies who operate in a global technological environment - by utilizing technologies of global availability and in the majority of cases also selling their product and services to international markets. Thus, the results obtained are likely to have generalizability beyond national context.

The interviews were done by the lead author in March-April of 2016, with the duration of 40-60 minutes, and were conducted in Finnish to help interviewees to express their views without restrictions in language. All interviews were recorded, loosely transcribed and cross-listened and -analyzed by 2 researchers to avoid the potential bias of a sole researcher. As van den Berg (1996) has pointed out: "Interview discourse is partly determined by the way the interview situation and the interview goal or research goal are framed. The selection and the approaching activities are crucial in this framing process." The chosen type of companies and interviewees were discussed in the research group in order to frame the issues and approach..

The data collection happened via semi-structured interview - where the interviewees were informed in advance by e-mail of the main target of the research in hand and core topics. Longhurst (2003) summarizes the core principle of such a research design, where the interviewer prepares a list of preliminary topics, but the discourse in the data collection unfolds in a way that allows the interviewees to express issues and opinions they feel important. No single method of foresight was named by researchers in the pre-interview information to informants - in order to avoid directing and limiting their thought processes. This suits to the exploratory nature of the research, as there was lack of prior research of the phenomenon in the given context. The research objectives were calling for the approach that has the characteristics that Stebbins (2001) list as the fertile ground for exploratory research: the researchers are trying to uncover something unstudied and unseen, they have a particular interest but the research process and data collection are built on openness, pragmatism and flexibility.

With regard to the type of industries, in 4 out of 5 cases the business is of Business-to-Business (B2B) type, company develops and sells solutions solely to corporate customers, who may then have their own business either in B2B or business-to-customer (B2C). The industries included in the sample were: Digital marketing solutions, cargo tracking technology, knowledge intensive energy market services, digital services to telecom operators, (high end) agricultural vehicles. The sample also had variety in the professional position of the

interviewees: Business development director (2), chief technical officer, CEO/Owner, Purchasing director. As is commonplace to qualitative research, in order to understand a relatively rarely studied phenomenon, having a wide approach in the angles to approach the topic is recommendable. Peskhin (2001) refers to this principle and practice as using different lenses for the purpose to expand the perceptual efficacy of the researchers. Khan (2014) titled his recent article on the issue very profoundly, highlighting well the essence of multiple angles - approach: "Qualitative Research: A Case for a Multi-Angle View to Enhance 'Validity[SB1] '".

4. The results - typology and features of technology anticipation approaches

The qualitative data from the interviews revealed, when coded, categorized and analyzed, three "main currents" of anticipation approaches that differ from each other in their processual vs. non-processual nature, engagement of different actors and forms of knowledge utilized. The typology of the three approaches is presented below in table 1 and also sharing the interviewees´ views of in which kind of context they are likely to appear.

Table 1: The typology of the technology anticipation approaches in tech start-ups

The TA Approach/ Paradigm	Timescope from today	Life-time expectancy of individual techs	nr of techs followed (not all reacted to)	Industry Clock-speed	Customer industry clock-speed	Role of standards and regulation
Loose Environmental scanning	appr. 2 years	1-2 yrs	some (3-5)	high	high	low to none
Company-based tech evaluation and selection	2-5 years	2-3 yrs	10+	medium	medium	medium
Network-based joint scenario creation	3-7 years	5-15 yrs	some key techs (3-4)	low	low	high

In the table 2 below are summarised the typical features - who, what and how - for the three different approaches. The table also proposes industries to which each approach would naturally fit.

Table 2: The features of the technology anticipation approaches in tech start-ups

The TA Approach/ Paradigm	Info sources	Info sharing tools	People responsible	Key question(s)	Strengths (+) and weaknesses (-) of the approach	Key skills when implemented, typical industries to use
Loose Environmental scanning	web discussions, crowdfunding sites, online media of the industry	meetings, blogs, internal discussion forums	the whole personnel, customer and supplier role low	How quick to implement for customer features, effort needed to master	+ max nr of "tech scouts" customer feature driven - unstructured, analysis and criteria for scouting ambiguous, difficult to share	-fast decision – making and rollout - realistic view of resources needed vs. value Digital Marketing, e-commerce, Media
Company-based tech evaluation and selection	related industries roadmaps, tech reports,	roadmaps, roll-out sequence plans	CEO as a customer, CTO Driven, (key)	The availability of tech (ownership,	+ dependent techs and industries	-ability to choose and abandon new

The TA Approach/ Paradigm	Info sources	Info sharing tools	People responsible	Key question(s)	Strengths (+) and weaknesses (-) of the approach	Key skills when implemented, typical industries to use
	research papers, customers if firm relationship	(scrum), meetings	customers involved	licensing model etc.) Fit to other techs in own process - synergy	scouted, integration to other techs evaluated - massive data, coordination	techs (and present ones) - agile testing of tech for process fit and performance - keep readiness to fast changes Telecom, Corporate System solutions
Network-based joint scenario creation	association and industry reports, supplier and customer workshops	roadmaps	CEO driven, Product Management resp. for the process, value chain partners involved	The availability of tech globally, resources of the developer, impact to own processes	+ Clear master document, the value chain committed, functional experts in organisation involved - Innovation potential from other industries unnoticed	+ clear visualization and responsibility charting, constant updating and communication - Resource demand high Manufacturing, Medical, Transport

The results show that despite the common context - technology startups - the process of technology anticipation differs. We propose that entrepreneurs should create their anticipation strategy or/and anticipation mix suitable to their resources and type of business to succeed in the changing technological landscape.

5. Conclusions

As a general conclusion of this study (described in Chapter 2), it can be stated that technology anticipation in startup firms is far from a standardized process. The individual characteristics and experience of the firm, people involved in the anticipation process, and industries the firms operated in and with influenced and affected their process of anticipation.

The studied ventures used multiple methods and various knowledge categories (like introduced by Dufva and Ahlqvist) in scanning of potential technologies. The results of scanning did not necessarily proceed to mapping - their findings only become codified and articulated once their scanning results fit into their planning horizon; i.e. to maximum of 2-year Product and Service -roadmaps and roll-out plans.

Gustafsson et al. have introduced in their article (2015) the anticipation efforts versus different horizons, namely those of *mapping* horizon and *planning* horizon. These horizons differ in the timespan and also in the intention. The mapping horizon – that can be also named *scanning* horizon (based on the findings of this study) — has a smaller role than the *planning* horizon. Even though start-ups create a picture of available technologies by scanning open-mindedly, their decisions to include a particular technology in future offerings (or exclude a technology) are made quickly and within a relatively short time span of launching product and features based on the detected technology in mind. The duration from scanning to planning is more rapid for these ventures than it would be in larger, established companies. As one of the interviewees put it, “this (flexibility and agility of adaptation) is the only true competitive advantage the start-ups have when entering the market”. This is consistent with statements done in scholarly writings: Patton (2004) commented that the inherent unpredictabilities of technology development and commercialization processes means that overly structured

technology plans based on predictions and point forecasts can be limiting if not dangerous when planning for new technologies. Maintaining the flexibility to accommodate changing market dynamics has become an essential factor in technology planning and foresight. The shorter-term view - planning - clearly dominated the long-term - scanning - in the processes and practices of the companies studied. Overall, the common tendency was to keep the anticipation as a relatively free format and unscheduled procedure. This was seen as an opportunity that enables flexibility. Only occasional remarks of potential shortcomings of such an open and non-formalized effort were made.

The start-up companies studied utilize, often in an unconscious manner, the processual model proposed by Cheng et al.: They proceed from informal preliminary discussions to inside-out roadmap creation, then to outside-in validation of their created roadmaps and then to follow-up, including their plans to acquire or develop chosen technologies. In startups these steps seem to be run parallel with their product development process and proceeds much faster than in established firms and industries.

6. Discussion

The short horizon of start-up companies in their anticipation efforts may lead to inability to anticipate the forthcoming profound technological changes in the mapping/scanning horizon. As a result, a company may direct their scarce resources to technologies that will have a short lifespan. The flexibility and agility has thus turned into a disadvantage – including unnecessarily fast changing product and service configurations. Quoting one of the interviewee - a business development director with CTO background: "Some companies could be called *technology tasters*. They try to cope with uncertainty by putting efforts to understand and embed the maximum amount of technologies. This means the offering never settles down". This comes close to the concept introduced by Fleming and Sorenson (2003) from MIT, labeled shotgun sampling: Running trials on a maximum number of technologies in order to decrease the perceived uncertainty of the route to take. In a completely contrary approach to anticipation – described by the same interviewee as above – some ventures "start their business development with the exit (=selling the company) in 5 years in mind". Mapping horizon is applied at the start, findings moved to the planning horizon, after which the key effort is in growing the sales revenue.

The behavior of start-up companies favoring planning horizon over mapping/scanning horizon can also be explained by the concept of two competing funnels. In the widely spread concept of *innovation funnel* (e.g. by Flynn et al., 2003) a company proceeds step-by-step from a vast number of ideas and opportunities to a decreasing number of solutions and features to be rolled out. The *Scenario Funnel* introduced by Gustafsson et al. (ibid.) works in the reverse way: "the farther we gaze from today´s standpoint towards the future, the more possibilities are open." Müller (2012) used the metaphor of continuous *branching in the landscape of possibilities* to describe this opening and widening funnel. Balancing between the decreasing uncertainty inside the innovation funnel and increasing uncertainty inside the scenario funnel seems to affect the anticipation efforts in the way that the focus shifts to shorter term view, planning horizon.

The approaches adopted by start-up firms in anticipation does not automatically link to their overall innovation strategy. The basic strategies of pioneering, fast-follower and opportunistic strategies of innovation can utilize all three of the technology anticipation approaches identified. Min et al (2005) point out that the adopted choice between pioneering and early following has an impact on the startup survival probability, but for an individual company no predictions of survival should be linked to this strategic dimension only. Also true success is a clearly different than survival. It seems logical that certain overall innovation strategies would have a natural fit to some anticipation approaches. Future research could include the analysis of general innovation strategies and linking them to anticipation approaches to determine impact on success of similar nascent science-technology based ventures.

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V

START-UP ENTREPRENEURS AND UNIVERSITY STUDENTS IN A CO-LEARNING MODE: LEARNING EFFECTS OF A COLLABORATIVE ENTREPRENEURIAL COACHING PROGRAMME

by

Juha Saukkonen, Jussi Nukari, Sharon Ballard & Jonathan Levie, 2016

Industry and Higher Education, 30(3), pp. 224-238.
DOI: 10.1177/0950422216653198

Article

INDUSTRY & Higher Education

Industry and Higher Education
2016, Vol. 30(3) 224–238

DOI: 10.1177/0950422216653198
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Start-up entrepreneurs and university students in a co-learning mode: Learning effects of a collaborative entrepreneurial coaching programme

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Abstract
Start-up companies have been recognized as key drivers of wealth and job creation. Many students now in universities will therefore find their future employment in start-up companies, or will found them. Success in the start-up environment requires a specific set of skills. There is a growing supply of university education for new venture creation and an increasing demand for interaction between universities and start-up ventures so that knowledge can be transferred between them. This article evaluates the potential of a programme designed to enable holistic collaborative entrepreneurial learning between start-up companies and students. The authors measure the impacts of the programme on participants' self-assessment of their capabilities and of critical capabilities for start-up success, comparing assessments before the start of the programme, at its end and 1 year subsequently. The results show that an impact on such assessments can be achieved and that the two distinct groups can learn together, but questions remain with regard to the retention of learning.

Keywords
capability assessment, collaborative learning, entrepreneurship training, start-up, start-up capabilities

> A start-up is a human institution designed to create a new product or service under conditions of extreme uncertainty. (Ries, 2011: 27)

Since the economic crisis of 2008, small and medium-sized enterprises (SMEs) have been the most important engines of net job creation in most economies (see Wymenga et al., 2011). For example, a survey published in 2011 found that SMEs were responsible for some 85% of the net employment growth between 2002 and 2010 (de Kok et al., 2011). Furthermore, between 2002 and 2010, SMEs had a higher employment growth rate (1% annually) than large enterprises (0.5%), and their annual employment growth rate was on average higher than that of the total European Union (EU) population (about 0.4% annually) and that of the total active population in the EU (0.8%; European Commission, 2012). The Ewing Marion Kauffman Foundation has examined the importance of specific types of start-ups in net job creation (Kane, 2010; Kauffman Foundation, 2013).

Thus, by providing relevant knowledge to support these evolving companies, universities can play a key role in the development of start-ups, enhance the employment prospects of their students and have a beneficial impact on society at large. To realize this potential, new forms of co-learning between universities and start-up companies

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need to be developed and, since the dynamics of start-up companies are different from those of established industries (see, e.g. Mohr et al., 2010), universities will also need to step out from their comfort zone to design and test new modes of working. Collaboration between industry and academia is not a risk-free activity but, as Jones and Clulow (2012) have pointed out, 'though industry-academic collaborations can be challenging, the benefits certainly outweigh the risks'. Jones and Clulow do not specify which of the many types of collaboration they have in mind – and of course industry–academic collaboration covers a wide range of activities, from joint research to technology transfer to joint venturing. To understand the specific risks and benefits of novel modes of collaboration, such as co-learning programmes with start-up companies (the subject of this article), and to make continuous improvements to the learning results of such programmes, the business impacts and learning retention need to be analysed and assessed.

This article describes an intensive 8-week coaching programme developed for first-time science and technology entrepreneurs and implemented in many universities in the United States and Europe, and analyses its effects on a cohort of students and entrepreneurs at JAMK University of Applied Sciences in Finland. The unique feature of the programme is that, on the one hand, it helps start-up entrepreneurs to develop an overall strategic plan, articulate and defend a business model for the nascent phase of their company-to-be, aiming for growth and a move into international markets and, on the other hand, it simultaneously forms part of a full-semester specialization course in high-tech management for a multinational group of bachelor's students, who act as 'assistant coaches' to the entrepreneurs guided by faculty members who are certified instructors in the method.

In the next section, we demonstrate a theoretical rationale for an experiential, 'structured facilitation' approach to enterprise education. In our methodology section, we explain how we measured the self-efficacy of students and entrepreneurs before the programme began, at its close and 1 year later. Our results show that it is possible to create co-learning modes through which students and entrepreneurs can learn together and support each other's learning. The results also show that notable learning results can be achieved in an intensive coaching arrangement that differs from standard university teaching practices. We conclude by discussing the pre-requisites for the success of similar types of co-learning initiatives and ways to improve the practice of entrepreneurship education. We also identify avenues for future research.

The theoretical basis

Specific nature of technology-based start-ups

Not all entrepreneurs are the same. The issues they face may vary according to the development stage of the business and the industry sector. The case studied in this article is an intensive coaching programme for first-time entrepreneurs in the fields of science and technology. Mohr et al. (2010) characterize high-technology ventures as facing high market uncertainty, high technological uncertainty and high competitive volatility. Fine (2008) suggests that the pace of change in the value chain structures of industries and the time frame in which the value chain must operate have been increasing with the evolution of new industries. These characteristics set a number of teaching and learning challenges for high-technology businesses. For example, learning from past examples (such as historical case studies) has limited applicability to present conditions. Indeed, since the future workplace of many students will be in companies and industries only recently born, or even yet to be born:

> live projects – solving research and development projects assigned by enterprises – have also a meta-purpose from the educator's point-of-view: in addition to offering networking opportunities and working-life based learnings to students, [they offer] the teacher or learning facilitator an opportunity to mirror the relevancy of the other theories and tools taught in other modes of learning. (Saukkonen, 2014: 7)

High-technology companies vary in the size of their sales, operations and organization. Mature firms have specific departments for research and development, business intelligence and so on perhaps leaving them less in need of seeking new information and knowledge through education–enterprise interaction. Start-up companies, however, are typically short of human resources. Furthermore, the dynamic capabilities needed for success vary as ventures develop (Marmer et al., 2011). These factors suggest that technology-based start-up companies may reap significant benefits from enterprise–education interaction, since their own knowledge resources are limited in size and variety, especially in the case of first-time entrepreneurs. Also, their projects tend to include many changes of direction and questions are more open-ended, leaving room for the student's own initiative and methods of getting results. This flexibility and mobility in relation to goals is captured by Ries (2011) in his definition of a start-up as 'an organization dedicated to creating something new under conditions of extreme uncertainty'.

High-technology business is a global marketplace in which solutions have the potential to spread rapidly, even virally. Thus international students with skills in multiple languages and knowledge of different cultures, and familiar with modern data search methods, can assist a non-mature technology firm with the outputs of their learning.

Education for entrepreneurship

Entrepreneurship as a topic of education is both widely implemented and widely debated. Scholars and

practitioners differ on *what* needs to be learned in entrepreneurship-related courses and *how* the learning can be achieved and supported/facilitated. One commonly promoted aim of entrepreneurship education is to foster an entrepreneurial mindset (EM). As Kleine and Yoder (2013) note, there is ambiguity in the literature on what exactly constitutes an EM, but nevertheless learning process designers must create educational activities that foster it. To give some practice-based clarity to EM ('M' stands for 'mindset' for some authors and 'motivation' for others), a recent literature review by Kauffman Foundation (2015) suggests that the most commonly explored constructs in EM research include: a need for achievement, risk taking, a tolerance of ambiguity, a locus of control, self-efficacy and goal setting.

