THE COMMERCIALIZATION OF TECHNOLOGICAL INNOVATION BY GROWTH ORIENTED FINNISH START-UPS

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ABSTRACT

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The purpose of this thesis was to study how to commercialize a technological innovation by a growth-oriented start-up company. The aim was to have a deeper understanding of deployment strategies and what challenges and risks are related to the commercialization process and how they can be overcome. The thesis was commissioned by a Company X, which is a start-up company itself and has recently launched its innovation in the domestic market and plans to scale-up to the international markets.

The theoretical part introduced first the concept of start-up and start-up ecosystem in Finland. After that the literature review presented the strategic management of technological innovation. This part included the basic concepts of innovation, innovation process and intellectual property rights and continued further exploring successful innovation team, value creation process, business model planning and strategies for commercialization. The thesis used a qualitative research method conducting a case study, where the data was collected through semi-structured interviews from eight respondents and analyzed following content data analysis process.

The findings proof that there is no single solution, how to commercialize technological innovation successfully but there are several strategies, which can be also combined. It is a strategic choice, which will impact the company’s business model and how it will define and develop its value proposition, customer relationships, key activities, key resources, key partners and channels. The research results suggest that the main challenge of commercializing a technological innovation is to proof a scalable solution and implement the transfer from pilot scale to industrial scale, which is required to bring the company to the next level.

Key words: technological innovation, start-up, commercialization, scale-up
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### ABBREVIATIONS AND TERMS

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BI</td>
<td>Born Internationally refer to companies that rapidly internationalize within their home continent and make over 50% of their sales outside the domestic market.</td>
</tr>
<tr>
<td>BG</td>
<td>Born Global refer to companies that make over 50% of their sales outside the home continent within max. 15 years.</td>
</tr>
<tr>
<td>EU</td>
<td>The European Union</td>
</tr>
<tr>
<td>NDA</td>
<td>Non-disclosure agreement</td>
</tr>
<tr>
<td>IPO</td>
<td>An initial public offering is when a private company or corporation raises investment capital by offering its stock to the public for the first time. Growing companies seeking capital to expand are those that generally use initial public offerings, but large, privately owned companies or corporations looking to become publicly traded can also do them.</td>
</tr>
<tr>
<td>IPR</td>
<td>Intellectual property rights</td>
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1 INTRODUCTION

Companies operate in the business environments, which are nowadays more and more global, they face fierce competition and technological development is reducing the life span of products. Therefore continuous improvement and innovation are necessary to succeed in the business in the long run. The pace of change is rapidly growing and will continue to do so bringing new opportunities in many industries.

Innovation is the core of each start-up company, which is trying to solve a problem and deliver new customer value. Innovations can be incremental, improving existing products, services and processes or transformational, often called also disruptive, such as a new technological breakthrough or business model. Many start-up companies target to make an impact and change the existing systems with their innovation even on a global scale. Especially the climate change and the global population growth are driving for sustainable innovations with global impact. According to Hitchcock and Willard (2009) some of the hottest growth industries in the manufacturing sector are part of clean-tech industry, which crosses over multiple sectors including renewable energy, cleaner transportation, water conservation and materials engineering. They share a focus on making money from innovations that reduce pollution and conserve natural resources. (Hitchcock & Willard 2009, 55.) The transformation from linear to circular economy has begun in several industrial sectors. Other megatrends such as digitalization and globalization are also drivers for start-up companies as these enable even small companies with ambitious growth targets to scale-up to the international markets. These start-up companies have unique possibility to become born internationals (BI) and born globals (BG). However, the early stage challenge for each start-up is to make its’ innovation commercially successful and then build a scalable business model to international markets.

When planning a go-to-market strategy for a new market, it is important to define the following things regarding the company’s objectives: target market and customers, as well as value proposition for customers, and which product, service, or product portfolio to introduce on the new market. It is also vital to consider business model, distribution channels, and logistics, without forgetting complementary services and marketing – and of course the necessary resources to carry all this out. (Business Finland Go to market 2018.) Internationalisation is a pre-requisite for growth-oriented start-up companies due to small
home market in Finland (Lahtinen, Pekkala, Halme, Salminen, Härnälä, Wiikeri, Lamminkoski, Lähde, Mikkelä, Rouvinen, Kotiranta, Pajarinen, Dalziel, Barge, Meade & Zhao 2016, 11). There are various business models for internationalization ranging from traditional export business to international partnering and the choice is obviously one the critical strategic decisions for a start-up company. It is typically a very company-specific process and there is no one size fits for all-solution. (Honkinen, Innanen, Lindgren, Pello, Rantanen, Siltala & Tuomala 2016, 157-159.)

The start-up companies are surrounded by continuous uncertainty, which is related to many things such as feasibility of the innovation, market acceptance and market size, business model validation and lack of human and financial resources. The start-up ecosystem in Finland has developed well during the past decade and provides a lot of support for start-up companies in terms of finance instruments, consulting and networking. The positive progress is driven by the political actions and various clusters or ecosystems, which connect companies in different stages as well as other institutions.

The focus of the thesis is on the commercialization of technological innovation by a growth-oriented start-up company, which is targeting to the international markets. The recent hype on start-up business in Finland has been very much around digitalization, which is characterized by quick commercialization, low investment needs and easily scalable business models and thus considered very attractive business. Whereas the technological innovations (physical product or production technology) require more capital for development process itself and traditional investments in manufacturing lines, facilities, organization, sales and distribution channels and so on. Time to market is relatively long and the speed of expansion is slower than in digital or service-oriented business. Therefore the financial risks are also much higher and it is more difficult to attract investors in the early stage.

The thesis aims to identify the key factors of successful deployment strategy of technological innovation. The topic is limited to start-up companies, which innovation is technological meaning that the selling object is either a physical product, manufacturing line or manufacturing method. Geographically this is limited to the companies, which are registered in Finland. The aim is to produce new knowledge about the successful commercialization approaches and to collect experiences about the challenges, which are faced during that process and how the start-up companies overcome them. The empirical results
will be reflected to the theoretical framework and thus the starting point for the research is to form points of views to the chosen subject. The empirical research will be carried out by interviewing start-up companies in Finland, who have innovated in the field of sustainable products, concepts or related production technology. The objective is to analyse what options there are to commercialize the innovation, how to scale-up to the international markets and what challenges they have faced so far or foresee in the near future.

The main research question is identified as: How to commercialize a technological innovation successfully by a growth-oriented start-up company? This is further elaborated with supporting questions such as:

- What kind of go-to-market strategies there are?
- What is the importance of timing of entry?
- What are the main challenges and risks when scaling up to the international markets?

Following the research process presented by Eriksson, Kovalainen and Kovalainen (2008) the research of this thesis was made in four steps. It begun with the literature review and writing the theory part. The next step was to contact the data resources or interview respondents and collect the actual data through interviews. This was followed by the data analysis and interpretation and finally the process was completed with drawing findings and conclusions. (Eriksson et al 2008, 30.)

FIGURE 1. Research process (Eriksson at al 2008, modified)
The thesis consists of six chapters. Chapter 1 gives an introduction to the thesis topic, the research process and the research questions. The literature review as theoretical framework is divided into two parts. Chapter 2 introduces the idea of start-up and its characteristics, followed by the presentation of start-up and innovation ecosystem e.g. public sector players, start-up services and support programmes in Finland. Chapter 3 introduces the concept of innovation, the intellectual property rights as a tool to protect the innovation and the benefits to the start-ups, the characteristics of successful innovation team, and the innovation process focusing on the commercialization part by introducing the value creation process and different strategies to deploy the innovation. Chapter 4 describes the methodology including the research strategy, the data collection and analysis methods and the quality of the data. Chapter 5 presents the results of the company interviews. Finally, Chapter 6 discusses the comparison of the empirical results to the literature review and concludes the study summarizing the thesis, discussing the limitations and suggesting further research around the topic.