These dominant research topics may give some guidance as to the kind of impacts entrepreneurship education is expected to have on its recipients, and they do not necessarily conflict with the way education has developed. According to Arum and Roska (2011), cultivating critical and creative thinking is regarded by many as the primary purpose of an undergraduate education, while Kleine and Yoder (2013) argue that the ability to think creatively and critically is fundamental to entrepreneurial activity. On this basis, there is a common goal in the education of entrepreneurs and of undergraduate students in general. At the same time, many if not all the items in the above list from the Kauffman Foundation's study cannot be learned from transmissive teaching methods, but rather are exercised or attained through working on an entrepreneurial activity.

Success as an entrepreneur is not due to mindset alone. Gompers et al. (2006) argue that entrepreneurship is a skill, pointing out that serial entrepreneurs who have succeeded in the past are more likely to repeat their success than first-time or failed entrepreneurs, which may suggest that success is not so much due to experience as to learned skills that can be reused. Such skills can be taught, although the most appropriate learning process is likely to differ from that of more traditional business education.

One popular method of enriching the teaching approach in entrepreneurship is to expose learners to stories and cases of discovery (of opportunities and solutions) and the exploitation of entrepreneurial opportunities. This approach helps students by providing them with examples they can recall when encountering market opportunities and resource gaps in their professional future. According to Fiet (2000), such examples help to create an understanding of what is possible and what is feasible in situations the student is likely to encounter later. Aronsson (2004) and Garavan and O'Cinneide (1994) point out that educational programmes that are highly specialized in a single technical domain or a specific profession are not well suited to the broad-based and practice-oriented training required to teach entrepreneurial skills. Thus training programmes designed to enhance entrepreneurship potential should have a high practice orientation, addressing a broad set of managerial, leadership and organizing skills. This quest for practice based and practice orientation has clear parallels with the concept of experiential learning in the pedagogical literature.

Corbett (2005), following the ideas of Luckmann (1996), explains that experiential learning, in which the learner constructs knowledge, skills and value from direct experience, suits the entrepreneurship arena much better than the alternative behavioural learning approach of stimulus-response. However, the Kolb learning cycle (Kolb and Kolb, 2005) suggests that entrepreneurs may learn best through a combination of active experience and generalizing their learning through appreciation of theory.

In summary, a body of scholarship suggests that entrepreneurship can be taught and, at its best, entrepreneurship education can serve the needs of both entrepreneurs and undergraduate students (and also of the educational institution facing demands for more intensive participation in wealth creation). For the optimal learning outcome, the learning process must have a strong practice orientation and must include elements of experiential learning.

Collaborative learning in university–company interaction

While teaching students about and for entrepreneurship is common practice, less common are programmes that bring external entrepreneurs into the same learning process with the students, thus making entrepreneurship education an aspect of university–company interaction.

The theory of the Triple Helix was developed by Etzkowitz and Leydesdorff (1995) to represent and analyse the interplay between government, academic institutions and business. Universities and industry, traditionally distinct spheres, are now each assuming tasks that used to be associated with the other (Etzkowitz and Leydesdorff, 1995). In the Triple Helix interplay, governments offer incentives to encourage academic institutions to reach beyond their traditional functions and make a more tangible contribution to wealth creation.

In addition to the growing pressure on universities to collaborate with business, traditional or 'transmissive' learning methods (Brown et al., 2014) have been partly replaced or complemented by a variety of new methods (see e.g. Astin, 1993; Gibbs, 2010). Many of these new methods focus on improved learning outcomes via two activities that are less common in traditional teacher-led knowledge dissemination: (a) improved student engagement, and (b) bringing real-life experience into the learning environment.

'Student engagement' can be understood as the intensity with which learners engage in the learning process. The terms student engagement and 'student motivation' are often used interchangeably (see e.g. Lin and Gregor,

2006; Oliver and McLoughlin, 1999). Engaged – that is, motivated – students are likely to undergo 'deep learning':

> In the deep learning approach: the intention to extract meaning produces active learning processes that involve relating ideas and looking for patterns and principles on the one hand and using evidence and examining the logic of the argument on the other. The approach also involves monitoring the development of one's own understanding. In the surface approach, in contrast, the intention is just to cope with the task, which sees the course as unrelated bits of information which leads to much more restricted learning processes, in particular to routine memorisation. (Entwistle, 2000: 3)

This analysis suggests that highly engaged learning modes and pedagogical choices that promote deep learning will be best suited to students with some background and experience of the subject, or at least students who can identify with the subject. Kay and Knaack (2009) argue that the achievement of high-level engagement and thus deeper learning is related to the amount and quality of interaction. While Kay and Knaack used web-based tools as learning objects to be examined in their study, the same approach and principle can be applied to other learning objects, from course workbooks to coaching session agendas.

Another line of research studies the impact of a team-based environment on engagement and learning. Teamwork should be conceptually distinguished from other work or learning activities that take place in groups. According to Ellis and Bell (2005):

> Organizations are increasingly relying on action or performing teams, which conduct complex, time-limited engagements with audiences, adversaries, or challenging environments in 'performance events' for which teams maintain specialized, collective skill. (p. 3)

The question then arises as to whether teamwork by, for example, undergraduate students can achieve the same learning dynamics as teamwork in the workplace. Volkov and Volkov (2015) answer in the affirmative based on their empirical research, reminding us also that the effect of teamwork goes beyond the academic learning process, aiding employability and career success. Goddard and Wood (2014) find that the deployment by teachers of modified team-based learning at both undergraduate and graduate levels has a positive effect on engagement in various respects: student engagement with the subject material, the engagement of team members and the teaching of the facilitating team. One recent example from the same educational/institutional context as this study was an international student group competition in business statistics arranged jointly in three universities (JAMK University of Applied Sciences and partner universities from Turkey and Spain). In their analysis of this initiative, Akpinar et al. (2015) conclude that the collaboration among students necessitated by the learning method had a positive learning effect.

Interaction, however, should not be seen only as an activity among students or between student(s) and learning objects. As Glückler (2013) points out, the contemporary literature on learning distinguishes between interactive and non-interactive forms. The interactive form of learning is characterized by businesses building strategic partnerships with other firms and external knowledge creators, while in contrast non-interactive learning is characterized by a lack of reciprocity and of the two-way transfer of resources (Glückler, 2013).

Learning processes that apply interactive methods are often referred to as problem-based or project-based learning (PBL). Following the ideas of De Graaff and Kolmos (2003), the basis of project work lies in the subject-oriented nature of the process, with learning objectives related to the subject matter to be learned within the framework of the educational programme. Projects develop skills and knowledge in the learner and form part of the process that connects with prior learning and post-project learning.

Students who have undergone PBL appear to be well received by the labour market (Kolmos et al., 2004), while the learning effects of problem/project-based pedagogy have been assessed in various contexts. For example, Pyykkönen and Kalliomaa (2013) analyse a PBL application at the School of Business, JAMK University of Applied Sciences. The method was used in international lecturing visits to JAMK partner universities. Pyykkönen and Kalliomaa found that student feedback was very positive compared with that from the traditional pedagogy in place on other courses in these universities, while the 'problem owners' (Finnish companies looking for new markets and ways of market entry) saw value in their engagement with the programme.

Learning processes naturally have immediate learning effects, or produce a short-term gain in knowledge. Research at the National Training Laboratories in Bethel, Maine, in the United States and earlier work by Dale resulted in Dale's (1969) 'learning pyramid of different learning and teaching methods', which posits that the higher engagement of the student leads to higher level learning of the subject matter. The levels range from solitary reading (the lowest level) to 'doing the real thing', indicating that project-based work has a role in improving the learning experience (see Figure 1).

A key question related to learning is that of retention – for how long the learners will possess the knowledge gained? Wee and Neo (2004) lists the average retention rate of different teaching and learning approaches as follows:

- Lecture – 5%;
- Reading – 10%;

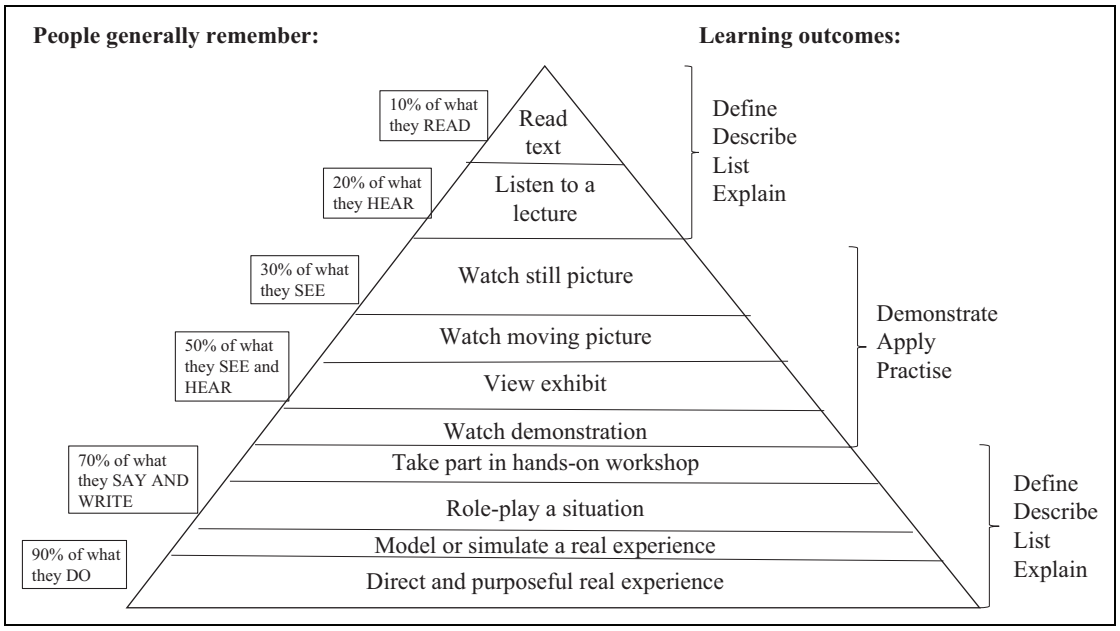

Figure 1. Cone of experience.
Source: Modified from Dale, 1969.

- Audiovisual – 20%;
- Demonstration – 30%;
- Discussion group – 50%;
- Practice by doing – 75%; and
- Teaching others – 80%.

Summarizing these studies, the best and most relevant (for professional advancement) learning outcomes for a student can be achieved in a programme which includes team-based work, a real-life problem and intensive interaction between practitioners, students and facilitating teachers. In addition, if learners have different experience levels and skill sets at the beginning of the learning process, they can potentially 'teach each other' by transferring their knowledge – and thus the highest rate of learning retention in Wee's list can be achieved.

Case background and implementation

Foundation and characteristics of the Supercoach® Launch Pad programme

Background. The Supercoach® Entrepreneurial Training (SET) Launch Pad programme – hereinafter abbreviated to SET – was formally developed at the request of professors who wanted to educate and coach early stage technology entrepreneurs. Since 2001, SET has been continuously delivered globally as undergraduate, graduate and professional development education for entrepreneurs and instructors and coaches. Sharon Ballard, one of the authors of this article, was inspired to create SET after serving a 10-month Management Fellowship in 1996–1997 for the Springboard programme of CONNECT, an entrepreneurial assistance initiative at the University of California San Diego (UCSD). During her Fellowship, Ballard provided one-to-one coaching to over 60 early stage high-technology and life sciences entrepreneurs. The centrepiece of the programme was a Springboard whereby – after 8–10 weekly coaching sessions – each entrepreneur presented a 15-min briefing of his or her business plan to a 'dream' panel of experts tailored for their unique needs. The entrepreneur received an hour of feedback and advice from the panel. Springboard became the most supported programme at CONNECT (and inspired similar programmes, often called Launch Pads). Under a Fellowship at the University of Strathclyde's Hunter Centre for Entrepreneurship in Glasgow, UK, Ballard formalized and delivered the first SET course with an emphasis on training instructors, based on her approach at CONNECT.

The SET curriculum was thus originally developed with a 'train the trainer' focus, with a view to passing on a set of exercises that could be delivered with results similar to those experienced at UCSD CONNECT without the need for deep educational or entrepreneurship business experience or expertise. Business faculty wanted to learn how to educate and coach science and technology-based entrepreneurs at a professional development level rather than at an academic level; and economic development organizations wanted to standardize the results with volunteer expert coaches while leveraging the UCSD CONNECT reputation for science and technology venture successes (CONNECT, 2015)

Instructors and coaches have been trained globally by SET: from engineering professors at Arizona State

University and educators at the University of Strathclyde's Hunter Centre for Entrepreneurship to high-technology investors and educators in Finland (University of Jyväskylä and Jyväskylä University of Applied Sciences), and from technology transfer officers in London to over 115 rural volunteer community coaches from the University of Kentucky Entrepreneurial Coaches Institute. Participants from over 300 universities in 30 countries have been trained and coached using SET programmes, which have been successfully applied to all types of entrepreneurial ventures, from advanced nanomaterials and medical solutions to ranches and farms.

A key feature of SET is that entrepreneurs and coaches are present and work and learn together (in this case, student coaches who are international business students at JAMK). JAMK SET Launch Pad Program is led by a Supercoach® instructor for a short classroom training session (weekly or twice a week) followed by one-to-one coaching sessions led by a certified SET coach joined by JAMK business students, who coordinate custom-tailored assistance and networking through the instructor to meet each venture's unique needs. The entrepreneurs are first coached by the Supercoach® instructors as the student coaches watch. Gradually, the student coaches take a greater role, holding entrepreneurs accountable for what they say they want to accomplish, checking for consistencies in the weekly Supercoach® exercises and helping with business research.

Implementation. SET is an exercise-based approach to help entrepreneurs think through and articulate all aspects of their business model and plan so that they can take their innovation, product or service to market. It is organized into eight sessions, each with a specific focus. Each session consists of a set of one-page exercises that are deceptively simple: they are in reality challenging to complete and often result in considerable backup research. The SET approach uses top-down business planning: An initial business plan is designed and delivered as a 15-min presentation at the end of a course. The programme starts by asking the entrepreneur to express his or her venture's story as a 30-s elevator speech. This forces the entrepreneurs from the beginning to express the essence of their vision. The story might include the value proposition – what is wanted from the listener (an investment, a partnership, a customer, etc.) – or some other key attribute. Next, the entrepreneur generates a one-page strategic business action plan which is presented to the instructors and coaches. From the start of the programme, each entrepreneur develops and delivers an oral and pictorial presentation of their business plan. A one-page storyboard of the entire business plan presentation is generated in the first series of exercises and presented formally to the instructors and coaches as part of the first session's exercises.

Over the next 8–12 weeks, a series of further necessary exercises involves the entrepreneur in the research needing to answer typical business plan questions and develop integrated Pro Forma financial details. The prototype presentation is enhanced and made weekly, as more is learned about the market opportunity and as the plan is developed in more detail from the weekly subject-specific exercises (Technology and IP, Marketing and Sales, Competition and Alliances, Operations and Manufacturing, Financials, etc.). Because entrepreneurs develop presentations of their business plans, they are readily able to produce other documents, such as an executive summary or a written business plan that might be required, say, for a competition or venture capital presentation. The SET process is iterative – the process and exercises are designed so that the entrepreneurial team and student coaches assigned to them can rapidly rethink the business model, story and plan after each session. On completion of the eight SET sessions, the entrepreneurs will have defined all critical aspects of their new ventures: strategy, offerings, markets, customers, partners, suppliers, competition, operations, management, financial future and investment requirements, along with critical milestones and risk mitigation strategies. The SET programme structure is illustrated in Figure 2.

What does 'coaching' do in the context of Supercoach® Launch Pad for entrepreneurs? It imparts a skill in viable business creation that entrepreneurs can use repeatedly and pass on to others. Coaching should not be confused with teaching, which imparts knowledge with the teacher as the expert who can answer questions and evaluate work. Nor should it be confused with forms of advising or consulting in which the core skills remain only with the experts, or with mentoring, in which the mentor uses personal experience to suggest a specific solution to a problem. Coaches, by contrast, act as resource facilitators by connecting entrepreneurs to others who can be of value to them. As noted above, SET instructors and coaches hold entrepreneurs accountable for what they say they want to accomplish, check for consistencies in their business plan thinking using facilitation methods and ensure the completion not perfection of Supercoach® exercises.

Implementation of the 2014 SET programme in Jyväskylä

In 2005, the International Business programme of JAMK University of Applied Sciences began a specialization track entitled 'High-Tech Management' for third and fourth year undergraduate home and exchange business students. The track is one semester long (5 months). It was developed from discussions with business practitioners from the local community to supply the capabilities needed to foster job growth and wealth creation. The track consists of four

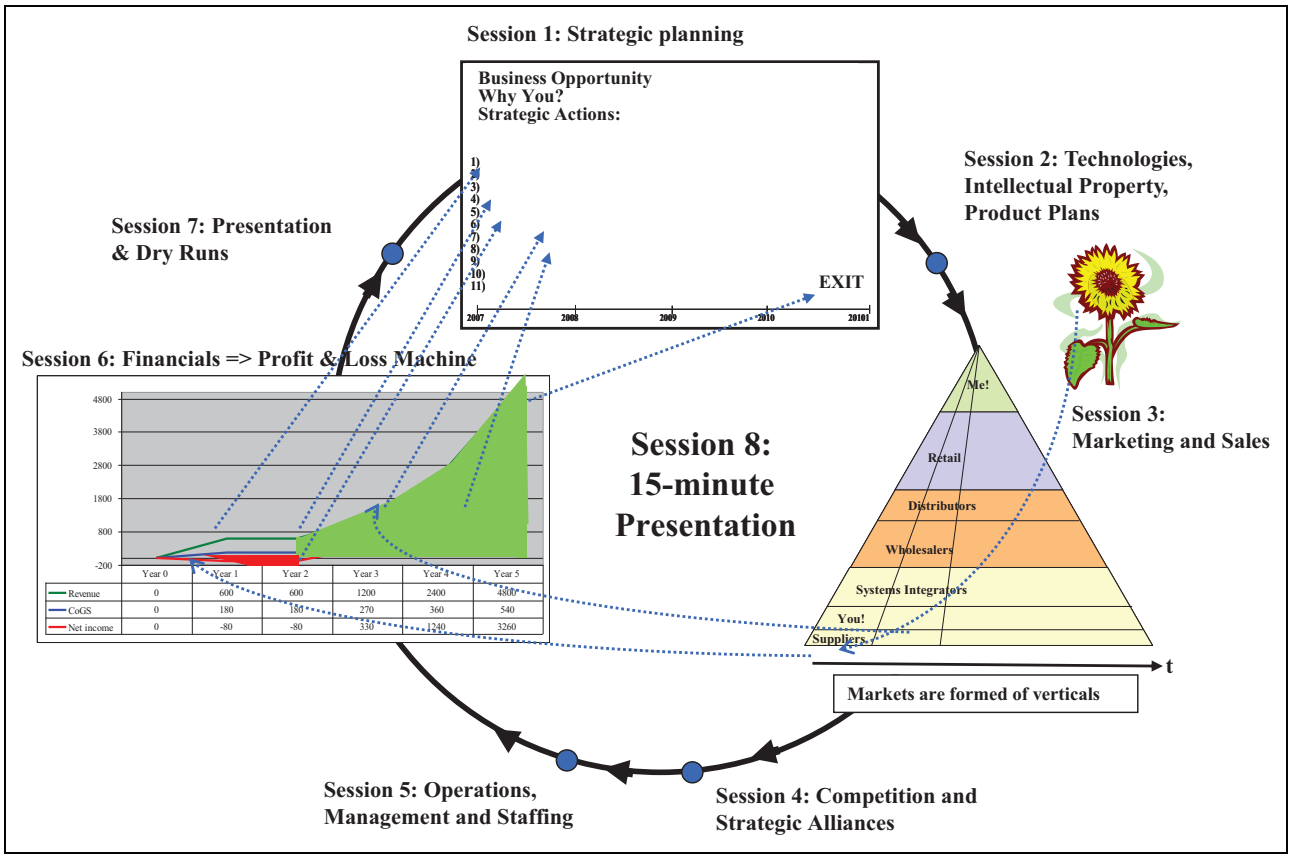

Figure 2. Schematic model of SET programme.
Source: Course material handouts, 2014.

separate modules (High-Tech Industry Dynamics, High-Tech Marketing, High-Tech Strategies, Managing Change and Innovation in High-Tech Business), taught as 1-month intensive courses in a lecture/masterclass mode, with more case studies and industrial guest speakers than average for the School of Business and other courses in the International Business programme. Parallel to these is a fifth module: 'Implementing a High-Tech Project', the approach of which is similar to that of traditional project-based learning: solving individual assignments from high-tech businesses.

To improve the connection to working life and collaborative learning with enterprises, the course managers decided to integrate a previously separately run intensive 8-week SET entrepreneurial coaching programme into the Spring 2014 implementation of the High-Tech Management track. The SET programme consisted of four intensive full-day seminars, in which the structure of the whole course and the main tools to be used were introduced, and students were assigned as assistant coaches to entrepreneurial teams according to their interests and skills. Weekly coaching sessions facilitated by certified instructors followed these introductory seminars. A holistic plan for new technology business development was gradually created through seven separate themes, one for each session, with collaborative exercises involving the start-up teams and students.

Research method and data collection

The research approach applied was inductive in nature and the case study method was used. A single case study was chosen, as it enabled an in-depth investigation of a new and emerging phenomenon (Eisenhardt, 1989; Yin, 2003), in this instance the collaborative learning mode implemented for the first time. Single case studies are likely to have limitations to generalizability (Siggelkow, 2007). However, as the market opportunity of technology-based start-ups is global in nature, as the educators, students and entrepreneur cohorts in this case represented many nationalities, and as the original scheme of the programme was international in scope, the results obtained should not be seen as applying only to Finnish educational and business contexts. Nevertheless, some of the issues tackled and the results derived might be weighted differently if the programme was implemented elsewhere.

Primary data were collected through online survey tools (Digium in 2014; Webropol in 2015), which allowed informants to answer anonymously. The links to the surveys were sent by e-mail. The researchers were able to see

whether or not an individual had answered the survey but were unable to match the answers to a specific informant. This anonymity was intended to enhance the willingness to participate and answer the questions truthfully.

The survey was carried out at three different time points:

- t_0 = pre-programme survey at the start of the first intensive seminar session, so before exposure to teaching content and coaching sessions, in mid-January 2014;
- t_1 = post-programme survey immediately after the 15-min presentation to the investor panel and the panel's feedback, in early April 2014;
- t_2 = survey 1 year after the programme, in March–April 2015.

Since the informant pool was limited, and the sample is close to a census of all participants, a quantitative approach (with regression analyses, etc.) is not appropriate. Thus the results are presented in a descriptive manner, highlighting the differences between t_0, t_1 and t_2 and between different informant groups, such as the entrepreneurial team members versus students, or informants who continued with their business idea (until t_2) versus those who were engaged in some other activity between t_1 and t_2. Both at t_0 and t_1 the response rate was above 90%, meaning the sample consisted of about 40 informants. The number of informants at t_2 was 18. The t_2 informants were approached via the e-mail address they had given at t_0 and also through LinkedIn where possible – one e-mail and one reminder were sent containing the short motivation text and the link. The loss of some informants can be explained by the fact that some students graduated between t_1 and t_2, and the (student) e-mail address they had supplied was therefore no longer in use. Also, some start-up teams had not continued their joint work, and so their interest in the subject had most likely diminished. However, the t_2 sample included representatives of all seven start-up cases (both start-up team members and students) which completed the programme in 2014. This sample can therefore also be regarded as representative.

Since there were changes in roles between t_0 and t_1, an additional question was asked concerning the main activity between t_1 and t_2. The respondents were grouped as follows:

- Those who continued work on the original SET case company (in the tables referred as 'start-up work'). This group contains some of the original start-up team members but not all – and some who were students on the programme and who continued in the start-up case teams but are no longer students.
- Others. This group contains both original start-up members who have since worked elsewhere than in the original SET case company and students who have either continued their studies or obtained employment outside the original SET case company.

The separate capability areas used in the questionnaire were based on the framework of the SET programme (session titles and course material), and in this sense are specific to the case study. The framework was developed over time based on the feedback of participants in earlier implementations of SET, and the programme developers therefore concluded that all capability areas addressed were important to start-up entrepreneurs. It should also be noted that the same issue areas are included in the curricula of various other academic and non-academic entrepreneurship courses, so the same categorization could be used for a comparative study assessing skills accumulation in other educational programmes.

Results

What are the critical capabilities for start-up development?

The first question in the survey at all three measurement points (t_0, t_1 and t_2) asked students and start-up team members to assess critical capabilities for start-up development (Table 1). As Table 1 indicates, at the start of the programme (t_0) start-up team members, facing a real-life challenge of defining a business plan and model and founding a company, considered all capability areas covered in the SET programme to be very important and there was little difference in the 'weight' they attributed to each area. Overall, the students tended to rate the importance of the different areas lower and there was more variation in their assessments of different capabilities. Over time, the start-up team members tended to rank the importance lower, whereas the students retained the same ratings. The overall assessment (on average across capability areas) varied less among students than among start-up team members, who saw greater differences in the importance of the respective areas at the later time points – as the standard deviations show. The importance of 'Marketing and sales' and 'Presentation skills' remains high at all time points in both groups.

The second question, asked at t_2, sought to compare the capability assessments of the participants who had continued to work at the start-up company with those of the others (Table 2). Continued work on the SET start-up case, as opposed to becoming involved in a different activity, has an important effect on the importance attributed to some areas. Those informants who continued with their case after the SET programme put considerable emphasis on 'Competition and alliance knowledge', 'Operations, management and staffing' and 'Financial planning', whereas those who did not continue the start-up process seemed to overestimate (compared with the previous group) the role of 'Presentation skills'.

Table 1. Importance of different capability areas for start-up development: survey responses at t_0, t_1 and t_2 of start-up team members and students.

	t_0		t_1		t_2	
Capability area	Start-up team ($n = 7$)	Students ($n = 20$)	Start-up team ($n = 11$)	Students ($n = 17$)	Start-up team ($n = 8$)	Students ($n = 10$)
Strategic planning	4.71	4.45	4.45	4.35	3.75	4.5
IPR and tech management	4.14	4	3.45	4	3.38	3.9
Marketing and sales	4.86	4.5	4.64	4.47	4.63	4.4
Competition and alliance knowledge	4.29	4.1	3.64	4.29	3.63	4
Operations, management and staffing	4.29	3.9	4	3.76	3.5	3.9
Financial planning	4.43	4.15	4.09	4.35	4	4.4
Presentation skills	4.71	3.9	4.18	4.06	4.38	4.4
Average	4.49	4.14	4.06	4.18	3.89	4.18
Standard deviation	0.25	0.23	0.39	0.23	0.43	0.25

Note: Response scale: 1 = *not important at all*; 5 = *extremely important.*

Table 2. Importance of different capability areas for start-up development: survey responses at t_2 of those who, between t_1 and t_2 worked on the original SET start-up case and those who became engaged in other activities.

	t_2		
Capability area	Start-up work ($n = 7$)	Other ($n = 11$)	Δ
Strategic planning	4.14	4.18	0.04
IPR and tech management	3.71	3.64	0.07
Marketing and sales	4.57	4.45	0.12
Competition and alliance knowledge	3.57	4	0.43
Operations, management and staffing	4.14	3.45	0.69
Financial planning	4.43	4.1	0.33
Presentation skills	4	4.6	0.6
Average	4.08	4.06	0.02
Standard deviation	0.33	0.38	

Note: Response scale: 1 = *not important at all*; 5 = *extremely important.*

How did the self-assessed skills of participants develop?

The second set of questions was intended to shed light on the development of personal skills. As in Tables 1 and 2, the survey results are presented in Tables 3 and 4 based on self-assessments at the three measurement points. Table 3 compares the results based on the roles at t_0 and t_1 – start-up team members versus students. The results in Table 4 are categorized according to the respondent's activity between t_1 and t_2.

It seems clear that, with a relatively short but structured 8-week intervention (t_0 to t_1), an impact can be achieved on the capabilities of both members of start-up teams and students in all issue areas. Despite the different backgrounds of the two groups – start-up teams being 'technology-heavy' and students having 2 or 3 years of business studies behind them before SET – the students rated their skills lower than start-up team members both at the start and immediately after the programme. Some of their earlier learning in university may not have been directly applicable to the start-up context. Interestingly, as time goes by, students report an ability to maintain and even improve their skill level, whereas start-up team members give themselves a lower assessment 1 year after the programme. The reasons for this may be increased self-criticism and self-assessment ability coupled with the real-life needs of the start-up team members. On the other hand, in many cases additional studies have been undertaken in the student group since SET.

In Table 4, compared with Table 3, the key finding is that those learners who needed to take the learning from the programme into their real-life business context tended to rank their skill levels lower than those who had not been exposed to start-up business development after SET. However, the skill level ratings of the start-up team members who continued with their original case in, for example, 'Operations, management and staffing' are higher than for the start-up group members at the start of the programme. This finding reflects the fact that no educational programme can fully replace real-life experiential learning in business development, as the participants who continued their start-up development had faced and solved problems in reality.

What capability areas were significantly impacted and did the impact last?

Although even minor differences between t_0, t_1 and t_2 are of interest to organizers and developers of entrepreneurship programmes (such as the tendency of start-up team members to rate their skills level lower at t_2, 1 year after the programme), not all changes are of statistical significance. The data collected were subjected to a Mann–Whitney

Table 3. Self-assessed capability levels: survey responses at t_0, t_1 and t_2 of start-up team members and students.

	t_0		t_1		t_2	
Capability area	Start-up team ($n = 7$)	Students ($n = 20$)	Start-up team ($n = 11$)	Students ($n = 17$)	Start-up team ($n = 8$)	Students ($n = 10$)
Strategic planning	3.29	2.84	3.73	3.47	3.63	3.8
IPR and tech management	2.71	1.8	3.64	3.24	3.25	3.3
Marketing and sales	2.43	3.15	4	3.78	3.88	3.8
Competition and alliance knowledge	2.71	2.45	3.82	3.53	3.8	3.8
Operations, management and staffing	3.14	3.05	3.55	3.53	3	3.5
Financial planning	3	2.7	3.64	3.18	3.25	3
Presentation skills	3.29	3.5	3.55	3.82	3.63	3.9
Average	2.94	2.78	3.7	3.5	3.41	3.59
Standard deviation	0.33	0.55	0.15	0.22	0.30	0.31

Note: Response scale: 1 = *no knowledge*; 5 = *expert knowledge*.

Table 4. Self-assessed capability levels: survey responses at t_2 of those who, between t_1 and t_2 worked on the original SET start-up case and those who became engaged in other activities.

	t_2		
Capability area	Start-up work ($n = 7$)	Other ($n = 11$)	Δ
Strategic planning	3.57	3.82	0.25
IPR and tech management	3.29	3.27	0.02
Marketing and sales	3.86	3.82	0.04
Competition and alliance knowledge	3.29	3.73	0.44
Operations, management and staffing	3.29	3.27	0.02
Financial planning	3.14	3.09	0.05
Presentation skills	3.29	4.09	0.8
Average	3.39	3.58	0.19
Standard deviation	0.23	0.34	

Note: Response scale: 1 = *no knowledge*; 5 = *expert knowledge*.

U test, which was chosen partly by excluding other options: the Wilcoxon signed-rank test would have needed the same number of data points from the two measurements compared, and the small sample did not allow a standard *t* test to be performed. The results of the test reveal whether two populations – such as the students before and after SET programme – differ significantly in the skill levels they believe themselves to possess. The Mann–Whitney *U* test also allows small samples to be used. The calculations were done by feeding the individual data values into the online Mann–Whitney *U* test calculator (Social Science Statistics, 2015).

The Mann–Whitney *U* test was run separately for the student and team member cohorts of the informant pool and three comparisons were drawn for both groups:

- from t_0 to t_1 – the immediate short-term effect of SET training on self-assessed skill levels as measured immediately after the programme;
- from t_1 to t_2 – the deterioration or improvement in self-assessed skill levels between the end of the programme and 1 year after completion;
- from t_0 to t_2 – the long-term effect of SET, from the start of the programme to 1 year after completion.

With regard to the first comparison, due to the intensity of the training (all areas covered within an 8-week time frame), it can be assumed that the major impact on skill levels would emanate from the SET programme, even though the start-up team members were at the same time business planning in their real-life environment and the students were undertaking other learning activities. The results (Table 5) show that, for the student cohort, a significant improvement was achieved in four out of the seven areas separately addressed in the SET curriculum, whereas the improvement was not significant for the remaining three areas. The students involved had all also taken standard university courses in those three subjects (e.g. courses in human resources management, financial management, management accounting) and kept classroom presentations over the 2–3 years of their studies before SET. In light of this background, one interpretation of the finding for this cohort is that the SET training approach and material offer them fewer new viewpoints and tools in these three areas than in the other four. On the other hand, the students also had a learning history in strategic management, marketing and sales courses, so in these areas SET seems to have added more to their pre-SET skill set.

Next, the same short-term effect was tested on the members of the start-up teams (Table 6). In the areas in which significant impacts were noted, three ('IPR and tech management', 'Marketing and sales', 'Competition and alliances knowledge') coincided with the findings for the student cohort. It is interesting that the 'IPR and tech management' area was impacted, even though most team members had a science and technology background. It is also evident that, in both cases, the capability areas assessed as high

Table 5. Students: short-term effect on self-assessed skill levels (between t_0 and t_1).

Capability area	*U*-value	*Z*-score	*p*-value	Significant at $p \leq 0.05$
Strategic planning	93.5	−2.1389	0.01618	Yes
IPR and tech management	42.5	−3.37555	9.00E−05	Yes
Marketing and sales	112	−1.7524	0.04006	Yes
Competition and alliance knowledge	67	−3.1238	0.0009	Yes
Operations, management and staffing	116.5	−1.6152	0.05202	No
Financial planning	124.5	−1.3714	0.08534	No
Presentation skills	135	−1.0514	0.14686	No

Table 6. Start-up team members: short-term effect on self-assessed skill levels (between t_0 and t_1).

Capability area	*U*-value	*Z*-score	*p*-value	Significant at $p \leq 0.05$
Strategic planning	38	1.1321	0.12924	No
IPR and tech management	28.5	2.5359	0.00554	Yes
Marketing and sales	39.5	2.9887	0.00139	Yes
Competition and alliance knowledge	27.5	2.3095	0.01044	Yes
Operations, management and staffing	29	1.0868	0.13786	No
Financial planning	30.5	1.4038	0.0876	No
Presentation skills	41.5	0.643	0.26435	No

Table 7. Students: long-term effect on self-assessed skill levels (between t_1 and t_2).