The researcher has a genuine interest in the topic while working herself in a start-up company, which develops a technological innovation and targets to international markets. Therefore the view-point of the thesis is operational. The thesis topic is topical as there is a very active start-up ecosystem in Finland, which is related to solving sustainability issues with huge global growth potential. It is also considered as practical as the research problem is about strategic choice, which every growth-oriented start-up company should be able to answer during the company’s transition from introduction to growth stage. Therefore the thesis is expected to be of interest to management of other start-up companies and other stakeholders in the innovation ecosystem as well. Hopefully it will give further insight about the critical elements of commercialization and help to succeed in the process.
2 START-UPS AND THE ECOSYSTEM IN FINLAND

2.1. Start-up company

There is no exact definition for a start-up company and not all new companies are start-ups (Honkinen et al 2016, 11). Start-up companies are typically young, technology-oriented companies, who have a new and different business idea and their target is to grow rapidly to international markets (Perustamisopas alkavalle yrittäjälle 2017, 12). Neil Blumenthal defines it as “A start-up company is a company working to solve a problem where the solution is not obvious and success is not guaranteed”. Eric Ries emphasizes the uncertainty in his definition “A start-up is a human institution designed to deliver a new product or service under conditions of extreme uncertainty”. (Honkinen et al 2016, 16.) Start-up company can be also a knowledge-intensive spin-off or spin-out, which originates for example from corporate business or public or private research organization (Kankaala 2005, 19).

There are at least following characteristics in common for start-ups: strong or even explosive growth, scalable and profitable business model, and target to exit or make an IPO. Typical life time of a start-up company is 3-5 years with the exception of those, which require a very long research and development time e.g. medical start-ups. Following Honkinen et al (2016) the development of a start-up company can be also described as problem solving and market evaluation, rapid growth and exit presented in figure 2. (Honkinen et al 2016, 12-16.)

![FIGURE 2. Development of a start-up company](image-url)
Honkinen at al (2016) define the start-up company’s life-cycle further in the context of growth and funding in figure 3 (Honkinen et al 2016, 67-70).

![Life cycle and funding serieses of a start-up company](image)

**FIGURE 3.** Life cycle and funding serieses of a start-up company (Honkinen et al, modified)

### 2.2. Start-up and innovation ecosystem in Finland

Finland is a small economy with a population of 5.5 million people and annual GDP of 251,885 million dollars. The exports amount to 67,876 million dollars or 27% of GDP in 2017. (Country Economy: Finland.) However, Finland is considered as Innovation Leader with innovation performance well above the EU average measured on 27 indicators (European Innovation Scoreboard 2018).

Research, development and innovation activities are important for the national economy and people’s wellbeing in general. The effects of innovation activity spread widely across the economy and society, increasing wealth and boosting employment and the vitality of the regions. (Business Finland Innovation Activity 2018.) Therefore it is of public sector’s interest to enable and encourage innovations by research and innovation funding, innovation-friendly legislation and environment, and the development of cooperation networks and platforms. The Ministry of Economic Affairs and Employment is responsible
for preparing and implementing Finland’s innovation policy. The Research and Innovation Council, chaired by the Prime Minister, coordinates the development of Finland’s innovation system. Furthermore, the EU is a significant innovation policy player, especially through its research and innovation program Horizon 2020, which is the biggest of its kind in the world. (Innovation policy.)

Team Finland is a network of public sector actors providing internationalisation services. The network consists of the Ministry of Economic Affairs and Employment, Ministry for Foreign Affairs, Ministry of Education and Culture, Business Finland, Finnvera, Tesi (Finnish Industry Investment), Centres for Economic Development, Transport and the Environment, Finnish Patent and Registration Office, Finnish-Russian Chamber of Commerce, Finnish-Swedish Chamber of Commerce, VTT Technical Research Centre of Finland, Finnfund, Finnpartnership and Finnish Cultural and Academic Institutes. The aim of the network is to provide businesses with a smooth service chain, ranging from advice services to financing. The network offers tailor-made service packages for companies’ internationalisation needs based on the services provided by the network actors. (Team Finland.)

One of the most important actor in the network is Business Finland, formed through the merger of Finpro and Tekes in 2018, who is an accelerator of global growth. Their strategy is two-fold: enable companies to grow internationally and also create world-class business ecosystems and a competitive business environment for Finland. Their services include funding for research, product and business development; boosting of innovation-based export growth, acceleration of internationalization and help in networking; discovering and testing opportunities; supporting go-to-market and scaling up phases. (Business Finland: About Us.) Business Finland runs theme-specific programs, which are related to bioeconomy and cleantech. As an example, the Innovative Bioproducts program, is organized to help Finnish companies to enter growing markets, accelerate international growth, and support companies’ readiness to succeed internationally (Business Finland Innovative Bioproducts 2018). Annually about 100-200 or 3-4% of start-ups receive funding from Business Finland in average 142 000 euros, but growth-oriented start-ups even more 232 000 euros in average. This is very important and often critical form of funding as less than 1% of start-ups receive private equity. (Lahtinen et al 2016, 22.)
A new phenomenon is a wide range of start-up services and support programs available for the companies. Most of these services have been established during the 2010’s and they are located in the Helsinki region or in other university cities in Finland. The services are widely used also by the start-ups, who are already scaling-up and/or in the internationalisation stage. (Lahtinen et al 2016, 104-105.) Table 1 presents the start-up services, actors and roles (Lahtinen et al 2016, 100-101).

TABLE 1. Start-up services, actors and roles

<table>
<thead>
<tr>
<th>Actor / Role</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-incubation programs</td>
<td>Target is to form new companies or team by bringing diverse resources, people and know-how together. Operated often in connection with universities. Short events or longer courses.</td>
<td>Startup Weekend, Startup Next, Summer of Startups, Proakatemia</td>
</tr>
<tr>
<td>Incubator</td>
<td>Development and growth of early stage start-ups by providing information services and resources such as offices and equipment. Often publicly financed and operate in connection with universities and technology and science parks.</td>
<td>Start-up Sauna, VTT Ventures, Spinno, New factory, Bio Incubator</td>
</tr>
<tr>
<td>Accelerator programme</td>
<td>More focused and specialising in the most potential companies with scalable growth. Organized by investors, corporates or public actors.</td>
<td>Vertical, Techstars Accelerators, Green Tech Challenge</td>
</tr>
<tr>
<td>Venture accelerator</td>
<td>Typically private and profit-targeted teams, which invest in the most promising start-ups and offer their own expertise. Operate often as a continuum of accelerator programme or in combination with that.</td>
<td>VIGO, Reaktor Ventures, First Round, Techstar Ventures</td>
</tr>
</tbody>
</table>
Co-working spaces | Open co-working spaces and other services such as internet and cafeteria against monthly fee. Courses, trainings and networking events are often organized. | Microsoft Flux, Kora, Business Kitchen, Startup Farm, WeWork |
--- | --- | --- |
Start-up hubs | Group of very diverse actors and events, which target to bring different players of start-up ecosystem together. | Meetups, Hackatons, Festivals (ex. Slush) |

According to the report “Growth factors and bottlenecks for business start-ups” there are about 4000-5000 new start-up companies registered annually and they present about 5% of all companies in Finland. Majority about 70% of the companies operate in the service segment and the rest 30% in the information intensive segment. About 70% of all start-ups survive at least for five years, however it is notable that only 6-7% of the start-ups achieve a moderate growth within three years. By Eurostat definition only 1% of all the start-ups can be defined as higher level technology companies, but these are more growth-oriented than the start-ups in average. The employment of growth-oriented start-up companies increases to five-fold during the first five years. (Lahtinen et al 2016, 16, 21, 25, 31.) The start-up dimensions in Finland are presented in figure 4 (Lahtinen et al 2016, 16).

FIGURE 4. Start-up dimensions in Finland
3 THE STRATEGIC MANAGEMENT OF TECHNOLOGICAL INNOVATION

What is an innovation? What is an innovation process? This chapter explains the innovation by introducing some different definitions from the literature review, explains how to protect the innovation with the means of intellectual property rights, describes the development or innovation processes highlighting the final part, commercialization and how to make it successful.

3.1. Innovation

Traditionally innovation is defined as commercially successful new product, process, service or concept. According to Finnish national innovation strategy the definition has been extended from the earlier so called technology-oriented innovation to utilized capability-based competitive advantage. This can be built on new technology application, new service and business models, working and operating procedure or product concept and brand management. (Fogelholm 2009, 13.) Carlson and Wilmot define innovation as a process that turns an idea into value for customer and results in sustainable profit for the enterprise (Carlson & Wilmot 2006, 4). Innovations can be developed from many sources like technology, process improvements, business models, cost of labour and so on (Carlson & Wilmot 2006, 41). Schilling defines a technological innovation as an act of introducing a new device, method or material for application to commercial or practical objectives (Schilling 2013, 1).