Capability area	*U*-value	*Z*-score	*p*-value	Significant at $p \leq 0.05$
Strategic planning	36	−2.6284	0.00368	Yes
IPR and tech management	24.5	−3.2996	0.0048	Yes
Marketing and sales	65.5	−1.4958	0.0681	No
Competition and alliance knowledge	30	−3.0576	0.00111	Yes
Operations, management and staffing	65	−1.5178	0.06426	No
Financial planning	79	−0.9019	0.18406	No
Presentation skills	74.5	−1.0999	0.13567	No

Table 8. Start-up members: long-term effect on self-assessed skill levels (between t_1 and t_2).

Capability area	*U*-value	*Z*-score	*p*-value	Significant at $p \leq 0.05$
Strategic planning	22.5	0.5786	0.28096	No
IPR and tech management	18.5	1.0415	0.14917	No
Marketing and sales	6	2.4881	0.00639	Yes
Competition and alliance knowledge	17	1.2151	0.11123	No
Operations, management and staffing	25.5	−0.2315	0.40905	No
Financial planning	24.5	0.3472	0.36317	No
Presentation skills	21	0.7522	0.22663	No

at t_0 are less likely to show a significant improvement in the limited time to t_1 than those areas in which the participants initially assessed their skill level to be low.

The analysis of changes in self-assessed skills immediately after the SET training (t_1) and 1 year after completion (t_2) did not reveal any statistically significant developments. The reasons for this and potential solutions are discussed in the 'Discussions and conclusions' section below. Given the absence of statistically significant changes, the details of this analysis are not presented in this article.

However, the minor changes between t_1 and t_2 are relevant to the long-term effect of the training. The aim of educators is to create a lasting learning effect, so that after some time learners will still report significantly higher levels of skill compared with the start of the training. The self-assessed skill levels at t_0 and t_2 were also subjected to a Mann–Whitney *U* test. The results in Tables 7 (students) and 8 (start-up team members) show that in the longer term there were fewer capability areas for which the positive impact had endured. More precisely, for the start-up team members only one capability area ('Marketing and sales') shows a significantly higher level statistically than before the training. For students the same applies to three different capability areas. Possible reasons for this and potential solutions for entrepreneurship educators and learners are more discussed later in the article.

As noted earlier, the SET entrepreneurship programme has been developed over time and improved in accordance with participant feedback collected at the end of each implementation. This has led to a relatively tight format in which the structure, exercise materials, recommended readings and practical arrangements (like the intensive 4-day kick off followed by weekly coaching sessions) are repeated for each case. Despite this, the participants in the case analysed here reported relatively uneven skill levels (see the standard deviations in Table 9), particularly the start-up team members. This finding requires additional analysis. Is the deviation due to varying engagement and effort put in by the learners, or differences between the coaches, or should the coaching take a more individual

Table 9. Standard deviations in self-assessed skill levels at t_1.

	Students		Start-up team members	
Self-assessed skill levels	Average	Standard deviation	Average	Standard deviation
Strategic planning	3.47	0.62	3.19	0.90
IPR and tech management	3.24	0.83	2.94	0.96
Marketing and sales	3.76	0.83	3.35	0.91
Competition and alliance knowledge	3.53	0.72	3.20	0.89
Operations, management and staffing	3.53	0.80	3.15	0.85
Financial planning	3.18	0.88	2.75	0.71
Presentation skills	3.82	0.53	3.52	0.91
Average	3.50	0.75	3.16	0.87

approach, addressing gaps in capabilities specific to each case and learner? These questions are further discussed in the sections that follow.

Measurement challenges and opportunities

With regard to methodology, this study measured the development of entrepreneurial capabilities through self-assessment. Objective tests of skills applicable to start-up development would naturally be a more reliable indicator of achievements and efficacy; however, given the complexity of holistic business planning, such objective tests would take considerable time to develop. As a method of measurement, self-assessment has its pitfalls because the scale one applies to self-assess is a personal matter and it also tends to be different at different times. We do not know for certain but we can assume that, when over a year has been spent on new venture development, additional difficulties have become apparent and consequently there is a tendency to provide a lower self-assessment of skills in light of the challenges experienced. The results indicate that this confrontation with 'real-life' challenges is an important factor affecting self-assessment. It is noteworthy that the student participants who returned to their traditional university study mode, or worked in a different type of business after the programme, provided higher self-assessments of their skill levels than the start-up entrepreneurs who were constantly testing their capabilities in reality. Additional research is needed on this matter.

Alternatively, we could assume that there was a low retention of learning, since we were not able to continue to coach the participants after the programme and they had either no time or no need to revisit the material. The role differentiation in the company may also be relevant here, and leads to another question for future research: Should the capabilities of a start-up team be measured at the level of the team or company rather than the individual? As the start-up company develops, the need for all team members to master the whole spectrum of skills is likely to diminish.

One method that could be used to overcome the weaknesses of self-assessment would be to establish a third-party expert assessment similar to that done in the United States for a National Science Foundation Study (Suhr et al., 2013), for which a control and a test group received over 500 video reviews and assessments by business and entrepreneurial education experts as to how the teams had performed against pre-designed criteria (the study assessed instructor-taught versus e-learning modules).

Another option would be to expand the questions with more descriptive content as to the amount of knowledge each score level would reflect. The skills in 'Marketing and sales' could be separated and 'IPR and tech management' could be divided into smaller categories, following the programme material and coaching session content. It would be a complex task to expand each question, but this approach might significantly enhance the results.

Given that the programme consists of teams of business study coaches and science and technology-based entrepreneurs following a curriculum with SET coaches/instructors facilitating the process, one might conclude that the instructors would not have much impact on self-assessment scoring. However, as indicated by the results presented in Table 9, the deviations in skill levels could be viewed as significant considering that all teams had the same time and materials in their training. In considering future assessment methods, there is a need to evaluate whether coaching personality and style affect learning outcomes and retention. The goal of such an investigation would be to achieve a more uniform high-level impact on acquisition of the desired skills by both business students and technology entrepreneurs. As described in an earlier section, the SET programme was originally developed with a train the trainer focus to disseminate a set of exercises that could produce similar results to those originally achieved by UCSD CONNECT.

This article describes our first attempt to quantify the efficacy of the SET programme. Our study has generated more questions than answers for the team. For the next study cohort, we might consider additional questions and follow-up questions to produce deeper insights into the

learning and the stickiness of the learning, and what additions or changes might be considered for the programme delivery and curriculum. Another method of measuring the efficacy of the learning could be through independent knowledge and learning assessments by expert judges.

Other measures of effectiveness could be applied to our initial and future cohorts. For example, one such measure is return on investment, used by professional investors and adopted by one of the authors of this article (Ballard) and her client academies and accelerators: how much has the input to the programme (monetized) produced output (revenue)? Furthermore, universities use initial and the long-term salaries and salary growth of their graduates hired by businesses to 'grade' educational value. This analysis could be applied to the initial cohort in this study to tease out additional efficacy results and compare them to those for other students from the same year.

Yet other measures could include future start-up activity and/or career selection with start-ups and small businesses by the student coaches as well as the technology entrepreneurs. Do they generate more 'start-up' activities in their careers than another cohort that has not been through the training? This type of long-term follow-up would require: (a) traceability of the participants over time, and (b) loss of anonymity in the initial rounds since there would need to be linking of personal future success to personal assessments done earlier. It should also be taken into account that, on the development path of a successful start-up company, there are changes in resources (knowledge, experience of personnel and board members and advisers, financing) and other intervening factors or incidents that make linking business success to any previously experienced entrepreneurship programme complex and debatable.

Discussion and conclusions

This case study of the SET programme implementation in Jyväskylä, Finland, in 2014 shows that entrepreneurial skills critical to start-up success can be disseminated in a collaborative mode, in which normally distinct categories of learners – science and technology-based entrepreneurs and undergraduate business students – are trained in a collaborative, team based and facilitated learning environment. The entrepreneurial teams bring to the learning process live start-up cases around which the experiential learning process can be built, as well as their own background and existing skills. The students bring fresh learning from their business studies, but often lack experience in putting their learning into action, especially in the start-up context.

Since this case study is of a specific educational setting and business environment in Finland, the findings cannot be directly generalized to a wider range of entrepreneurial programmes. Also the types of company and student need to be taken into account when comparing the achievements of this programme to others. On the other hand, both the start-up entrepreneur group and the student (and coaches) group had multicultural backgrounds, which may support the generalization of the results. Also, the SET process has been implemented in various countries, so the learning process in this case is not unique.

As reported in an earlier article (Saukkonen, 2014), the feedback at JAMK University of Applied Sciences for the course on High-Tech Management received more positive assessments over several years compared with randomly selected courses in the same institution involving less interaction with companies. The impact of interaction was notable in the students' self-assessment of the extent to which they had achieved their learning goals and in the degree of activity the students had put into the learning process (student engagement). Furthermore, the 2014 implementation of the High-Tech Management course, when the SET programme was first built into the curriculum, received better overall student feedback than in previous years. For students, this new mode of learning led to deeper and wider learning (Saukkonen, 2014). Saukkonen's (2014) study, however, did not examine the specific impact of the SET programme on learning within the course and did not focus on the start-up team members as learners; nor did it look at the retention of learning achieved by SET.

In the present study, both groups – start-up teams and students – self-assessed improvements in their own skills across the given capability areas after the intensive 8-week programme. However, the impacts were not significant for every capability area and they varied between the areas.

Other interesting findings emerged from the study that requires interpretation and further research. First, the self-assessments by the start-up team members 1 year after the programme produced lower skill ratings than those immediately after the programme, despite the fact that most informants from that cohort had continued their work in the start-up team and thus one might expect an increase in skills. The student cohort in the informant pool believed they had maintained or even improved their skill levels. Further research is needed to ascertain whether there should be additional support for learning retention or whether the lower ratings are due to exposure to real-life business challenges. Lasonen (1995: 3) suggests that 'self-assessment of the outcomes of affective and cognitive learning takes place at the individual level but reflects, at the same time, the individual's social environments with their events and people. Learning often occurs in social contexts.' And since the post-programme environments in which the start-up entrepreneurs and non-entrepreneurs are expected to use their learning are significantly different, the divergence in the self-assessments of skill levels is unsurprising.

Second, not only the coaches using the SET programme, but all coaches or facilitators in entrepreneurship learning processes can learn from the assessment of critical

capability areas when designing entrepreneurship courses. 'Marketing and sales' was the domain that remained on the highest level in assessments of importance to start-up success at all three measurement time points. This was also the area in which a significant long-term learning effect was achieved for both start-up team members and student cohorts. Additional studies could be done by using successful technology entrepreneurs as informants: What capability areas they see as crucial for the success achieved?

Third, as noted in our literature review, there is no generally agreed set of entrepreneurial skills or method of when and how the level of those skills should be measured. We aim to contribute to the research and practice of entrepreneurship education with our approach, based on the SET model of entrepreneurship education. We see no major obstacles in using the same methodology for other entrepreneurship programmes. Bearing in mind the multitude of such programmes, comparative studies of learning impacts would help both scholars and practitioners to develop this special type of education–enterprise interaction.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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VI

ENTREPRENEURS AND GROWTH: AN OPTION, OBLIGATION OR OBSESSION?

by

Juha Saukkonen, 2018

Chapter in *Entrepreneurship: Development Tendencies and Empirical Approach, 1*.
InTech Open, Zagreb. pp. 3-33

DOI: 10.5772/intechopen.70527

Chapter 1

Entrepreneurs and Growth: An Option, Obligation or Obsession

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.70527

Abstract

"Growth" as a word carries a positive tone in it; human beings grow and mature, gaining new knowledge and resources, and so do companies. Growth, however, has never been for all. In competitive markets, some grow and others do not—or grow at slower pace than others. Furthermore, growth is a process that strains the capabilities and resources of an individual, company, and its acting entrepreneurs to their extreme. Growth means also learning and leaving behind something learned of possessed before. Growth disrupts the history and path of a single company and its entrepreneur. The text synthetizes the scattered literature in growth and entrepreneurship. A case study shows how growth is viewed in an entrepreneurial company. The author shows how companies can be categorized to different sub-segments based on their growth opportunities, urge to grow, and growth aspirations. The typical enablers and hindrances of growth hindrances get introduced. The chapter underlines that for some companies, growth is one of the strategic options, whereas to some, it is more of an internal and external obligation. Despite the existence of multiple stage-based models, growth is an individual path and no model should be taken in a law-like manner.

Keywords: entrepreneurship, growth, opportunity, evolution, disruption

1. Introduction

Growth and growth entrepreneurship are current buzzwords of business development. They have made their way recently also to political vocabulary. National, regional, and local authorities and organs create and maintain programs and policies that aim at fostering growth among the enterprises they support and regulate. Also, the word "startup" is well known and actively used by all type of actors in business and policy arena. The name of startup itself

implies that it is started from scratch, with the only option to grow (or die) soon. This topical area deserves a treatment also when entrepreneurship get pictures and investigated.

In this chapter, the aims are:

- To understand what we mean with the concept of "growth" itself;
- How growth as a concept and process could be understood is a wide yet concise manner inside the field of entrepreneurship;
- Introduce methodological and conceptual models that can be used as models when researching growth in the field of entrepreneurship as well as practical tools to analyze growth opportunities and obstacles within a firm and act on it.

We look at growth from processual, dynamic, and individual points of view. Elements of growth get discussed, and also, some taxonomies of companies in relation to growth are introduced. In the latter part of the chapter, recent studies of the growth companies across continents, their growth enablers, and hindrances are presented. In order to mirror entrepreneurial reality against the models and theories of the literature, a portrait of a growth trajectory of a fast-growing environmental technology individual firm gets presented. To conclude, the future of growth as a phenomenon is discussed.

2. Methodology

This chapter combines the practices of conceptual research in the literature review and qualitatively oriented case study research in the empirical part. As Ravitch and Riggan [1] put it, the conceptual framework includes not only the relevant theoretical literature but also aims at fitting into it the findings of prior research as well as the researching authors own experience-based knowledge and commitments. Furthermore, they define conceptual framework as "an argument about why the topic one wishes to study matters, and why the means proposed to study it are appropriate and rigorous" [1], also pointing out that they tend to and even should change along the study process, as the knowledge of the researcher changes in volume, content, and direction. From this methodological viewpoint, this chapter should be seen as a journey in the vast supply of frameworks and research findings related to the chapter topic. The author aims at creating a certain level of synthesis of the scattered literature. The wide treatment of different angles related to the phenomena of growth and entrepreneurship serves as a basis for students and researchers of the topic to choose the areas from within the big picture to drill into.

The exploratory approach to scan, compare, and synthetize (where possible) represents the "reason" element of the framework building, following the ideas of Ravitch and Riggan [1]. The other element "rigor" means choosing a method and using it with rigor to create knowledge out of data gathered. In this chapter, the rigor is represented by the use of case study method to link the conceptual framework into the trajectory of growth of an individual firm.

The research approach used in the case study (Chapter 3) was inductive. The research project proceeded from collecting the primary data of the object of study to recognize patterns that

would then serve as basis for model creation. The process also included critically reviewing the identified issues against conceptual and process models of prior research and proposing improvements or modifications. As it goes for inductive approach, models and concepts presented in the literature review can affect but neither decide nor limit what the researchers will find when collecting primary data [2]. Single case study was selected, since the case study method is well suited to the aim of understanding new and evolving phenomenon [3, 4].

Qualitative research method was chosen due to the opportunities it gives to the researcher to develop a complex, holistic picture of the target [5]. The data were collected using semi-structured interviews. There were pre-planned themes to ensure the interviewers covered the essential topics emerging from the framework creation and to guide the interviews so that they allow summaries and comparisons between individual respondents. The informants were informed of the key themes—but not exact questions—when agreeing the time and place for the interviews.

Choice of respondents plays a crucial role for data quality and affects the ability of the researchers to come up with concise conclusions. Altogether four respondents from the target company were interviewed. To balance and mirror the internal view and in order to have a wider and more neutral view to the case company, three external experts of the industry in question and growth company management were added to the respondent pool. The final pool consisted of following types of respondents as listed below:

1. In-house resources in company X

- Founder-Owner-Manager—later in this paper referred as FOM—the person behind the core innovations of X acts as CEO and is the biggest shareholder in X
- Owner-Manager—OM—works in business development, experience in environmental/energy business also from a large corporation, has an equity stake in X
- Sales & Marketing Personnel—two respondents; SMP_1, SMP_2—work in the commercial activities of X in different markets areas, no equity stakes in X

2. External experts

- External Industry Expert (EIE): an expert in energy and environmental technology business.
- Business Development Expert (BDE): an experienced start-up business coach and board member in start-ups
- Venture Capital Expert (VCE): over 15 years of experience in VC and private equity investments

The researcher team for the case study consisted of two researchers with different educational and background and researcher experience. In order to avoid biases in conducting interviews, a joint semi-structured frame was created in advance. In the interviews, the frameworks of earlier research were shown to respondents on a schematic level in order to spark and steer the discussion. All interviews were recorded and loosely transcribed after which the researchers first analyzed the data independently. Next, the individual findings by the two researchers

were compared and fused for a joint view. All interviews took place within 3 weeks timeframe, so the contextual factors were the same for all interviews.

3. Literature review

3.1. Growth in business: definition and its relativity

Is 1.0% growth per annum really growth? In the economic downturn that started in the latter half of 2000s, we have learned that even this type of growth on the society level is a good sign for many economies. Doubling it to 2% will prove the economy is back on growth track. Naturally, the same scales should not be applied to individual entrepreneurial firms. Compared to societies that have a lot of inbuilt inertia, force of slowness, a firm, and entrepreneur (s) in it can move in a much more agile way, grasp the opportunities, and find new markets. Yet, growth in business is not nearly as common a phenomenon as the popularity of the term and research on it would suggest.

An often and officially used definition for a growth company is the one by EU and OECD that claim that: "A growth company is a firm that at the starting point of the follow-up period employs at minimum 10 people, and for the next 3 years, the average growth in the employment is at min. 20% annually" [6]. This may sound like a modest demand in the world where there are companies that mushroom, go global, and get funded heftily in a short few years' time. Widely published stories of unicorns (whose market capitalization is 1 billion USD or more) are however just the top of the iceberg, growth is taking place in all segments of business and most often outside the radar of the mass media and public recognition. As an example, in the timespan of 2006–2009 in Finland (an advanced economy in terms technological level, education and GDP), this country with 5.5 million population only had 665 true growth companies, out of 280,000 total number of companies registered. This means that a mere 0.2% of companies are growth companies. However, at the same interval, the growth in these companies was a major vehicle of employment and net job creation in the economy.

The abovementioned definition focusing on the company's headcount as the measurement of growth has been criticized. In the era of networking, outsourcing and digitalization sales revenues can scale up fast with minor impact to the number of people in the payroll. Shifting the measuring stick to average 20% sales revenue for 3 years in a row does not change the big picture. In the Finnish context, the amount of "growth companies" doubles. However, growth companies of this kind still represent 0.5% fraction of companies!

There are also whole industries and markets, where the 20% annual grow definitely is not enough and not a satisfactory achievement. Entrepreneurs funded by professional Venture Capital companies (VC) are posed to high expectations and demands for growth. The Venture Capitalists′ agenda is straightforward: Invest → help to grow (during Holding Period) → Exit → Invest to next target. Venture Capital firms differ in their IIR (Investment Rate of Return) demands and do not share their targets on IRR publicly. Journal articles and start up training programs have introduced some "typical demands" from the VC community [7, 8].

These vary between "(invested) money back 10-fold in 5 years—via IPO or trade sale exit" to "3-fold in 10 years—that most of other companies would see as a failure". The National Bureau of Economic Research has found out the average return in reality to be 25%, but occasionally even up to 700% returns have materialized. It is not likely any VC firm would be satisfied being average or would state publicly industry average is sufficient for them. Putting the figures given above to the IRR conversion table (**Table 1**), we see what kind of multiples to original investments and exit times are needed to high end (10-fold return in 5 years), average (25% return), and low end (3-fold in 5 years).

Naturally, the IRR also is dependent on the ownership stake that the VC firm takes in the company into which they invest. Using the high-end IRR demand (10-fold return in 5 years), we see that if a VC company takes a 25% stake in the company—rather typical practice in VC operations—the company value has to grow aggressively (**Table 2**). If the stake that the entrepreneur sells out to investors is just 10%, the growth needs to be even more spectacular to satisfy the return needs of the investor.

In today's economy, the valuations of companies are rarely based on asset value. An often used basis in the pricing of the company at exit is the multiple on the net sales. A multiple of 2

	EXIT YEAR				
Multiple	**3**	**4**	**5**	**7**	**10**
3 x	44%	32 %	25 %	17 %	12 %
4 x	59	41	32	22	15
5 x	71	50	38	26	17
7 x	91	63	48	32	21
10 x	115	78	58	39	26

Table 1. Return on investment vs. exit time and multiple on original investment.

If you sell this part of your company	For an investment of	With the return of investment of 10x in 5 yrs	The company needs to be worth in 5 yrs
100 %	€ 1 mill	(€10 mill)	€ 10 mill
50 %	€ 1 mill	(€10 mill)	€ 20 mill
25 %	€ 1 mill	(€10 mill)	€ 40 mill
10 %	€ 1mill	(€10 mill)	€ 100 mill

Table 2. Stake sold to investors and its impact of growth demand in value.

means company sale value being net sales of the last fiscal year multiplied by 2. In the above examples, the net sales have to reach either 20 or 50 million a year. The multiple of 2 is on the mid-range of typical valuations for enterprise value [8]. If the year of investment the net sales were 5 million, the official demand of 20% annual growth would lead them in 5 years to just over 10 million, which would not satisfy the investors.

As a summary it can be stated that

- Growth is needed for advancements in economy and society, on an aggregate level;
- True growth in business is not as a common phenomenon as assumed and wished, huge majority of the companies fail in fulfilling the official growth company criteria;
- Growth does not bear the same meaning and urge for all companies, industries, and stakeholders.

Logically, the findings above propose that we should approach growth in the entrepreneurial context from multiple angles. We want to shed knowledge on what growth is made of, how and why does it happen, and what is the role of entrepreneur or entrepreneurial team in the growth. We also need to see if there are foreseeable profound changes in economics, societies, and technology affecting entrepreneurial growth both in its chances to flourish as well as in the way, it is executed.

3.2. Growers, hypergrowers, and non-growers

The literature on SMEs and entrepreneurship does not fall short in presenting options for taxonomies of companies in relation their growth. Based on the views of Birch and Hagerty [9] and Storey [10], one can come up with the following hierarchy that divides companies into five categories:

1. **Shrinkers**: Negative growth, the ones that are going down in size of business subcategories: (1) passive shrinkers; (2) deliberate shrinkers (e.g., family firms not having successor to take over or a self-employed person gradually retiring)
2. **Trundlers**: No growth, e.g., mature firms with nongrowing market
3. **Triers**: Some growth and some aspiration to grow
4. **Fliers**: Rapid growth
5. **Hypergrowers**: Exponential (and today: viral) growth

The research intensity on company growth has been understandably placed to the high end of the growth continuum. An appealing research objective has been the cohort of Gazelle companies, a category with widely accepted definition. A Gazelle company has increased by at least 20% annually for 4 years or more starting from a revenue base of at least $1 million. This pace means that the company is able to double its revenues over a 4-year period. A gazelle company acts like an animal chosen to its symbol—it runs fast and, when needed, jumps.

The questions that have interested numerous researchers of gazelles have been: Why and how the entrepreneurial firms then end up into one category in the continuum—e.g., how and why they become gazelles? Are there some practices that can be learned to foster growth or practices to avoid that are hindering growth? Numerous researchers (e.g., Calvo [11] on Spanish manufacturing SMEs; Parker et al. [12]) have been drawn to test the classical Law by Gibrat [13] that says in its simplified format that firm growth is independent to its size. So understanding growth is not a SME and entrepreneurial phenomenon, but growth can occur in any size of a company. Gibrat's inputs propose that if firm growth do is a random variable, three outcomes would be excluded: (1) firms of a given size will grow faster (or slower) than other sized firms; (2) firms that grow faster (or slower) in one time period will grow faster (or slower) than in a later time period; (3) there will be factors that powerfully and consistently explain firm growth performance.

Parker et al. [12] used British data set on more than 100 Gazelles. They state that the Gibrat's law does not generally hold. They also add that "best practice learning", i.e., routine application of strategies adopted by successful companies is unlikely to foster firm growth in a changing economic environment. Calvo [11] analyzed whether small, young, and innovating firms have experienced a greater employment growth than other Spanish firms over the period. His results show that old firms grow less than young ones, and high level of process and product innovating activity is a strong positive factor in the firm's survival and its employment growth. Conclusion is that small size of a company is a potential set up for growth. The key variables for growth are still the deeds, strategies, and action suitable to the dynamic environment. These deeds are to a certain extent individual to each company.

In addition to the academic research, the consulting company Deloitte has acted in adding knowledge and understanding of high-growth companies. For more than a decade, Deloitte has surveyed growth companies across markets. The reports published on growth companies by identify them and present the enablers of the growth that has already taken place as well as enablers and obstacles for future growth. Deloitte lists on a yearly basis top 500 growth technology companies, separately for EMEA, Americas, and Asia regions [14]. Findings support the earlier studies in showing that the environmental factors affect firm growth. According to Deloitte, the innovation and growth context also referred as entrepreneurial "ecosystem" impact the growth. Large domestic market does not seem to that important a variable for growth, at least not in the technology business that is the overarching theme for the Deloitte study, as **Table 3** shows. For example, countries of Northern Europe are overrepresented in the listing compared to population. Germany as the biggest single economy in EMEA falls short in the presence of growth companies.

The other environmental factor affecting growth is the industry and the nongeographical marketplace in which companies operate. Industries vary in opportunities of scalability and resource demands (capital, capacity, and assets) for growth. Certain industries (see **Table 4**) seem to offer a more fertile growth for hypergrowth than others. In software business, the threshold or "barrier of entry" for high growth seems to be the lowest one (highest number of companies listed), whereas the growth opportunities in hardware, media, and cleantech are the highest for those who can surpass the threshold (highest average growth in the sector).

Top 10 countries with the greatest number of winners	
Country	**Number of ranked companies**
France	94
United Kingdom	70
The Netherlands	54
Norway	50
Sweden	50
Israel	27
Finland	23
Germany	23
Belgium	22
Turkey	21

Table 3. Fast 500 growth companies according to country of origin: EMEA region.

Companies and growth by sector		
Sector	**Number of ranked companies**	**Average growth per sector (%)**
Clean Technology	20	471
Communications	61	345
Hardware	49	962
Life Science	29	347
Media	70	644
Software	271	362

Table 4. Fats 500 growers by sector and growth rates per sector: EMEA region.

Average growth rate of Deloitte EMEA 2016 awardees is 967%, ranging from 212% up to 28,000+ %. Despite the obvious support from the context surrounding the company, growing companies of total 28 countries were awarded as top 500 growers. This underlines the fact that growth is still to an extent of an independent entrepreneurial effort that can be born in numerous contexts. This phenomenon has also been recognized by Mahroum [15]. The title of his book reveals well a certain context independent of modern growth businesses: "Black Swan startups: Understanding the Rise of Successful Technology Business in Unlikely Places".

3.3. Elements of growth

Researchers, statisticians, investors and policy makers, and evaluators alike need and produce numerical proofs and measurements of growth. However, these statistician views may be

http://dx.doi.org/10.5772/intechopen.70527

misleading in the sense that (1) they see the growth as an end rather than means; (2) they fail in understanding the multifaceted nature of growth; and (3) they assume all aspects of grow are demonstrated in the numerical data with a relatively short lead time.

The analysis of the nature of growth and elements making the totality of it by Wickham [16] shows what a wide look at the phenomenon called growth may be (**Figure 1**):

When analyzing and acting upon Wickham's framework, it is worth noticing that

- There is not a sequential order of growth elements to occur

  Example: Good performance accumulates resources that can be used to build/acquire assets or alternatively: Organizational growth helps the company to define and find direction that leads to better performance that strengthens financial position etc.

- There are iterations and loops

  Example: Resources allow acquisitions of assets that, when properly used, allow the organization to grow and perform, adding again the resources etc.

- Every elements acts in an interplay with others

  Example: Growing an organization is not a value *per se*. Organizational growth only makes strategic sense when connected to the assets and direction to move forward

- Some elements of growth do not get an immediate manifestation in numbers available from official and public data like income statements and balance sheets

  Example: Without proper strategic direction, the Wickham's cycle of growth is "broken": Sometimes a direction means a temporary de-growth as some products/services or customer segments are abandoned in order to make room for new ones. The impact on numbers in employment and revenue can even take a backslash but impact positively on long-term success

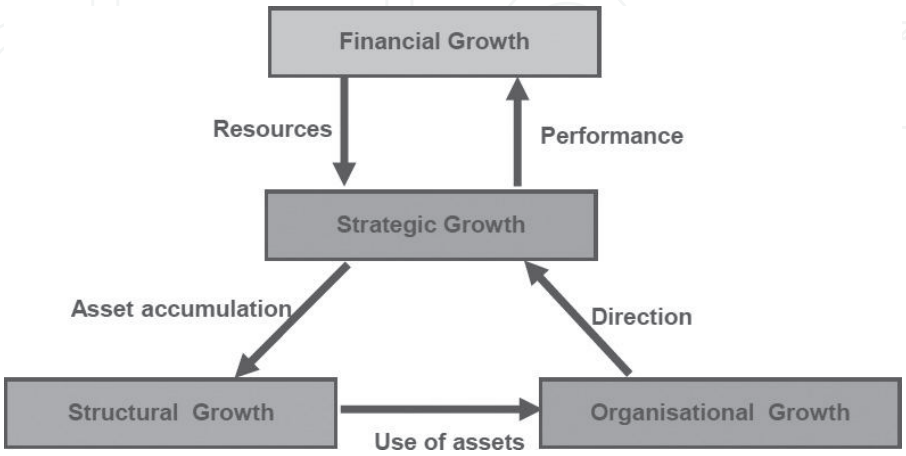

Figure 1. Nature of growth adapted from Wickham [16].

- The model does not state that all elements need to be internal to the company

  Example: Structural and Organizational Growth—elements can be also partnerships and networks in which the company and entrepreneurs become part of.

Typical for a growth pattern of entrepreneurial companies is that the elements of growth at one point of time do not take place at same pace and magnitude. There are developmental stages where one element is weighted over the others. The key knowledge for a growth-aspiring entrepreneur is to recognize what is the "bottleneck element" hindering the growth. Logically, the next managerial step is to figure out how that element could be "fed" to reach a level that allows growth cycle to spin.

Wickham's model is not a sole one that describes the dimensions of growth. For example, Hanks and Chandler [17] propose the dimensions of age, size, value, sophistication, and complexity. As can be seen, some of the dimensions offer a clear-cut measurability, whereas some are more open to relativity and subjective/qualitative judgment. Building on that, e.g., Laukkanen [18] and Muhos et al. [19] have utilized a dichotomy of qualitative and quantitative dimensions for SME growth. Independent of the dimensional framework used, all authors seem to agree on the complex and multifaceted nature of growth. This view requires both wide and deep study into the actions as well as causes and consequences of that action.

3.4. Growth as a sequential process

Researchers have been fascinated in building process models of entrepreneurship and growth of entrepreneurial companies. These stage-based models have varied in naming the stages, but the overall philosophy has remained the same—growth starts at some point of the company journey and stops or stagnates as some later point. These stages bear importantly different issues, opportunities, and obstacles for growth between them. In their large study, Levie and Liechtenstein [20] identified and analyzed 100+ stage-based models of growth. One of those models often cited is the one by Scott and Bruce, where they presented a trajectory consisting of stages of (1) Inception, (2) Survival, (3) Growth, (4) Expansion, and (5) Maturity [21]. Interestingly, growth is separated to be stage of its own right and separated from other three early stages. Stage sequences between three to six stages can be commonly found across scholarly literature, models going down to two stages and seven or up are more rare but existing. The validity of staged-based models has been often defended by the observation that entrepreneurs have been well able to place themselves into some of stages presented in the models, e.g., Eggers et al. [22].

The stage-to-stage movement is not linear and not happening at a constant pace. Numerous scholars have stressed the important role of discontinuities and crises in the development. Some like Kazanjian [23] use terms like "developmental problems" or "developmental hurdles" [24], instead of "crises." Dodge et al. state that there is a consensus of different problems occurring at during different stages of growth, and they are of sequential nature [25]. According to Scott and Bruce [21], the "crisis" stages are more likely to cause the organization to fail than other phases of development, if the company fails in solving the development obstacles. The crises and hurdles are negative to the development of a start-up company and

entrepreneurs. When in crisis, the entrepreneurs can learn new ways of thinking and acting. According to Greiner "…these periods of tension provide the pressure, ideas and awareness that afford a platform for change and practices" [26]. Greiner's model (**Figure 2**) shows the sources of growth through the stages of growth and likely sources of crises.

A new stage-based model is the one introduced in the start-up genome report [27] by Marmer et al. The researchers state that at start, they saw "describing the repeating patterns of startups an impossible task or even a disgraceful reduction of the artistry of entrepreneurship to numbers and graphs". Marmer et al. claim to have gained understanding of success and failure factors over growth stages. The project started with basic assumptions held by many earlier researchers:

1. Startups evolve through stages of development. Stages can be measured with specific milestones and thresholds.
2. There are different types of startups. Each type evolves through the stages differently.
3. Learning is a fundamental to progress for startups. More learning increases chances of success.

With point 2 above, Marmer et al. mean different types of Internet start-ups. So it is industry specific and based on their own sample. Points 1 and 3 provide wider applicability.