Innovations may result from diverse sources e.g. systematic new product development processes, research programs or private inventions. Often there is a clear need to differentiate or to lower cost in order to outperform competitors. Sometimes there is an existing problem in the market, which needs to be solved. Innovation can be also something, for which there is no market existing yet but it will be created over time. Innovations can be classified into six categories according to the degree of newness to the company and to the customer as shown in figure 5 (Hooley, Piercy & Nicoulaud 2012, 339).
The strategic role of new product types varies greatly and only those, which are new-to-the-world products can exploit technology in a novel way, pre-empt competition or segment of the market, enter future or new markets, and maintain technological leadership (Hooley at al 2012, 340). More specifically, technological innovations are often categorized by using the following four dimensions according to Schilling (2013):

1. Product innovation vs. Process innovation, which are both extremely important to an organization’s ability to compete and which often occur in tandem.

2. Radical innovation vs. Incremental innovation, which consider the degree of differentness and newness compared to existing practices. The radicalness of innovation can be defined in terms of risk as well. However, it is relative and may change over time or with respect to different observers.

3. Competence-Enhancing innovation vs. Competence-destroying innovation, which build on or makes obsolete existing knowledge and skills.

4. Architectural innovation vs. Component innovation, which consider the impact level of overall design or configuration of a system or the way its components interact with each other. (Schilling 2013, 46-49.)
The term “disruptive” is often used in the context of innovation too. Disruptive innovation is defined as a process where a smaller company with fewer resources is able to successfully challenge established incumbent businesses (Christensen, Raynor & McDonald 2015, 4). They originate in low-end or new-market footholds that incumbents overlook (Christensen et al 2015, 5). The essence of disruptive innovation is the creation of something new with the aim of to replace what already exists (Wördenweber & Weissflog 2005, 12).

3.2. Intellectual Property Rights (IPR)

In the start-up context the role of immaterial property is substantive. The immaterial property can be for example an idea, research result, design, technological innovation or brand image. This is often the only asset that the company has in the early stage of its life cycle and it serves as a basis for the whole business.

Whether and how to protect the technological innovation is a crucial element of company’s innovation strategy. Some technological innovations are difficult to copy due to tacit or socially complex knowledge. However, many innovations are relatively easy to imitate and therefore legal protection is often employed to protect the innovations. (Schilling 2013, 182.) Honkinen et al suggest that IPR will also guarantee that the start-up company can grow and expand to different geographical areas and the company’s business can be successfully continued for example after an acquisition (Honkinen et al 2016, 15). IPR is not only about protecting own innovation, but also enables the company to act in case of violating actions by other companies (Honkinen et al 2016, 81).

According to Fogelholm a technology-based innovation is understood as physical product, method or new technology, which is industrially protected with patent (Fogelholm 2009, 13). Innovation must be useful, novel and not obvious to be patentable (Schilling 2013, 183). Common way is to apply for a patent of technological innovation, however this may not be sufficient in early stages of development. Through legal agreements, such as non-disclosure agreements (NDA) or development agreements with confidentiality provisions and rights of control of technological intellectual property, the inventor is perhaps more willing to share information to an external party. (Touhill, Touhill & O’Riordan 2008, 12.) Other agreements may also contain a non-disclosure clause e.g.
employment, consulting, partnership, investment, license, acquisition, subcontracting and different collaboration agreements (Honkinen et al 2016, 121).

In general, IPR is divided into copyright and industrial property rights. The industrial property rights - patents, utility models, trademarks and design - are means to protect, manage and commercialize the results of development work. The owners of IPR’s have legal right to deny others to utilize as well as to grant a licence to utilize the object of the rights such as technology, brand or design. Industrial property rights play an important role particularly in product development and marketing, both in Finland and on the international market (Finnish Patent and Registration Office, IPR Information for SME’s). It is vitally important for a start-up to create immaterial property and consider it as an investment, which increases the company value (Honkinen et al 2016, 15, 80).

The list of advantages that a patent can give to the business is presented in table 2 (Finnish Patent and Registration Office, Protect your invention).

**TABLE 2. Advantages of a patent**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing</td>
<td>Patents are important to your marketing because they put “an innovative label&quot; on your product, which may increase its value.</td>
</tr>
<tr>
<td>Value of your business</td>
<td>Patents are used as one factor when assessing how much a business is worth.</td>
</tr>
<tr>
<td>Attractiveness to investors</td>
<td>Capital investors do not normally invest in businesses that do not have an appropriate patent strategy.</td>
</tr>
<tr>
<td>Source of income</td>
<td>Licence fees can be an important source of income to your business.</td>
</tr>
<tr>
<td>Strategic benefit</td>
<td>Patents are an integral part of a business’s IPR strategy, together with other forms of protection such as the design right and trademark.</td>
</tr>
</tbody>
</table>
Due to the fact that patenting is an expensive process and as the financial resources of a start-up company are always limited, it is advisable to use a patent attorney. Patent offices provide with professional services in wide areas e.g. in the initial novelty search, application process, management of IPR portfolio, drafting agreements and competitor monitoring.

3.3. Innovation process

In order to manage innovation systematically, it should be seen as a process, which consists of several steps that must be thoroughly planned and implemented. The product life cycles are presented by Stutely (2002) in five stages: Development, Introduction, Growth, Maturity and Decline. When looking more specifically at the new product development, it is traditionally presented in seven linear stages as in the figure 6 (Booz, Allen & Hamilton, 1982).

FIGURE 6. Linear stages of new product development
For a start-up company, which is typically established based on one single innovation, the time to market is crucial. Literally, time is money. The minimization of development cycle time, which is the time elapsed from project initiation to product launch, is important in terms of timing of entry and development costs involved (Schilling 2013, 234). Many companies have adopted a partly parallel development process (simultaneous engineering) presented in figure 7, in which some or all of the development activities at least partially overlap (Schilling 2013, 235-236). However, this is not recommended universally, if for example the variations in product design require significant changes to the process design (Schilling 2013, 236). As innovations are formed in very different circumstances and environments, there is no universal strategy for development, productization and commercialization of for example a private inventor (Fogelholm 2009, 14).

FIGURE 7. Partly parallel development process

The productization can be considered as a preliminary stage of commercialization of product idea, which will ensure the successful commercialization. It can include the following measures: selection of manufacturing method for series production, industrial design, documentation of product features, market study, preparation of marketing communication and sales materials, selection of distribution channels and product pricing. (Fo-
One of the most important factors of successful innovation is the degree of technical and commercial readiness. Accomplished productised product or industrial process, which is possibly approved by the first reference customer, is always in a much better position than just an idea. (Fogelholm 2009, 30.) Or as Carlson and Wilmot (2006) conclude, the innovations are possible only when the product or service, infrastructure, and other inventions and resources can be put in place. The opportunity must be feasible (Carlson & Wilmot 2006, 60). Carlson and Wilmot present the five disciplines of innovation to master and increase the success of an innovation in the exponential economy. These are 1) important customer and market needs, 2) value creation, 3) innovation champions, 4) innovation teams, and 5) organizational alignment. (Carlson & Wilmot 2006, 300.)

Inevitably only a small share of innovations will be feasible and successfully commercialized. Many studies suggest that only one out of several thousand ideas result in a successful new product and the rest fail as they are not technically or commercially feasible (Schilling 2013, 4). Pontin suggests the following rule of innovation: “The first attempt to commercialize the invention almost never succeeds.” for two reasons. These are: 1) the innovator is often too early and the really important market for the invention does not yet exist and 2) the innovator doesn’t know how to make money from the invention meaning that the business model that will support the invention is imperfectly understood. (Touhill et al 2008, 34.) Peter and Donnelly (1991) list typical causes of new product failure more in details as follows:

1. Faulty estimates of market potential
2. Unexpected reactions from competitors
3. Poor timing in the introduction of the products
4. Rapid change in the market (economy) after the product was approved
5. Inadequate quality control
6. Faulty estimates in production costs
7. Inadequate expenditures on initial promotion
8. Faulty market testing

In order to improve the innovation success rate, the company must have an in-depth understanding of the dynamics of innovation, a well-crafted innovation strategy and well-
developed processes for the strategy deployment (Schilling 2013, 10). A coherent technological innovation strategy both leverages and enhances the company’s existing competitive position, and it provides direction for the future development of the company. The strategy process should include the current state analysis, definition of strategic intent and the gap analysis of resources and capabilities, how to achieve its intent. (Schilling 2013, 110). There are several standard tools of strategic analysis for analysing the external and internal environment of the company. Two models, SWOT Analysis and Porter’s Five-Force Model, are presented next.

Generally, a company builds on strengths, exploits opportunities, fixes weaknesses and develops a strategy for dealing with threats (Stutely 2002, 49). SWOT analysis is one of the basic and most useful tools to analyse a company’s internal and external environment. Strengths and weaknesses are internal factors over which you have some control or influence whereas opportunities and threats are external issues that you cannot control (Stutely 2002, 47). Stutely (2002, 48) lists ten simplified and generic areas from both internal and external perspective to review during the planning process as presented in the table 3.