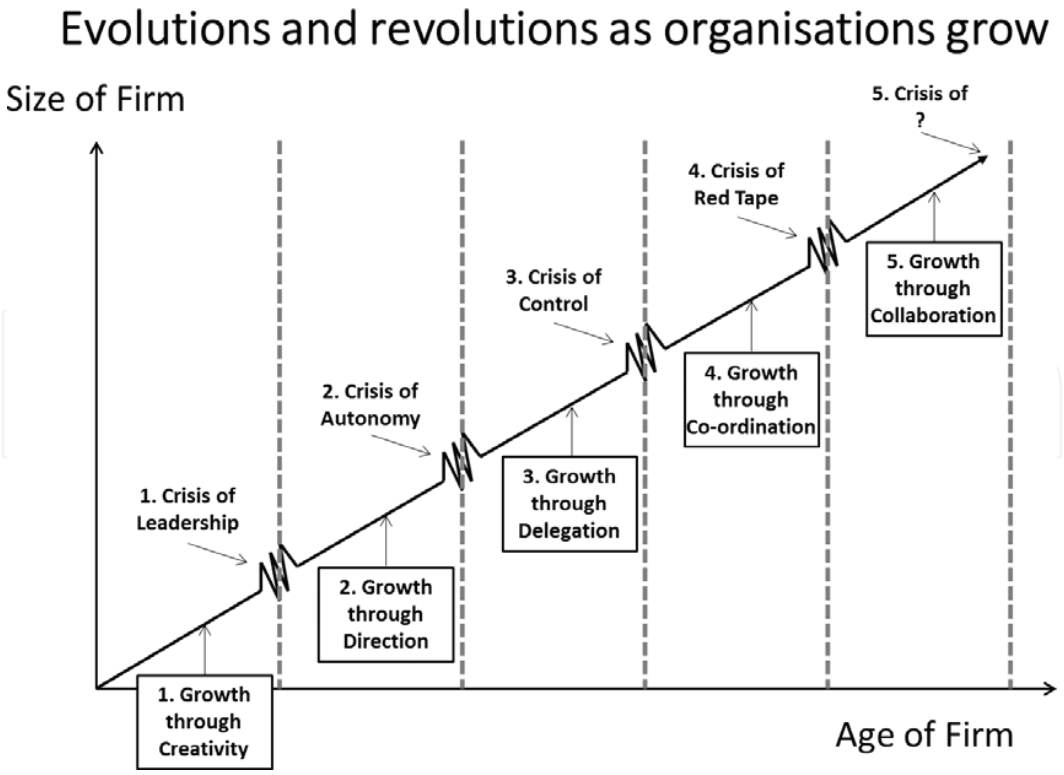

Figure 2. Sources of growth and crises in a growth trajectory of a firm (based on Greiner [26]).

The four stages identified—"Marmer stages"—are Discovery, Validation, Efficiency, and Scaling. As a conclusion, it is stated that:

1. The Marmer stages correlate with traditional indicators of progress.
2. The startups do not move through the stages (called non-consistent growth) in order show less progress.

In their research, Marmer et al. observed a specific phenomenon of Premature Scaling [28]—a development trajectory that jumps over a stage or overspeeds through it has a high correlation with a later failure of a start-up. Opposite to "growth obstacle," this phenomenon can be called "wrongly directed growth" that consumes and misdirects the growth resources of the company. In their data originating of 600+ Internet-based businesses, Marmer et al. found that 70% of startups which they studied scaled prematurely and thus were not able to exploit their growth potential.

3.5. An alternative look: growth as a dynamic movement

The key theme of previous chapter: stage-based models of entrepreneurial growth have not been popular only in doing. The models have been tested for validation and improvement in numerous contexts and set-ups. A summary made by Muhos and Kess [29] proposes that "The empirically based stage framework seems to be an effective tool for r*eflecting on and predicting* the challenges faced during the early development of a company". Moreover, their study revealed specific viewpoints contradictory to the framework: companies in different contexts face *culture-and context-specific issues* in their early growth, allowing the following statement to surge: "Growth is a multidimensional phenomenon, and each and *every early technology-intensive company is unique to an extent."*

Levie and Lichtenstein [30] state that the stage-based models fail as they suggest a certain level of determinism. There too are cases where the entrepreneurial firms and entrepreneurs in them can retrospectively see their development to have followed closely one growth model. This does not yet give justification to call them *models* of growth. Since there is a supply of 100+ models, it is statistically speaking logical to make a good match with one or many of the models. The suggestion of Levie and Lichtenstein is to see growth rather consisting of dynamic states between which the firm moves. This approach gives space to discontinuities and iterations. Various researchers like Cope and Watts [31] have shown interest to understand growth paths as a series of critical incidents that trigger actions affecting growth and adaptability and action learning [32]). According to Evers [33], even the entrepreneurial capabilities should be considered dynamic. They vary in content and value, as the firm and entrepreneurs move along their trajectory.

Figure 3 shows a schematic model of the dynamic state model, where the entrepreneurs action and reasoning have an effect on and are effected by its resources and interactions with other stakeholders, creating a cycle of continuous change.

As Levie and Lichtenstein (ibid.) summarize, "not only is the dynamic states approach more accurate than stages theory, it is also more optimistic for entrepreneurs. With flexibility and

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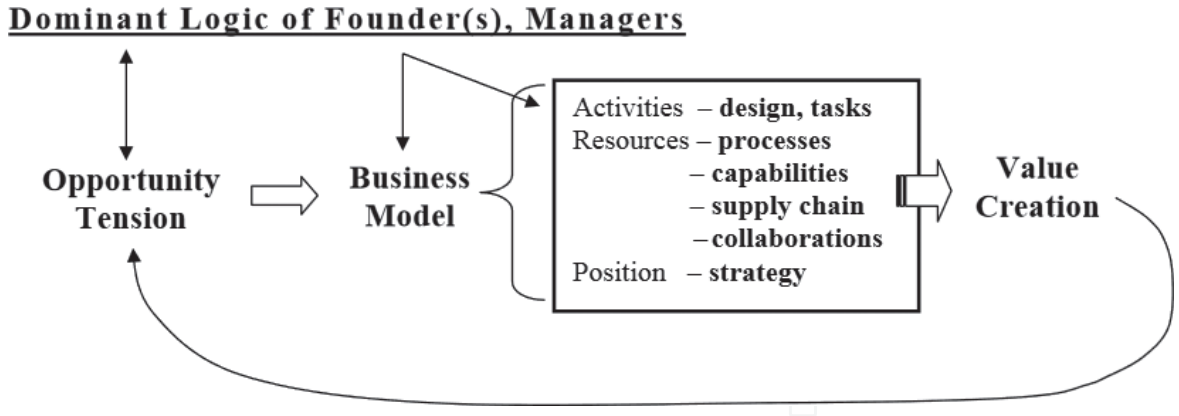

Figure 3. The elements of dynamic change [20].

awareness, ventures can endure far longer and in much greater variety than has ever been predicted by stages theory. Further, the dynamic states approach shows that it is normal for a firm to survive and maintain fitness by continual change…" This idea of never-ending development is studied more closely in the empirical case part (Growth trajectory of an environmental technology startup) of this chapter based on research by Saukkonen and Vänttinen [34].

3.6. Growth as a personal path of an entrepreneur

There is a consensus view that the development of an entrepreneurial company should not be (fully) separated from the personality and development of people running it. These intervening factors include the personality traits and life stage of the owner/manager (see **Figures 4** and **5**).

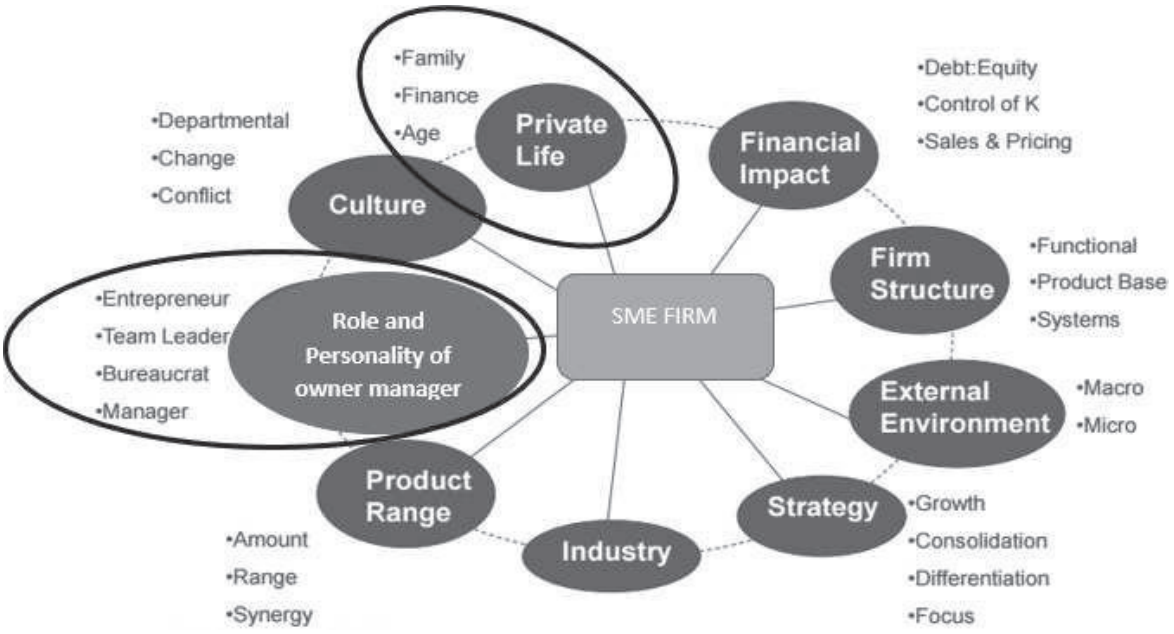

Figure 4. Factors affecting growth: Compiled from multiple sources.

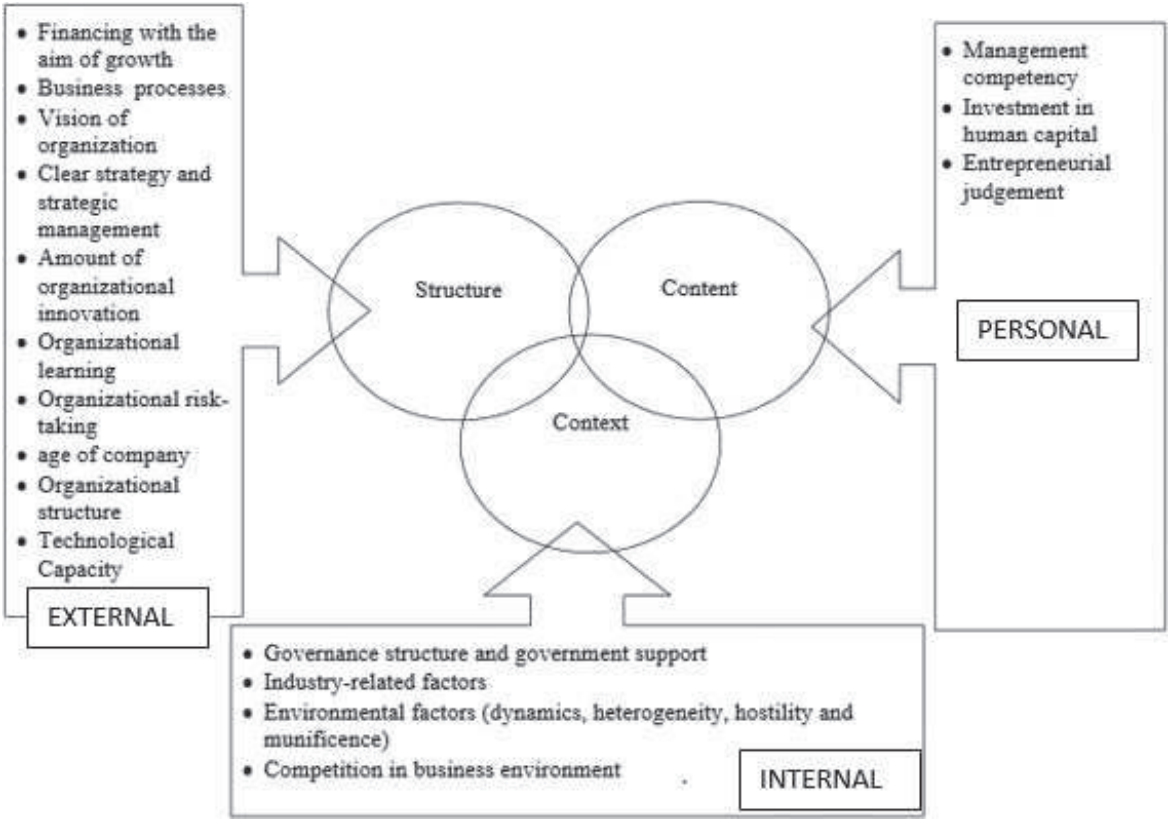

Figure 5. Categorized model of factors affecting growth adapted from Farrokh et al. [35].

More structured view of these individual factors has been presented, e.g., by Farrokh et al. [35] with a trichotomy to Internal, External, and Societal factors. Internal factors refer to the organization and resources inside the firm. External factors are societal and business network based. Personal factors include owner-manager's drive and capabilities. These are needed to be present for growth to take place.

Just like personal life, goals and situations can affect either way (positively and negatively) to growth aspirations and willingness, the dynamics can also act in a reversed direction. Growth can lead an entrepreneur to situations and conditions that serve another purpose than the growth itself. In this view, growth is a means of getting somewhere, not a value or target *per se*. This view got support in the classical volume by Hampden-Turner and Trompenaars named "Seven cultures of capitalism." In their work [36], it gets shown how there were deep and important underlying basic motivations of people working in these different capitalism-driven systems.

Capitalism is too a major extent based and dependent on free enterprise. The free enterprise is made of individuals engaging into entrepreneurial activity to reach their goals. They are the backbone of all capitalistic systems. That much so, that the US Small Business Act from 1953 boldly opens by stating (Paragraph 1): The essence of the American Economic System of private enterprise is free competition and (Paragraph 3) Security and wellbeing of the society

cannot be realized unless the actual and potential capacity of small business are encouraged and developed [37].

If and when we believe the statements of US Small Business Act and also Friedman, entrepreneurs grow because they want to earn more than their nongrowing business would yield. Hampden-Turner and Trompenaars [36] interestingly prove that to be a false assessment. In his study and book, the nation whose "culture of capitalism" was primarily based on "creating personal wealth" was UK. The driving force in American capitalistic culture was "creating something new." And often the creation of new products, services, and markets requires additional resources, and the way to attract resources is to grow. This view suggests the process of growth is of a value per se, the growth is not solely driven by the target of increasing size of the business and resulting wealth.

There has been a wide array of studies focusing on the entrepreneurial cohort of people as a collection of different persons, personalities, and behaviors. This school of entrepreneurship studied is called cognitive perspective to entrepreneurship. The basic thought of this view is that individual characteristics, interpretations, and directions affect (1) the likelihood and action in starting a new business and (2) the way, the path of entrepreneurship will continue. In a study by Kelley et al. [38] based on large data derived from 2010 to 2011 US Survey for GEM (Global Entrepreneurship Monitor), researchers found support to their hypotheses that individuals with (1) high income orientation, (2) high independence orientation, and (3) high self-efficacy (self-assessed ability) are more likely to engage into high job growth intentions. Also, the perceptions of opportunities (market newness, competitive uniqueness and international intensity) that vary between individuals in same circumstances play a significant role [38].

Naturally, some of these variables may not be stable indicators. The independence variable and self-efficacy had not significant correlation to growth intentions in a data collected 2 years earlier. The prolonged economic downturn may have caused that despite entrepreneurs´ ability, the perspectives of growth were not in sight. So the motivation to give an extra effort for growth was missing. Also in the economic doldrums, the risks in seeking growth may overweight the desire for independency, as Kelley et al. speculate.

As an overarching summary of relation of entrepreneur as person and growth, it can be stated that studying growth path of an entrepreneurial company without looking also at its owner/managers is missing a critical element. But as shown, in addition to individual characteristics, also cultural and situational contexts affect growth and aspirations for it. Churchill and Lewis [39] claimed that evolution of an entrepreneurial company will lead to changes and revaluations of the role and core capabilities of founders (see **Figure 6**).

Findings by Churchill and Lewis point out the necessity of the entrepreneur to renew and redefine his/her role along the trajectory of the firm. Just like when raising a child, growth means also letting go. This alone might be one hindering factor of growth: Do I want to manage an organization or am I more on my own turf running a stable business that I can steer independently.

A real-life question posed to Finnish SME companies (the survey panel for of the 2016 National SME barometer of an OECD-wide study "Financing SMEs and entrepreneurs 2017," and this

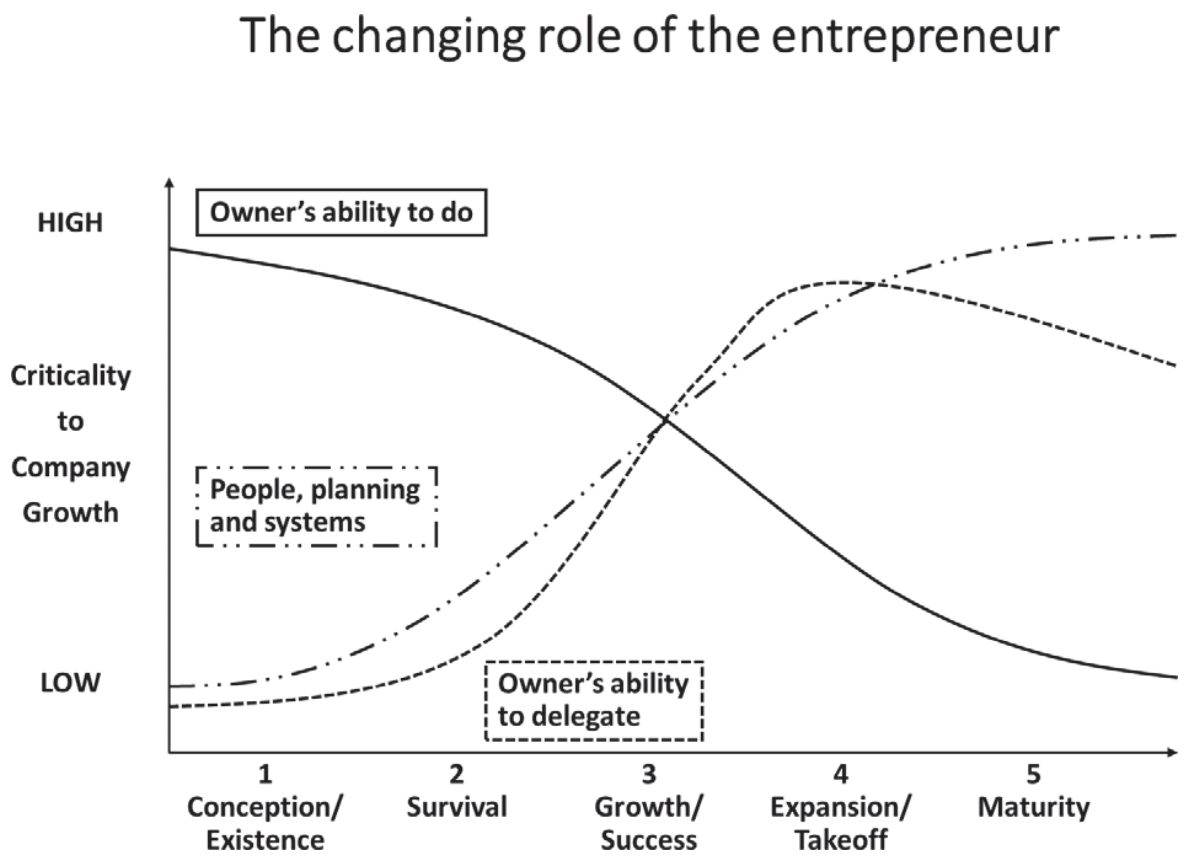

Figure 6. Change of managerial factors over time [39].

question was proposed to be included to the survey by the Association of Finnish Entrepreneurs!) was: "If your company suddenly got a sum of money that corresponds your last years sales revenue, what would you do?" [40] What was then the most popular answer?

Nr 1 (most popular) option*: "We would keep most of it as a reserve for future needs."*

The cause-effect or reasoning for such an answer was not conducted, but one can speculate with a few alternative reasons: (1) the 10-year economic downturn had consumed the earlier reserves and new buffers for bad times were really needed; (2) the companies do not find appealing opportunities to invest the money to and (3) the companies have no ideas that would need developmental investment into?

Nr 2 (second most popular) option: *"We would increase our investments."*

Nr 3 options (a draw between two options): *"We would pay back some of the debt we have"* and *"We would increase our innovation activity"*.

But there are entrepreneurs: and then there are growth-oriented entrepreneurs. Whereas the aforementioned choices of action were the ones surging among the whole sample of 500 SMEs participating, the action plans of the subset of companies identified (by their answers to other

questions) to be strongly growth aspiring. They would (1) Invest, (2) Innovate, and only (3) keep in reserve.

The last conclusion of the study in question is that companies and entrepreneurs do differ in their aspiration and willingness to grow. This may link to the markets they operate in and opportunities in there, but it may also be a personal value statement by the entrepreneurs in relation to growth. This view suggests that growth is not just a phenomenon; it is also a mindset. How are those "entrepreneurial mindset" and "growth mindset" then born and developed? In a study among the students (Business Administration, undergraduate level) that have participated in a specialization program of technology business and entrepreneurship and later engaged to a start-up activity as business owners of employees, Saukkonen [41] observed a gradual conversion into entrepreneurial activity through identifiable stages instead of a sudden decision to embark on an entrepreneurial journey. The key learnings and actions on this path were all related in mingling with entrepreneurs or other entrepreneurs-to-be via *networking, trying, and learning*. These findings hint that here might be more social elements in entrepreneurship development than in the traditional view concentrating on individuals alone.

3.7. Growth companies of today: Why and how do they grow?

Learning from the best seems at surface a natural and recommended way for an entrepreneur to grow from growth aspiration to growth that really happens. In the opening words of "Deloitte Fast 500 EMEA" report on high-growth tech companies. Bucaille points out that the four elements of growth capital, labor, knowledge/creativity and energy/resources are not enough to explain the difference between fast and slow growers [42]. High-growth companies [42] have created out of these a unique combination of value, often referred as business model. In addition, they have added a person-based flavor as a fifth element: leadership.

This opportunity of agile entrepreneurial firms of the new breed to take over the market from traditional players with a superior new value offering is not new. Harvard professor Clayton M Christensen made already at 1990s an interesting finding: When key technologies in an industry change, the dominants' firms in the "new world" are not the ones they used to be [43]. The industry originally under Christensen's study was external computer memories: disk and diskettes from 5.25 inch floppy disks to 3.5 inches, and then to hard disks, etc. Why do the best firms of their breed tend to miss the train of change, then? Christensen had altogether five complementary explanations for this. One of them states that *capabilities of an organization define its incapabilities*. Very few companies are brave enough to admit that a big part of their legacy in knowledge, practices, facilities, machinery etc. are not asset in the new landscape, but rather a burden that brings with them inertia—*force of slowness*. An entrepreneur starting from a clean slate has then an upper hand to react, adapt, and proact.

The same plot can be found in the early writings of the forefather of innovation theorists and researchers Joseph Schumpeter [44], who proposed at 1930s that at times every industry is shaken by waves of *creative disruption* that rearrange competitive positions and rewrite "the rules of the game" [39]. Mark Jenkins from the Cranfield University in England made a corresponding observation when studying the different eras of technical regulation and

competitive success between companies in Formula 1 car racing; technological evolution often means competitive revolution [45].

In the era of ubiquitous technology, these rules of the game change more often than ever before, so unforeseen entry and growth opportunities are available but so are the opportunities for sharp decline and death. Following the ideas of Cinzia Parolini [46], entrepreneurial opportunities can arise in various forms of value system re-engineering: Creating new activities into a value system or making some traditional activities is obsolete. In both cases, business model works, if it helps the whole value systems to reduce cost and/or increase the end customer value.

Deloitte [42] also makes a remark based on their reports and research that has spun over a decade: The quality of the high growers is largely based on the quality of their environment. Partners provide talent, expertise, revenue, research, and capital that are needed to fuel growth. Understanding growth of an entrepreneurial company should not forget the entrepreneur as an individual or the individual company that has set a goal to grow, but it should not stop there but look also around them.

To support their listings and aggregate figures of the selected growth awardees, Deloitte has at constant intervals looked at the root causes and affecting factors to grow by surveying the highest management (CEOs) of the high-growth companies.

The listings and company analyses are done by Deloitte in a yearly basis and available over the Internet to all parties interested. CEO surveys do not happen on a yearly basis for all major regions (Americas, Asia, EMEA), but in country level, there are unbroken time series in various countries. To highlight some main contents, here are some excerpts for the 2016 results: Growth continuum, sources, and hindrances of growth among the management of Turkey's Fast 50 technology business growers [43]:

- 85% of the CEOs believed they will maintain the high rate of growth (even though only 42% believed the economy in general will grow and only 9% that economy will grow substantially)
- 70% believed the growth can be continued organically, not by structural arrangements such as acquisitions
- the biggest single contributors to the past growth have been high-quality employees and exceptional/unique products created by them
- 61% believed they will grow their personnel between 1 and 25% - obviously in the digitalized world the growth and employment curves differ
- 64% list HR issues (finding, hiring, and retaining talent) as major challenge to growth
- 39% mention as the top personal challenge raising and delegating responsibility—moving from entrepreneurial management more toward an organization; the second one being reaching profitability—supporting the notion that growth is resource-demanding, and it fires back on profits that will follow only later on, so it is risky.

The finding gives support to the statement that growth is still even in the technology business sphere based on individuals. First, entrepreneurs are willing to explore, create, and take risk, and subsequently, growth is continued in the talented individuals that the entrepreneur is able to attract, motivate, and lead on the growth trajectory.

4. Case study: future growth of an entrepreneurial start-up and its impact on entrepreneurs

In a single case study, Saukkonen and Vänttinen [34, 47] assessed the suitability of models of growth dimensions, sources, and obstacles proposed by earlier research and literature to a case company: an entrepreneurial start-up company providing environmental technology for global business-to-business markets. Researchers used method of qualitative, interview-based data collection among the company's internal stakeholders and external business experts. Through an analysis of the obtained data, researchers drew conclusions of the compatibility of (some) earlier models to the unique case of new company growth.

4.1. How do prior-art models of growth suit true start-ups, specifically one operating in environmental technology business?

As a reflection of results vs. earlier models of venture growth, it seems defendable to state that the dimensions in Wickham model can be pictured from the research data, even in a certain sequential order: First, a strategic choice of (first) solutions to be completed is done. Second, the funding for the implementation needs to be secured, after which the (minimum) organization to accomplish the task is put together. Structural and organizational dimensions of growth combine the internal and external resources: The mission-critical parts are kept in the control of the company and complementary, but less strategic or innovative capabilities are extracted from the partner network.

The four first stages of the model by Marmer et al. were all referred to, but the events did not follow the sequential order. The studied startup company had simultaneous and parallel growth processes. The Greiner model-based discussion of crises stages and sources did not bring up relevant information. The sources of growth from the model by Greiner were clearly easier to discuss: "Customers are currently most important element for company growth" (Owner-Manager OM).

Despite the avoidance of the usage of expressions like "environmental technology" or "cleantech" in the spontaneous discussion, the special characteristics of the business segment were well visible. The specific context contained issues such as:

1. The unavoidable role of regulatory framework, or frameworks, when the company acts in multiple markets and many solution areas. The role of regulations and other interventions by governments and other public authorities serves both as enablers as well as obstacles for growth

2. A company operating in this segment has long lasting and tight connections with their stakeholder network. "You need have customer side for speakers for promoting your technology" (External Industry Expert, EIE).

3. The clock speed in environmental technology business differs from many other fields. The long development time of regulations (that affects the decision-making ability of the firms, suppliers and customers alike) was mentioned earlier as a source of slow clock speed. Other factors are related to the depth and volume of R&D before sales can be done. "Unit cost is pretty high when you are environmental and energy business. You need a real life demonstration, which is working … then pilot1, pilot2, ½ scaled unit and full scaled unit" (EIE).

4. The specific nature of the financial dynamics in this industry. The capital injections are needed early on, long before the sales revenue starts to act as a source of financial resource but "If we go in as an investor early on, the risks are humongous but so are the potential rewards. If later, the company value has gone up already, so the risk is lower but so is the potential multiple to your investment" (Venture Capital Expert VCE).

4.2. How are dimensions, sources, and challenges of growth interpreted and prioritized?

Despite the findings presented in the Chapter 3.1, where a clear order of the growth dimensions emerged from the data, separating the dimensions from each other seemed artificial to the interviewees. The different fields of the growth are intertwined, and the order of priorities was dependent on the financial status of the company. A single capital injection would have changed both the order and speed in which different dimensions develop. The volatility of a growth pattern is therefore clear.

Strategic decision-making was seen as the key foundation for all other areas of growth across the respondent pool, but views on what makes "growth" in strategic terms differed a lot. For some respondents, growth in strategic dimension was a synonym to having a wider offering, whereas to some, it was more of narrowing and focusing. In enhancing the value of the company to its owners and customers, the innovativeness acts in controversial manners. To attract a portfolio of customers and fulfill multiple needs, strategic choice of having one main solution to offer was regarded as a risky option. "To me having different solutions for different end-users gives more options to customers to choose from" (Sales and Marketing Professional SMP_2). On the other hand, limited resources must be well addressed to limited number of directions, as there is a need for efficiency from early on. Investor view preferred a clear focus: "In early stage, the way you should have a fairly limited portfolio. You better be somewhat single-minded. But all products and services have a life-cycle, so the portfolio needs to grow and renew over time. However, the portfolio growth should not kick in before break-even" (VCE).

One way to impact the business portfolio and also the structure of the revenue streams would be to move from mere product supplies to product-service system (PSS) bundling services to the technology supply and thus allow the company to better fund its development organically: "By adding services like operating the plants on behalf of the customers is a future way of improving the constant cash flow. The margins are different to tech supplies but so is the

predictability. And the purchase threshold for services is lower than that of buying hardware—the latter one has a life cycle of 30 years" (Founder-Owner-Manager FOM). This means that growth models should avoid labeling the firms studied to product or service companies but rather see how those two basic business types can be combined.

One difficulty to adopting Wickham's model was the networked in which today's companies operate. Talking of growth only within company boundaries felt falling short: "Ecosystem is needed for real size unit: sustainable production, sustainable fuel supply security, logistics, maintenance … you cannot do it yourself" (EIE). In manufacturing companies, the trend of outsourcing the manufacturing and thus reducing capital needs has been a long prevailing trend. Based on the case study, outsourcing without holding a control over operations grows the risk. "Own manufacturing is not a red flag to an investor, if that is needed to control the entire process in its critical parts" (VCE). The views of the internal and external interviewees matched in this respect. "Own manufacturing is a strategic choice. I want to reduce the risk by having a clear and firm view on what is happening, I know and can promise the delivery times we can do. This may change over time, but at this point we do want to have a tight grip on the process" (FOM). The usage of subcontractors and many of them may seem a good risk-aversion policy, but it may contain a strain to company resources: "The wider the network, the higher risk of quality issues and delays. And truly managing a supply chain of networked companies is rare and demanding skill" (VCE).

4.3. Entrepreneur's changing roles and capabilities

The external experts in the sample put more emphasis on the traditional management skills—process and systems management—from early on than in-house respondents. That gives support to Start-Up Genome Report [27] findings that if processes are not efficient and the scaling up occurs, the phenomenon Premature Scaling is a potential misstep on the growth path. A remark made underlined that the processes should not be seen from only engineering angle but instead "There must be a sales process from early on, who sells and how. If I do not get that I cannot invest" (VCE, Venture capital expert). The later decline of the importance of mastering processes and systems (as seen by external experts) should be looked at in conjunction with their views of the changing role of the entrepreneur (**Figure 7**).

Figures 8 and **9** show how the interviewees—internal vs. external—saw the role of the entrepreneurs to change over different development stages. There were some surprising findings between the two groups (internal vs. external) as well as when compared to the original model by Churchill and Lewis.

The external experts clearly expressed that the ability to delegate has to start early on and owners' own ability to do starts diminishing also at an early stage. The need to delegate is also a concern of entrepreneurs in the case company: "It's a dilemma that too much is in our hands and we don't have enough time to handle everything … we really in the process how to delegate and to whom, it's the huge challenge for us" (OM). Ability to delegate is also a part of process management capability, and it also touches the network partners of the company: "To delegate is to co-operate" (Business Development Expert).

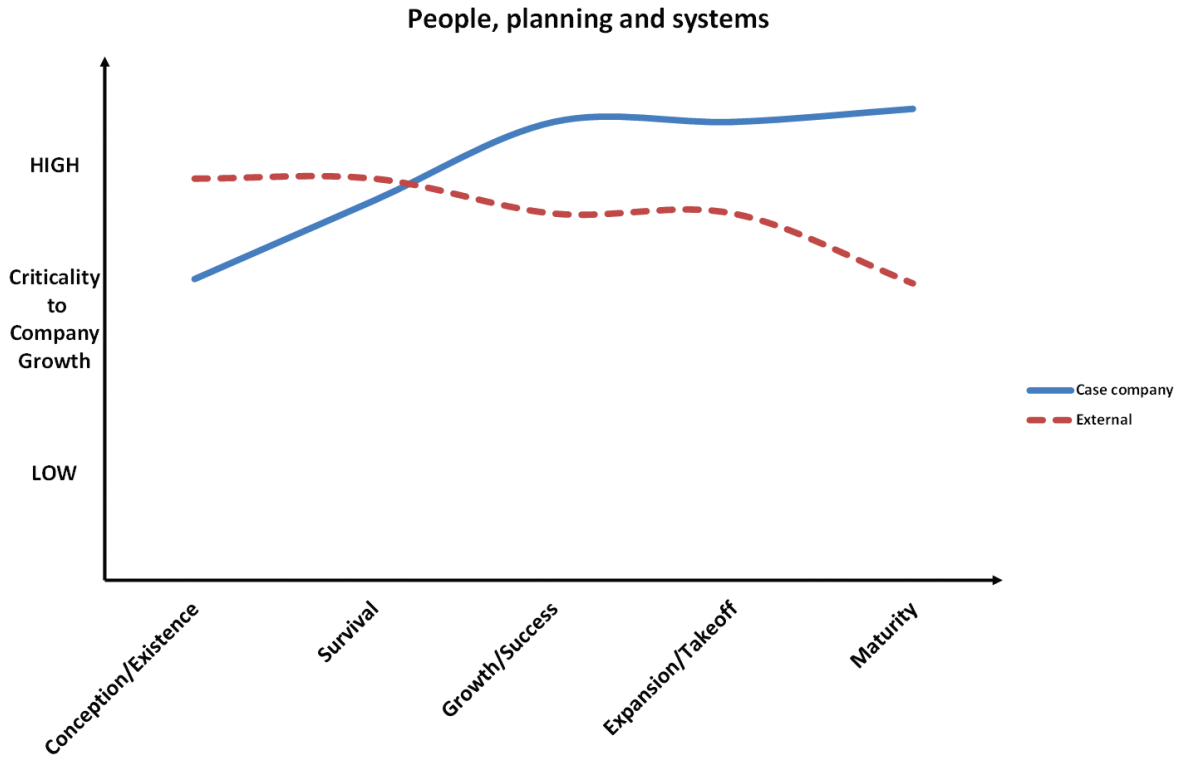

Figure 7. The changing criticality of skills in process, people and systems management following the model by Churchill and Lewis—averages of the graphs drawn by informants in the interview sessions.