TABLE 3. Areas to look in SWOT analysis

<table>
<thead>
<tr>
<th>Area of your business to look for strengths and weaknesses</th>
<th>Areas where opportunities and threats can arise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processes</td>
<td>Market</td>
</tr>
<tr>
<td>Management</td>
<td>Industry</td>
</tr>
<tr>
<td>Marketing and sales</td>
<td>Industry association</td>
</tr>
<tr>
<td>Other skills</td>
<td>Labour market</td>
</tr>
<tr>
<td>Experiences</td>
<td>Financial markets</td>
</tr>
<tr>
<td>Intellectual property</td>
<td>Exchange rates</td>
</tr>
<tr>
<td>Premises</td>
<td>Green (environmental) lobby</td>
</tr>
<tr>
<td>Plant, machinery</td>
<td>Economic trends</td>
</tr>
<tr>
<td>Information technology</td>
<td>Government policies</td>
</tr>
<tr>
<td>Finance</td>
<td>Natural disasters</td>
</tr>
</tbody>
</table>
Porter has developed the five-force model to assess industry attractiveness, however in practice it is often used to assess the external environment of a specific company (Schilling 2013, 110). The five forces are presented below in details and summarized in the figure 8.

1. The degree of existing rivalry, which is influenced by a number of factors such as the number and relative size of the competitors, the degree of competitor’s differentiation and the demand conditions.

2. Threat of potential entrants is influenced by the degree to which the industry is likely to attract new entrants and the height of entry barriers such as large start-up costs, brand loyalty, difficulty in gaining access to suppliers or distributors, government regulation and threat of retaliation by existing competitors.

3. Bargaining power of suppliers is affecting the company’s ability to leverage over the supplier to negotiate commercial terms. There can be also factors that cause switching costs and thus increases the bargaining power of suppliers.

4. Bargaining power of buyers is analogous to the bargaining power of suppliers.

5. Threat of substitutes comes from the products or services, which are not competitors but fulfil a strategically equivalent role for the customer. (Schilling 2013, 113).

FIGURE 8. Porter’s Five-Force Model
Deployment of technological innovation is a core part of the innovation process itself. Effective deployment strategies can reduce the uncertainty about the product, lower resistance to switching from competing or substitute goods and accelerate adoption. (Schilling 2013, 284.) Generally, companies try to decrease their development cycles in order to decrease their costs and to increase their timing of entry options (Schilling 2013, 285). There are several factors affecting the decision on timing: customer certainty, the margin of improvement offered by the new technology, the state of enabling technologies and complementary goods, the threat of competitive entry, the degree to which the industry exhibits increasing returns and the company’s resources (Schilling 2013, 95).

Schilling (2013) divides the entrants into three categories: first movers, early followers and late entrants. As a **first mover** a company can enjoy several advantages. Introducing new technology and gaining a technological leadership reputation helps to sustain company’s image, brand loyalty, market share and enable to establish customer requirements such as technology’s form and features, pricing and other characteristics. (Schilling 2013, 89.) They may benefit from increasing returns to adoption due to learning curve effects and network externalities (Schilling 2013, 99). First movers may also preemptively capture scarce resources such as key locations, government permits, access to distribution channels and relationships with suppliers. After adoption of a good, the buyers may face switching costs, which will help a company to keep the customers even if superior technologies are introduced later. (Schilling 2013, 90.) There are also disadvantages if entering the market too early and even leading to a failure. Studies show that even if earning greater revenues, the first movers also face higher costs and thus lower profits in the long run. There is the bulk of R&D costs related to the product or service technology and also the costs related to develop suppliers, distribution channels and consumer awareness. (Schilling 2013, 92.) Thus the first movers often need significant amounts of capital and be able to withstand a significant period with little sales revenue from the product. In addition to capital resources, a company’s reputation and credibility can also influence its optimal timing of entry. (Schilling 2013, 98.) These topics can be major concerns for a start-up company, which typically has limited capital resources and there is no established market presence and proven track-record. Normally start-up companies cannot finance their operations with the sales revenues and they run out of cash at some point of their runway (Honkinen et al 2016, 18).
Second movers and later entrants can have several advantages at the cost of pioneers. They often capitalize on the R&D investment of the first mover, finetune the product to customer needs as the market becomes more certain, avoid the mistakes of earlier entrants, exploit incumbent inertia and can adapt newer and more efficient production processes (Schilling 2013, 92). If the company is to beat the earlier entrant to market with a new version of this technology, it must have fast-cycle development process (Schilling 2013, 99).

3.4. Innovation team

Typically no single person can successfully implement and commercialize a technology innovation, but it requires teamwork and setting up an innovation team. The team members should all have different roles and profiles such as Inventor/Innovator, Investor, Technologist and Entrepreneur (Touhill et al. 2008, 5). As the timing of entry is tricky, balance has to be sought in exploiting the idea and access the impact that timing can have by the team core members based on their expertise (Touhill et al. 2008, 35). Every team member should feel secure about having a significant role in the project, bring critical skills that are necessary for the success of the project but also trust their teammates’ skills, judgement and determination to push through their parts of the project (Carlson & Wilmot 2006, 192).

Inventors are often characterized as pragmatic rather than scientists. They are highly creative with the ability to simplify complex problems and generate useful concepts. (Touhill et al. 2008, 10). Inventors are also very passionate and this can sometimes cause blindness to his/her inventions. Furthermore, they are protective, suspicious and stubborn which can cause challenges for funding and getting investors or further development of innovation based on other’s ideas. Finally, they can be also described as dedicated and persevered people, who never give up. (Touhill et al. 2008, 11-13.)

According to Arthur Rock the key attribute of an Investor is the ability to identify successful people and invest in them. Being well-connected with those who present opportunities for success is another key feature. Investors can be described capitalistic and impatient, even as cold and calculating, but they do understand money as a measure of performance. Therefore their focus is on return on investment, profitability and keeping the
innovation team solvent. Regarded as dispassionate can be seen on the other hand objective and realistic characteristics, which are important to keep the process on track and to avoid micromanagement. Investors key role is to understand the big picture of the potential impact of successful development and commercialization. (Touhill et al 2008, 18-21.)

The primary role of the **Technologist** is to test the inventor’s technology and if worth of development, improving the original idea and to get it work reliable at the lowest cost. Key attributes of the technologist in the development process are imagination, project discipline in terms of financial budget and time schedule, and willingness to meld the ideas of other functions throughout the organization. Good collaboration skills and diplomacy are essential to succeed. Technologist is a key person in the commercialization process as a cost estimator and a primary planner during the different phases of development. This leads naturally to a key role after commercialization phase too, being accountable for hiring and training new people, and designing and implementing operations and maintenance procedures. (Touhill et al 2008, 23-27.)

**Entrepreneurs** are the motivators, who make the things happen. They can be described as success-oriented team builders with high energy level. They are also socially skilled and thus great sales people, having a central role in the commercialization process. Recognition and power are more important motivators than making money for entrepreneur. (Touhill et al 2008, 29-31.) They can be also called Champions, who has the passion, value-creation, and human skills needed to make an important innovation happen (Carlson & Wilmot 2006, 199).

Furthermore, managing innovation team interactions require some rules of engagement e.g. the entrepreneur as a chief operating officer is in charge of daily decisions and the investor acts as a chairman of the board and thus as a final authority (Touhill et al 2008, 33). The essential elements for collaboration are a shared, strategic vision, unique and complementary skills and shared rewards. The vision must be clear and often with a higher purpose to inspire the team. (Carlson & Wilmot 2006, 188.) According to Carlson and Wilmot (2006) the key elements of organizational alignment are:

1. Shared vision, strategy values and goals
2. Commitment to delivering the highest customer value
3. Commitment to continuous improvement processes using innovation best practices
4. Creation of innovation organizational structures and processes with the appropriate staff
5. Organizational transparency, including staff communication, knowledge, and intellectual property
6. Shared recognition and rewards
7. Commitment by the CEO, president and senior management team (Carlson & Wilmot 2006, 258).

Innovation team plays an important role also when attracting investors. The individual team members must have the required competencies with proven track record in place and the team must be able to demonstrate the capability to manage the innovation process and bring the start-up company to the next level. The venture capitalists often state that they do not invest only in promising innovations but in people.

3.5. Value creation and business model plan

Following the defined company vision, strategy, values and goals, every company must answer the simple question “How you plan to make money?”. Profitability is a key for any successful company in the long run. The choice of business model and starting of the planning process becomes relevant for a start-up company as soon as it proceeds from initial development phase to productization and commercialization.

Magretta defines the business model in terms of value chain consisting of two parts: 1) All the activities associated with making something and 2) all the activities with selling something (Ovans 2015, 2-4). Product or service positioning within its ecosystem is crucial for success. It allows the organization and its partners to develop an effective business model and to succeed financially. (Carlson & Wilmot 2006, 148). Basic positioning is based on price, technical quality, service, customization, benefit differentiation, and innovation (Hooley et al 2012, 517). Start-up company need to take their customers´ perspective to understand how to approach the market and how the product can solve their problem (Ashkenas & Finn 2016, 3). This is also emphasized in the Stacy’s (2014) recommended mindset of focusing on possibility, rather than short-term profitability when
marketing breakthrough innovations, which transform categories and create long-term sustainable growth opportunity for the company (Stacy 2014, 2-4).

Customer value can have various dimensions such as physical features, quality and durability, service and convenience, experience and trust, emotional appeal and identity, and costs. Value can be increased either by increasing the benefits to the customer or by lowering the costs. (Carlson & Wilmot 2006, 19.) Carlson and Wilson (2006) suggest that the core for value creation process is to answer the four fundamental questions:

1. What is the important customer and market need?
2. What is the unique approach for addressing this need?
3. What are the specific benefits per cost that result from this approach?
4. How are these benefits per costs superior to the competition’s and the alternatives?

Based on this NABC-model a value proposition can be created. However, the focus should be on need and competition. (Carlson & Wilmot 2006, 88). The value proposition will also help to reduce risk, which can occur in the form of market, technical, people, financial and business-model risk and it will serve as a basis for the full innovation plan (Carlson & Wilmot 2006, 123, 142).

True competitive advantage is a combination of technological advantage and marketing and organizational superiority (Laukkanen 2007, 202). Sustainable competitive advantage can be created when the advantage-creating resources are 1) unique to the firm, 2) are hard for competitors to acquire or imitate and 3) contribute to providing value for customers as presented in the figure 9 (Hooley et al 2012, 264).
FIGURE 9. Resources creating sustainable competitive advantage

From the value creation model the company will move to the business model planning. The relevant questions are “How does the company deliver value?” and “How does the company capture value?” The core elements of business model can be described by using the Business Model Canvas in figure 10. This will include key partners, key activities, key resources, value proposition, customer relationships, customer segments, channels, cost structure and revenue streams. (Kaplan 2012, 57.)

FIGURE 10. Business model canvas

According to Blank and Dorf it is typical for the start-up companies to change their business plan during the development, sometimes even very radically (Honkinen et al 2016, 17). This can happen controlled as a result of strategic management of innovation process,
when more information and knowhow is collected and processed, or sometimes the start-up company is forced to do so if the risks are realizing, resources are becoming inadequate and it is not possible to implement the original plan.

3.6. Commercialization

There are several models and strategies for commercialization, which forms the core of business model and business plan. It is noticeable that the commercialization of remarkable innovation may take 5-10 years or even more (Fogelholm 2009, 30). Touhill et al (2008) suggest that the following four key ingredients make the commercialization successful: teamwork, planning, discipline and perseverance (Touhill et al 2008, 3). The role of teamwork and planning was discussed already in the previous chapters, but the discipline and perseverance should not be underestimated. As the innovation process is characterized by continuous uncertainty, it is utmost to keep constantly in mind the company vision, the mission and the strategic goals. It is for sure that during the process there will be a number of disappointments due to failures, delays and unexpected changes which will lower the motivation and question the success of whole business. However, these moments should be temporary and the organization must be able to overcome and learn quickly from the negative events and process them into new knowledge and future success.

Andrew and Sirkin (2003) suggest based on their study that there are three approaches to commercialize an innovation: Integrators managing all the steps to needed to take a product to the market, Orchestrators focusing on some parts of the commercialization process and depending on partners to manage the rest and Licensors selling or licensing a new product to another organization that handles the rest the commercialization process. These approaches have their own investment profile, profitability pattern, risk profile and skill requirements which are presented in the table 4. (Andrew & Sirkin 2003, 2-3.)
TABLE 4. Innovation approaches

<table>
<thead>
<tr>
<th>Integrator</th>
<th>Or orchestrator</th>
<th>Licensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment requirements</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Capability requirements</td>
<td>Strong cross-functional links within organization</td>
<td>Ability to collaborate with several partners simultaneously, while not having direct control</td>
</tr>
<tr>
<td></td>
<td>Product design</td>
<td>Complex project-management skills</td>
</tr>
<tr>
<td></td>
<td>Manufacturing-process design skills</td>
<td>Customer insight</td>
</tr>
<tr>
<td></td>
<td>Technical talent sourcing</td>
<td>Brand management</td>
</tr>
<tr>
<td>Best used when</td>
<td>speed-to-market is not critical technology is proven</td>
<td>there is a mature supplier/partner base</td>
</tr>
<tr>
<td></td>
<td>customer tastes are stable innovation is incremental</td>
<td>there is intense competition – a need for constant innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strong substitutes exist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>technology is in early stages</td>
</tr>
</tbody>
</table>

The selection process of the most effective innovation approach should include a systematic analysis of three dimensions of the opportunity: the industry, the innovation and the risks (Andrew & Sirkin 2003, 5). Furthermore, company’s capabilities must match with the requirements of approach to successfully commercialize the product. Sometimes less-attractive approach is used to take the product to the market while the skills and capabilities will be developed for the optimum approach. (Andrew & Sirkin 2003, 7.)

The challenges in a growth company are related to the identification of potential customers, acquiring new customers, developing the product offering to the customers to guarantee the optimal value adding and managing the project portfolio (Laukkanen 2007, 192-197). According to Laukkanen a growth company should also follow and prioritize during
different growth phases, which network relationships are relevant at the time (Laukkanen 2007, 197). When building effective marketing strategy, the company should consider a variety of inter-organizational relationships such as vertical channel relationships and supplier/manufacturer collaborations and horizontal relationships in the form of strategic alliances and joint ventures, which all share a growing emphasis on collaboration and partnerships rather than simple contractual obligations (Hooley et al 2012, 421). Collaborating on development projects can offer a number of advantages such as obtaining necessary skills or resources more quickly, which can further help the company to reduce its asset commitment and enhance its flexibility. Collaboration with partners helps primarily to share the costs and risks, but it can be also an important source of learning. (Schilling 2013, 156.) The most common forms of collaboration agreements used in technological innovation include strategic alliances, joint ventures, licensing, outsourcing and collective research organizations (Schilling 2013, 158). These vary in terms of speed, cost, degree of control, potential for leveraging existing competencies and developing new competencies and potential for accessing other companies´ competencies (Schilling 2013, 163). The partner selection should be made considering the resource fit and the strategic fit, assessing how the partner would impact company´s SWOT, potential sustainable competitive advantage and the company´s ability to achieve its strategic intent (Schilling 2013, 166).

Fogelholm suggests two possibilities for commercialization: 1) licensing of product rights or 2) commercialization of product as own business i.e. manufacturing and/or sales (Fogelholm 2009, 15). Under a licensing agreement, the licensor permits another company, the licensee, to use its intellectual property in exchange for compensation designated as a royalty. The property might include patents, trademarks, copyrights, technology, technical know-how or specific marketing skills. (Czinkota & Ronkainen 1993, 431.) There are several uncertainties related to licensing such as 1) if the distribution channel of licensee is appropriate for the product, 2) if the resources of licensee are adequate to commercialize the product and 3) if there is a risk that the licensee will develop a competing solution and discontinue to pay royalties (Fogelholm 2009, 46). From the licensee point of view it is important that the development stage is mature enough and there is concrete evidence of feasibility, marketability and size of the market even though the right moment for the licensing may vary from prototype to finalized product (Fogelholm 2009, 48, 53). The most common point is either after assessment and evaluation or in the early stages of development (Touhill et al 2008, 83).
In order to start licensing negotiation the licensor must provide following information to convince the potential licensee: application areas of the product, real benefit for the customer, competitive advantages to competing products, development phase of innovation, financial calculations, description of market, competition, phase of intellectual property rights, knowhow related to invention and inventor’s professionalism and terms for the technology transfer (Fogelholm 2009, 52). Licensing can be a lucrative option, but it requires monitoring and control and therefore also causes high administrative costs. Licenses can be either exclusive or non-exclusive. (Touhill et al 2008, 83.) Exclusive licenses are more common in the field of technology. They have a unique right to the intellectual property with higher fees and the monitoring effort is manageable. In case of multiple exclusive licenses, areas must be well defined in the contract license documents to avoid any overlapping (for example geographical). (Touhill et al 2008, 84.) Franchising is a form of licensing (Czinkota & Ronkainen 1993, 454).