An important challenge for the entrepreneurs seems to arrive, when the company reaches some level of maturity. Managing company at that stage differs from start-up management. New skills are needed, and new angles to look at the company must be established. In addition to funding rounds, there should be management upgrading rounds: "Management and funding should update many times in growth company … management and funding are the sources of crises. Aspiration to company growth is of high criticality to company growth" (Business Development Expert, BDE). If the aspiration diminishes, the company can start to stagnate. Both respondents that have an entrepreneur role in the case company wanted to keep us a start-up mentality in the firm they manage: "I want to see this as an eternal start-up but the term can perhaps not be used for a very long time" (Founder-Owner-Manager FOM). "I don't want to be in mature company, I want to develop" (Owner-Manager OM). Their views were supported by the VCE "Thing to keep as long as possible from start-up is the entrepreneurship spirit, but it must be combined with growth in leadership skills" and BDE: "renewal is needed in growth company … is it synonym for continuous start-up".

4.4. Can the growth be maintained?

One of the iconic figures in 1990s–2010s corporate management and leadership Steve jobs has been quoted to describe Apple Inc. as an "eternal start-up". Being the member of the original founding team, Jobs enjoyed and kept up an entrepreneurial relation to Apple despite its growth into a global corporation.

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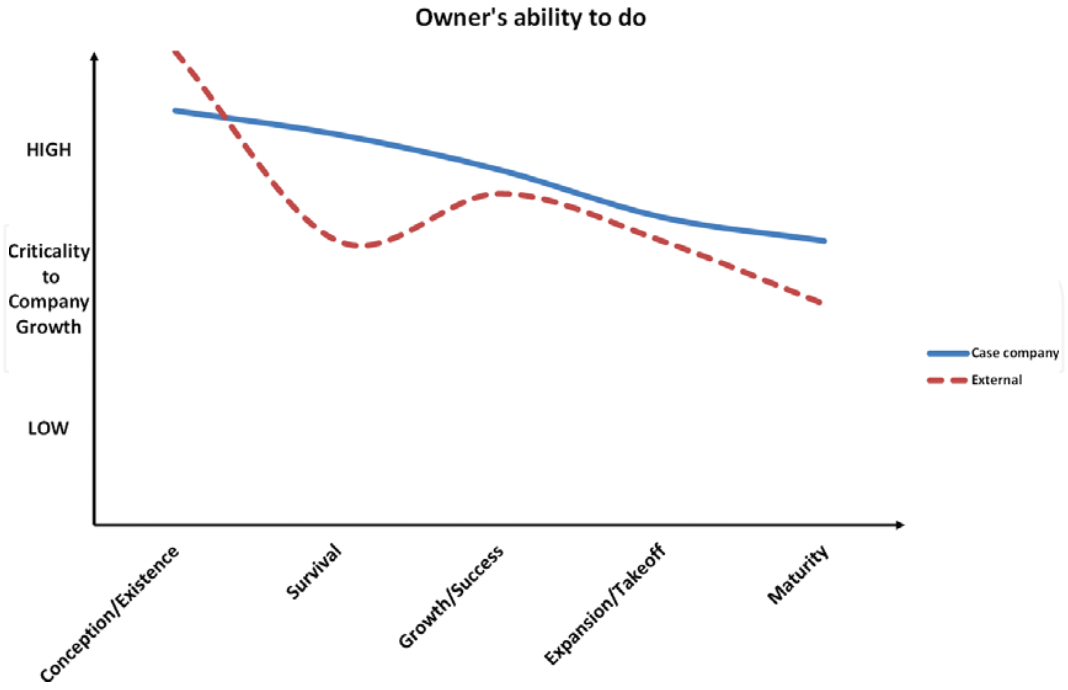

Figure 8. The changing role of the entrepreneur across the development stages (1) following model by Churchill and Lewis—averages of the graphs drawn by informants in the interview sessions.

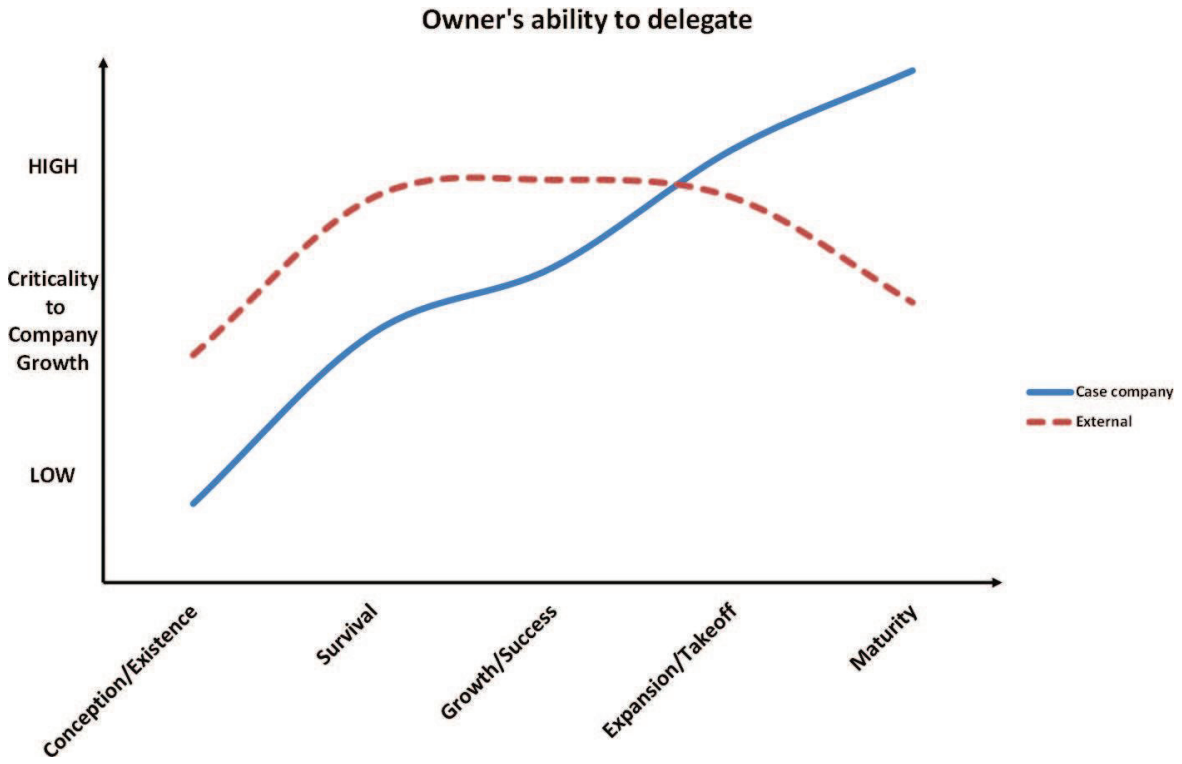

Figure 9. The changing role of the entrepreneur across the development stages (2) following model by Churchill and Lewis—averages of the graphs drawn by informants in the interview sessions.

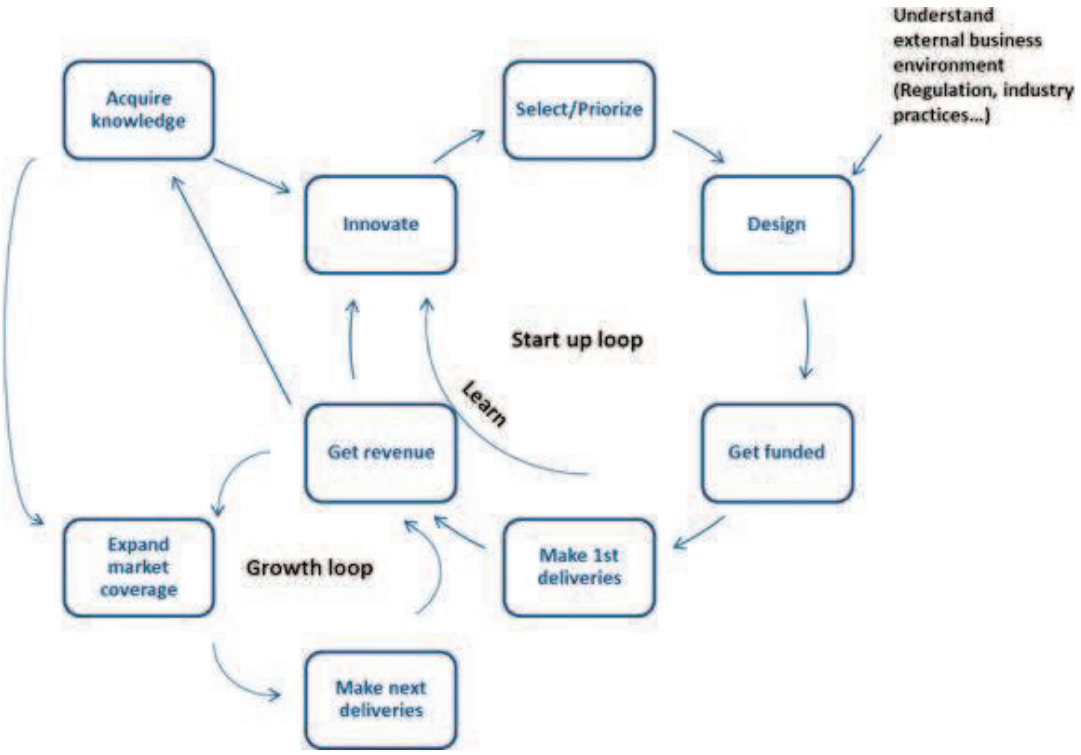

Figure 10. The cyclical two-loop model of growth and development Saukkonen & Vänttinen, [34].

Interestingly, the same echo of never ending growth was heard in the young and small aspiring company studied in the case. Based on the case study findings, it can propose a replacement of linear or at least sequential growth construct model with a more cyclical model (**Figure 10**). The model highlights the finding that an innovation-based company needs to simultaneously run processes leading to scalable and optimized processes ("growth loop") and keep on a new venture-type search of novel ideas ("start-up loop").

5. Conclusions and discussion: future of growth

The conclusions of this full chapter are:

- Growth in an entrepreneurial company is a relative, context—and stakeholders´ expectation—based phenomenon.
- Factors in the resources, market opportunities, and personal aspirations affect the stance taken toward growth as well as its directions and speed of growth. No single model to describe growth in an entrepreneurial firm can be found, the growth has individuality in it. Based on the case research findings, it can be also stated that search for one best model of growth for a single start-up venture is not a viable effort. Instead, various models should be studied and utilized. Researchers as well as business developers aiming at growth should identify the most relevant elements of these models to the case in question

as well as the context in which the companies operate. Industries have their specific features that should be woven into the models for company growth in that sector.

- The models of growth do have their role: the phenomenon is better understood and acted upon by having a wide and versatile supply of models that contribute to the understanding of the phenomenon and individual cases. The research findings and the proposed new cyclical model of start-up growth in environmental technology business developed give support to the view presented by Levie and Lichtenstein [20]. Stage-based models have clarity and structure but reflect poorly growth business reality that is made of uncertainty, loops, and flexibility. Newer models such as the one by Marmer et al. acknowledge the importance to pivot when necessary and to find new directions by revisiting the work done in earlier phases when the development stagnates. The growth stagnating can be a result of both internal reasons as well as external feedback.
- Growth should be seen as a vehicle of reaching something by action rather than as an end result of action.
- Companies in the growth mode identify the sources, enablers, and obstacles to growth largely in a same manner, giving support to views that studying growth companies can serve as an agent for future growth.

In addition, it is not enough for companies to recognize the developmental phase they are in but also to develop and implement strategies to tackle the challenges viable to the industrial context they live in and taking in account the resources of the company, its entrepreneurs, and value network.

Various megatrends suggested to act as drivers of global change such as Globalization, Digitalization, Acceleration and Network organizing [47, 48] can be seen to offer wider and faster opportunities for growth than the past periods of time. New industries and markets are developed to a remarkable size at higher and higher speed. In the world of virtual goods memes, network externalities, low (capital) barriers to entry and viral spreading all seem to point out that growth is better available for all than we are used to.

An example of such a mushrooming market is mobile gaming, which in the first quarter of 2017 showed 53% growth to previous year [49, 50]. The global yearly revenue at the sector globally was predicted to reach 46 billion USD for 2017 and to grow to 64 billion by 2020 [51]. The other side of the coin of hypergrowth is the hypercompetition. It can be estimated that the supply of the games available at this moment (mid-2017) exceeds 1200 new games *per day* coming to the market via the two main platforms iStore and Google Play. This means a monthly growth in supply of approx. 40,000 new options for customer to choose from on top of the existing ones. Naturally new products and companies can only succeed, if the customers abandon earlier games they played. Major trends in the future of growth might be *polarization* and *volatility* of growth. The new world may give an unprecedented opportunity to grow for some, leaving a very minor role for the rest. Ideas of reaching massive consumer bases with low-cost pricing strategy applied, e.g., by Spotify for streamed music leaves very limited opportunities for profitability to nonhypergrowers.

Technological advancement is another Janus-faced force that affects firms aspiring to grow. The global availability of digital technologies and the opportunities they give to spread the

new solutions seem to favor growth. Simultaneously, the abundance of technologies is making the right choices regarding technologies both complicated, risky, and short lived. The megatrend of acceleration means the birth and growth happen at faster pace but so do decline and death. The accelerating pace of change referred as "increased clockspeed" by Fine from [52], and the increase in the sheer amount of potentially transformative and often intertwined technologies has made technology anticipation more complex. Global ICT consultancy firm Gartner publishes their "Hype Cycle curves" of emerging technology areas and particular technologies. As the representative of Gartner, J. Fenn coined the purpose of them: "Hype Cycle for Emerging Technologies targets strategic planning, innovation and emerging technology professionals by highlighting a set of technologies that will have broad-ranging impact across the business" [48]. Gartner publishes both broad and more specific Hype Cycles. There are close to 2000 individual technologies under Gartner's radar [53].

Investing money and effort to technologies in their early stage sounds a risky choice. But it is also risk baring for a company to wait until a technology reaches the more predictable development stage. Acting first in a stage where more and more insights of how the technology can benefit the company start to crystallize, and the whole value chain and customer-base means the competitive advantage potential for a company has vastly diminished. One interesting line of research could be studying the means entrepreneurs are trying to balance the growth of business value and the risk that growth bears. One approach to this direction is the framework by Skok [54] based on his view that increasing of the value and reduction of the risk are key targets for any start-up management. He linked some key events or artifacts (**Figure 11**) that lead to success in relation to these two targets. Empirical research on that framework would

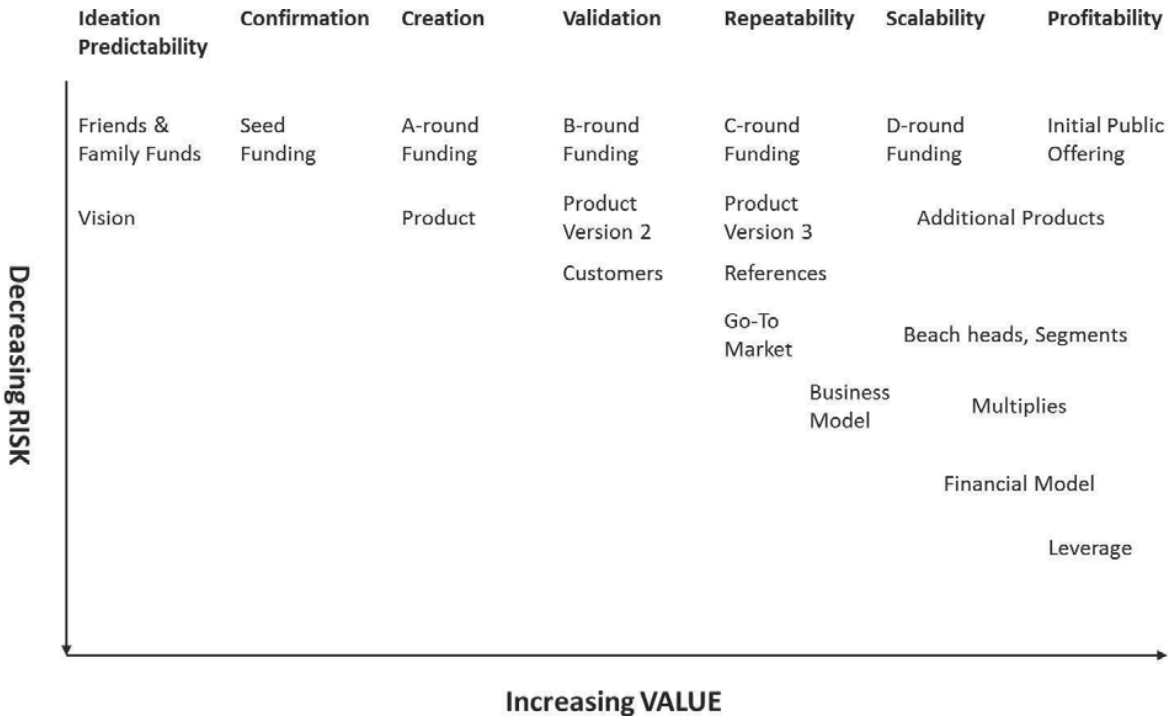

Figure 11. Key artifacts and events in risk/value framework across development stages (Skok [54]).

however require an opportunity for a longitudinal study with close involvement to the decision-making process of the studied growth companies.

Perhaps, growth has never been democratic but in the future perhaps even less so. The shortened life cycle of products may also lead to short-living companies. We all know "firefly products" that shine bright and short. Will the business climate of future be apt for firefly companies as well?

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