Fogelholm suggests that in many cases starting own manufacturing and sales is more meaningful and profitable than licensing and may enable that companies get interested in later on and offer to redeem the IPR´s (Fogelholm 2009, 53-54). In case of starting own manufacturing and/or sales, there are several key selections to be made: is manufacturing organized as in-house operations, outsourced or through partnering and what will be the channels of distribution and the role of intermediaries. Contract manufacturing allows companies to meet the scale of market demand without committing to long-term capital investments or an increase of labour force. It also enables the companies to specialize in their activities, which are central to their competitive advantages. All in all, contract manufacturing offers greater economies of scale and faster response time of a dedicated manufacturer, thereby reducing costs and increasing flexibility. (Schilling 2013, 162.)

Companies can sell their products directly or alternatively use intermediaries. Direct selling gives the company more control over the selling process, pricing and service, enables to capture more information about customers and to facilitate the customization of products. (Schilling 2013, 290.) The direct channel is often used in the distribution of industrial goods due to the structure of most industrial markets, which often have relatively few but extremely large customers. Many industrial products need also a great deal of pre-sales and after-sales service. (Peter & Donnelly 1991, 178.)
In case of choosing to use intermediaries, they have two primary forms of operation: 1) they either take title to the goods and operate internationally on their own account (distributor), or 2) they perform services as agents (Czinkota & Ronkainen 1993, 445). Distributors are used in industrial markets when the number of buyers is large and the size of buying company is small. Agents can be used in cases where manufacturers do not wish to have their own sales forces. (Peter & Donnelly 1991, 178.) Intermediaries provide a number of valuable roles in the supply chain, including breaking bulk, transporting, carrying inventory, providing selling services and managing customer transactions (Schilling 2013, 301). Not to forget about the valuable information about the target markets, customers and competitors, which is often difficult and time consuming to collect from another country due to for example language barriers. The choice of channels can be refined in terms of distribution coverage required, degree of control desired, total distribution cost and channel flexibility (Peter & Donnelly 1991, 180). Typical channels for the sale of industrial goods are presented in the figure 11 (Peter & Donnelly 1991, 179).

FIGURE 11. Typical distribution channels of industrial goods

Selling a patent or a trade secret is an option too, if the innovation team decides for reasons of risk or modest interest not to expend development money to pursue an idea. In this case, it is hard to get full benefits from anticipated or projected success due to risk avoidance and gauging the full potential of an idea. (Touhill et al 2008, 12.) One of the most common endgames for innovation teams, is to develop a technology further and then sell the patent or license. This is the case especially for innovation teams with lots of
capital backing. (Touhill et al 2008, 84.) Ideally from the buyer’s perspective, he should not pay for an idea until the commercialization process is complete (Touhill et al 2008, 133).
4 METHODOLOGY

Scientific research always involves a method. It can be considered as a single complete sub-process and thus it is an essential part of the research process (Mapping Research Methods). This chapter explains the research methodology of this thesis and the used methods in data collection and in data analysis as well as the reasoning for selecting them.

4.1. Research strategy

This is an instrumental case study, which is made to serve business purposes of a commissioning company, and in which a case is examined mainly to provide insight into an issue (Silverman 2005, 127). Due to confidentiality reasons, the commissioning company is not named here. A case study is useful, when the aim is to compare a few organizations and to identify the key differences in approach (Research Methods). The advantages of this kind of research design are that it enables a more in-depth examination of a particular situation; the yield information can be rich, enlightening and provide new leads and questions; and the people involved usually comprise a fairly well-circumscribed and captive group, making it possible for the researcher to describe events in details (Brewerton & Lynne 2001, 62).

The chosen methodology for the empirical study of the thesis is a qualitative research and the methods are interviews and secondary data collection (table 5).

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Qualitative research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods and techniques</td>
<td>Interviews</td>
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</table>

4.2. Data collection method

The data collection method used in the research process of this thesis was made through personal one-to-one interviews. Interview was chosen to the data collection method as it is a good way of gathering rich qualitative information from a limited number of people.
(Research Methods) and it allows the researcher to participate interactively in the production of the data, control the degree of interaction, interpret the questions and specify the answers (Metsämuuronen 2000, 40). The characteristics of an interview are that it is planned in advance, it is guided and motivated by the researcher, it allows interaction and it must be always confidential (Metsämuuronen 2000, 40). Interview techniques can be typified according to both the structure of the interview and the degree of interaction between you and interviewee. The basic structures are unstructured or open interview, semi-structured interview and structured or form interview depending on the range of opinions. The form was chosen to be a semi-structured or theme interview, which is a usual form for management research and social sciences (Mapping Research Methods).

In this research the interviews were made using the positive, open-mind approach containing information questions and looking for facts e.g. what happened, when and how but in a semi-structured way having some flexibility and more conversational and informal atmosphere (Eriksson et al 2008, 79-82). The interview questions were formulated as what, why and how questions (Appendix 1). “What” questions are descriptive and focus on exploring and describing states, situations and processes. “How” and “Why” questions focus on causes and consequences aiming to answer or explain something in qualitative terms. (Eriksson et al 2008, 39.) This kind of question set-up is open, simple and neutral and thus helps to receive more detailed, responses and to avoid pre-assumptions. The interview began with introduction of questions and topics that wished to be explored. The individual questions were used as a starting point but the format allowed to explore interesting, company-specific areas in more details. Specific questioning techniques were used in the interviews: 1) basic probe to repeat the initial question was used in some cases to remind the interviewee about the subject of discussion and 2) focused probes were used to have in-depth understanding of some specific questions with some of the interviews (Research Methods).

The identification of research participants was made as purposive sampling, which is a goal-oriented method and enables to select samples that match with the aim of the study (Mapping Research Methods). As the research focused on sustainable, technological innovation, the companies were carefully identified and selected based on their innovation type. This was made by using the researcher’s connections within start-up networks, e.g. Business Finland’s Innovative Bioproducts -program, Packaging valley -ecosystem and other existing contacts. The original plan was to interview ten companies. The selected
companies were contacted first face-to-face, by-e-mail or by phone to invite them to the research and to agree on the interview date, time and mode. Earlier networking and the researcher´s similar position to the respondents were likely to help with making contacts, creating a trustful atmosphere and receiving positive replies, even if there were no previous personal contacts with all the respondents.

Finally, eight out of ten companies participated in the research and the interviews were conducted as one-to-one meetings, either face-to-face, phone or skype during June-August 2018 (Appendix 2). Different forms of meetings were a result of compromising with the time of both interviewees and the researcher. This was a must in order to be able to arrange the interviews in the very busy business time in June followed by the holiday season in July. The respondents’ position in the company was managing director or other director and most of them were also founders and co-owners of the company. All participants were handled anonymously in the research process to guarantee the confidentiality of the information. All the interviews were held in Finnish as it was the mother language of the respondents. The interviews took about 0,5-1 hour and they were recorded with the voice recorder application of iPhone with the permission of interviewees. This allowed the researcher to return to the data in its original form afterwards and check the answers during the data analysis process. The collected data may vary in terms of in-depth discussion and insight to the company information depending on the form of meeting and if the interviewee was very busy not wanting to spend too much time on the interview. Generally, the interview sessions were really inspiring and the atmosphere was very open and discusive.

4.3. Data analysis method

As Lancaster defines, the data analysis is the process of turning data into information, which can be used for explanation and decision making (Lancaster 2005, 155). In general, there are several problems with the case-study design in terms of interpretation: risk of getting caught up in minutiae, losing impartiality, the information yielded can be difficult and time-consuming to analyse, “now” design produces evidence that cannot be generalized beyond local circumstances, and project participants may feel negative under intense scrutiny (Brewerton & Lynne 2001, 62). To avoid and overcome the mentioned issues, content analysis was used as an approach to analyse the qualitative data. A key aspect of content analysis is to decide on what is to be measured or noted (Lancaster 2005, 162).
The first two steps of the content data analysis process were well done in the very beginning of the thesis process through orientation to the theoretical framework. Based on domiciliation phase the classification was made with the help of semantic mapping (Metsämuuronen 2000, 54). As the literature suggest, the innovation is successful only when it is both technically and commercially feasible. In this thesis it is assumed that the innovation is technically feasible and therefore the focus is on the commercialization part. There are a number of different factors affecting the successful commercialization, but the strategic management of innovation process and building a strong, multi-skilled team are considered the main factors for successful deployment. Funding is inevitably also an important factor and closely related to the commercialization and building financially solid operations. During the data collection process the interviewed companies were often referring to the importance of networks and partnering options and therefore this topic is
also included in the classification. The main themes are presented in the following semantic map (figure 13).

![Semantic map of the main themes of the research data](image)

FIGURE 13. Semantic map of the main themes of the research data

The answers of the interviewees were transcripted based on categorized themes to discover how the selected companies are approaching the topics. Finally, the conclusions were drawn upon the data analysis.

4.4. The quality of the data

Three dimensions of the quality of data are validity, reliability and generalizability stemming from the need within the deterministic model of research to produce results that are scientific and reproducible (Lancaster 2009, 72). The quality of this research is assessed below considering all the three criteria.

Validity relates to the extent to which the data collection method or research method describes or measures what it is supposed to describe or measure (Lancaster 2009, 72).
The validity can be assessed by significance, completeness, consideration of alternative perspectives, sufficient evidence, sensitivity and respect (Brewerton & Lynne 2001, 65). The subject matter is of public interest due to a current large number of technical innovations and start-ups in Finland and the importance of international commercialization for both the companies and the economy in Finland. This research can be considered fully accomplished as all the respondents answered all the questions despite of somewhat sensitive and strategic nature of requested information. The completeness of the data in turn enabled the researcher to answer the original research questions. The data collection is considered unbiased due to the formulation of open questions. The proper storing and analysis of the interviews was ensured via recording, which allowed to repeat the interviews and to avoid any biased notes or perceptions by the researcher. As Brewerton and Lynne request from the ethical and practical point of view, it was granted that the interviews are handled anonymously and with confidentiality (Brewerton & Lynne 2001, 56). The recording was made with the permission of each respondent, too. However, it is difficult to assess if the answers would have been more open up without recording.

**Generalizability** is essentially another dimension of validity quality in data and relates to the extent to which results from data can be generalized to other situations (Lancaster 2009, 72). The sample size was eight companies and it was geographically limited to Finland. Based on the start-up dimensions i.e. the amount of growth-oriented start-up companies in Finland, it can be stated that the sample is comprehensive. The research results can be considered generalizable in the context of commercializing technological innovations by Finnish growth-oriented start-up companies. However, it is unsure if the results could be generalized to another setting, including for example a commercialization of other type of innovations or a different geographical market area.

**Reliability** relates to the extent to which a particular data collection approach will yield the same results on different occasions (Lancaster 2009, 72). This research was specifically designed to investigate the Finnish start-up companies, who are commercializing technological innovations to the international market. Therefore, this research is unique and reliable only in this thesis at this particular moment.
The relationship between the researcher and the research participants remain neutral, meaning that the researched are subjects, data sources and respondents in a research setting (Eriksson et al 2008, 65). However, the researcher is representing one of the companies and thus participating the interview as a respondent too.
5 RESEARCH RESULTS

The results of the empirical study are presented and reflected in this chapter.

5.1. Results of the company interviews

The interview questions were divided into 1) Company information, 2) Innovation information, 3) Commercialization plan and 4) Financing. There were in total 38 questions and the list of questions is presented in the Appendix 1. However, as the interview was a semi-structured one, the list of questions was not always strictly followed in the same order and it allowed also deeper discussion of some of the topics.

As to the company background information the companies were established during the years 2011-2016. It was noticeable that 50% or four out of eight interviewed companies were spin-offs originating from research findings, business management consulting or existing corporate business (figure 14).

As to the company background information the companies were established during the years 2011-2016. It was noticeable that 50% or four out of eight interviewed companies were spin-offs originating from research findings, business management consulting or existing corporate business (figure 14).

Most of the companies had defined their mission, vision and values very clearly. These were very much based on sustainability and collaboration aspects. The number of personnel varies between 2-13 and apparently there is a clear division between technology and
business development within the teams. The board members and owners are also actively contributing to the business development of the company. Technology know-how and experience in the particular field of industry or value-chain of the team was considered the main competence area of all the companies. Due to the nature of innovations, developing products and/or related manufacturing technology, most of the companies have their own laboratory and pilot facilities. A couple of companies utilize the facilities and equipment of their development partners thus avoiding early-stage investments into technology.

The following innovation types were provided: new product, new technology, new concept and improved product based on new production technology. All the companies are in the business-to-business sales and two companies do also have sales to consumers. The typical customers are in the field of packaging, food, textile and construction industry as well as in retail. It is notable that several companies are developing their solution to fit to the existing processes in the value chain in order to be able to scale-up fast. All the companies are targeting to the international and even global markets. Most of the growth plans are ambitious targeting to turnover of hundreds of millions of even billions of euros within 5-10 years. The plans are justified due to the high market potential as the companies are trying to solve world-wide sustainability issues by offering alternatives for example to fossil-based materials used in various industries and solutions to reduce waste. Some of these solutions can be considered even as disruptive innovations.

All the companies have been very active in protecting their innovations by industrial property rights like patenting the products or technologies, applying for utility models and protecting their brands by registered trademarks, logos and domains. Creating an IPR portfolio was considered highly important when proceeding to international markets and attracting new funding. In addition to this, the first reference customers and other type of recognitions e.g. awards in the industry-specific competitions were found important in creating brand image and company credibility.

The companies were at the end of development process approaching or being already in the commercialization stage. Five companies had launched the innovation so far and one of these five was already having sales to the international market. These can be considered still pilot cases, in which the main purpose is to gain first valuable references and proof the concept by the market. The others expected to make the launch soon, even during this
year. Time to market within the companies analysed can be considered rather long as it is also to be kept in mind that half of the companies were spin-offs and thus there was already preliminary development work done, which preceded the official registration of the company. Majority of the companies believe that there is a true market pull supported by emerging legislation for their innovations at the moment as the sustainability is an increasing topic in many industries. Some companies were claiming that there is already a continuous flow of huge inquiries, which they cannot offer and deliver yet due to the proof of scalable solution and/or required production capacity. Overall, it was considered important to enjoy the advantages of a first mover, act as a trend setter and develop new product categories before competing solutions enter the market. Only one company was hesitating about the timing of the entry if it is too early and the market is not ready for their solution yet due to prevalent consumer habits. Table 6 presents the summary of companies’ year of foundation, status of innovation launch, opinion about market pull or push for the innovation and their view about the timing of entry.

TABLE 6. Summary of companies’ go-to-market status

<table>
<thead>
<tr>
<th>Company</th>
<th>Year of foundation</th>
<th>Launch</th>
<th>Market</th>
<th>Timing of entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2014</td>
<td>Done</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>2</td>
<td>2015</td>
<td>Soon</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>3</td>
<td>2015</td>
<td>Done</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>4</td>
<td>2011</td>
<td>Soon</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>5</td>
<td>2016</td>
<td>Done</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>6</td>
<td>2016</td>
<td>Done</td>
<td>Push</td>
<td>First mover</td>
</tr>
<tr>
<td>7</td>
<td>2015</td>
<td>Soon</td>
<td>Pull</td>
<td>First mover</td>
</tr>
<tr>
<td>8</td>
<td>2014</td>
<td>Done</td>
<td>Pull</td>
<td>Early follower</td>
</tr>
</tbody>
</table>

The companies found themselves in the introduction stage or starting to grow already (figure 15). The next step was considered to be either launch or industrial piloting to proof the scalability of the business. The industrial piloting was considered the most critical phase due to the technology and financial risk. The piloting was planned to be done either by the company alone or with the industrial partners depending on the innovation type and the selected business model.
The question, what is the strategy to commercialize the innovation to the international markets, was really an interesting topic. It turned out that there were several options for the deployment of innovation that the companies were considering and no clear, final decisions were made yet. The options raised up during the interviews were service sales, project sales, product sales based on own manufacturing, co-branding and product sales based on subcontracting, product sales with local distribution network, joint ventures with manufacturers, licencing of technology and licencing of product or the combination of these (figure 16).
The invested capital among the companies was ranging from “small” amounts to several millions of euros. The number of funding rounds varied between 1-3. The ownership structure was very diverse, ranging from a few private owners to a combination of private investors including founders and management, angel investors, family funds, venture capitalists and industrial investors.

The role of public funding has been very important for all the companies. The different financial instruments offered by Business Finland has been utilized to fund the development and introduction stages, when there has not been sales revenues yet to cover the development and operating costs. Some subsidies offered by the Centres for Economic Development, Transport and the Environment and funding from EU Horizon 2020 -program have been granted as well.

Despite of successful development and introduction of innovations, the companies see a lot of challenges and risks ahead. Due to the nature of diverse technological innovations there was no single, common nominator but the biggest challenge turned out to be the
proof of scalable solution and getting the funding for the required pilot investments. The challenges and risks are summarized in the table 7:

TABLE 7. Challenges and risk types in the innovation deployment process

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Type of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof of scalable solution</td>
<td>Technology risk</td>
</tr>
<tr>
<td></td>
<td>Product development risk</td>
</tr>
<tr>
<td></td>
<td>Financial risk</td>
</tr>
<tr>
<td>Investments in scaling-up</td>
<td>Financial risk</td>
</tr>
<tr>
<td>Market acceptance and creation of new market segment</td>
<td>Market risk</td>
</tr>
<tr>
<td>Limited resources and finding the right partners</td>
<td>Financial risk</td>
</tr>
<tr>
<td></td>
<td>Personnel risk</td>
</tr>
<tr>
<td></td>
<td>IPR risk</td>
</tr>
<tr>
<td>Uncertainty with product life cycle and related end user application</td>
<td>Product development risk</td>
</tr>
</tbody>
</table>
6 CONCLUSIONS

In this chapter the findings of the research and the conclusions, which can be drawn after analysis, are discussed. Finally, the research limitations are considered and some recommendations for further research are proposed.

The thesis subject is topical as there are dozens of promising start-up companies in Finland, who develop and offer sustainable innovations and circular solutions to save our planet. Many of these companies utilize renewable forest sources as a basis for their solution and it is also nationally important to develop and commercialize new wood or fiber based innovations to the global markets.

The sample was very unique presenting start-up companies, who develop sustainable technological innovations in Finland. The selected companies were quite heterogeneous in terms of innovation type. The sample size was eight companies. Due to these issues the results may not be generalisable in any other context. However, the findings are considerable as there is no similar previous research combining these topics into one context.

The findings of this research are of interest to entrepreneurs and managers of start-up companies in the development phase. This research will help to understand and plan the innovation process and deployment strategies as well as to foresee and overcome the start-up challenges in the introduction phase. Furthermore, the findings will offer food for thought in the start-up ecosystem widely and encourage other players and stakeholders to evaluate and develop their roles in the ecosystem, how they can support start-up companies in the commercialization and international process.

6.1. Comparison of the results to the literature review

Commercialization is a core part of any innovation process. The empirical study confirms that there is no one-for-all solution when it comes to the deployment of innovation as already learnt during the literature review. There are several deployment strategies especially for technological innovations and the decision is a result of thorough evaluation of
business potential, market dynamics, company’s and its potential partner’s capabilities and competences.

As to the protection of technological innovation, the empirical research highlights the importance of intellectual property and agrees on the multiple advantages presented in the literature. Having a credible IPR portfolio the start-up company will be able to market it’s products with an innovation label and price them as premium, attract new investors which are most likely needed when proceeding to industrial scale and build an important source of an income for the future, if the licensing or technology selling is the chosen revenue model.

Successful commercialization requires a multi-skilled and committed team, who is able to transform the inventor’s technological innovation to profitable business. Most of the companies, which participated the research, had already started to build an organization, which combines the skills and features of inventor, investor, technologist and entrepreneur as described in the literature review.

Furthermore, the empirical research reveals that the process of technological innovation and the time to market is fairly long. This can be shortened through partly parallel development process presented in the literature. The research also confirms that the timing of entry is important for various reasons. It is reasoned to act as a pioneer, when the technical feasibility is proven, the product or the process is well productised and there is an obvious market pull for the innovation, thus reducing the market risk.

### 6.2. Answering the Research Questions

The main research question was defined and formulated as follows: How to commercialize a technological innovation successfully by a start-up company? The supporting questions raised were such as: What kind of go-to-market strategies there are? What is the importance of timing of entry? What are the main challenges and risks when scaling up to the international markets?

The research supports a wide range of strategies to commercialize a technology innovation as presented in the literature and listed below:
1. Service sales
2. Project sales
3. Product sales based on own manufacturing
4. Co-branding and Product sales based on subcontracting
5. Joint ventures with industrial partners
6. Licensing of technology
7. Licensing of product

All options will directly impact on the core elements of business model as described in the business model canvas: value proposition, customer segments and relationships, channels, key partners, key activities and resources, cost structure and revenue streams. In case of technological innovation it may be often necessary to build a pilot manufacturing site to proof the technology and gain the first valuable reference customers. The choice will depend on e.g. innovation type and required manufacturing infrastructure, intellectual property rights, technological readiness, organizational capabilities and financial resources. It may be worth of implementing one strategy in the introduction/growth stage to launch version 1.0 and introducing or combining different strategies later on for new geographical markets and market segments.

In addition to own strong expertise in technological know-how, networking and partnering with international companies was highlighted in several interviews. Building strategic partnerships in the value chain help start-up companies to explore further opportunities and establish solid international market presence quicker than trying to do everything in-house. Protecting intellectual properties and building a portfolio of patents help companies to increase interest and attract partners and new investors, still maintaining the negotiation power and business value in their own hands.

The main challenge outlined by the interviewed companies was the industrial scale-up itself. This was seen as the most critical step when moving from development to introduction stage as it will proof whether the innovation and the business model is truly scalable to international markets. At this point all or at least many assumptions related to technical and commercial feasibility can be verified. If the attempt to transfer from development to introduction stage fails and the technology or product development risk realizes this can have dramatic consequences for the company. This would require further
development work, postpone the start of sales thus eat up the capital and likely require more funding with uncertain payback.

The financial resources are closely related to industrial scaling as it requires often very heavy investments in production infrastructure. If the innovation can be produced with the existing technology, it may be cost-efficient to outsource the production in the beginning and to avoid or postpone heavy investments in the manufacturing infrastructure. In these particular case companies the product or technology approval processes may be also very long and thus resource consuming. The continuous challenge is to ensure the adequate financing to bring the company to the next level, when there is still no or only minor sales revenues. Some of the companies plan to overcome this challenge through subcontracting and building partnerships, thus relying on external resources and existing production infrastructures.

Another severe reason for a failure would be the realization of market risk. There can be several topics, such as market acceptance of the final customer in relation to timing of entry, target market segment and target price point in relation to profitability, improper reference customers, and development of competing solution and entrance of second movers.

6.3. Research limitations and suggestions for improvement

The companies included in the research had not yet scaled up to the international markets but plan to do so in the near future. The selection of interviewed companies could have also included those companies, who actually had already started the commercialization process to the international markets. This could have provided more insight about the finally selected approaches and real experiences on them. However, the objective of the research was achieved and the pre-determined questions were answered in a semi-structured way by eight start-up companies.
6.4. Recommendations

The answers to the main question “How to commercialize a technological innovation successfully by a start-up company?” revealed the dilemma. There is a plenty of options available, but their investment and capability requirements vary substantially. The choice is a strategic one and will determine the company’s future success very much. Most of the innovation teams were characterized by very high-level technical expertise and industry-specific know-how, yet the answers to commercialization strategy were not always very clear. This could be due to the stage of the company and the lack of industrial proof of concept, which does not enable final strategy on the subject yet. However, this will be the next critical phase for most of the companies and thus the different options should be studied carefully and considered, if the teams should be strengthened by experts in the commercialization/internationalisation with the proven track-record.

The financial resources are always limited and the pre-revenue company is fully depending on the commitment and resources of existing owners of the company and/or the ability to attract new investors. This is very important to keep in mind and proceed with development work and market feedback according to agile development model and launch the version 1.0 as quickly as possible. If you fail, do it quickly.

6.5. Further Research

As there is a lot of potential among the start-up scene in Finland this topic could be studied further, both wider in terms of sample companies and deeper in terms of proven deployment strategies. One suggestion would be to conduct a wider research among the Innovative Bioproducts Growth Programme, which is organized by Business Finland. The results of public survey could benefit all the companies within the programme but also other start-ups. It could also reveal the development areas of the national innovation system and give ideas what kind of services are needed and how the existing ones could be improved to boost successful commercialization. As the research was limited to the start-ups in Finland, country-specific benchmarking for example in other Nordic countries and in Estonia would be very interesting and also valuable to learn if any differences could be found.
Another very interesting area to research would be the strategic partnership network of a technology start-up company. It would valuable to learn what kind of models and agreements there exist, if these are back-end or front-end partners and if there is any correlation with the time to market or scaling-up successfully from pilot to industrial stage.
REFERENCES


Stacy M. 2014. For breakthrough innovation, focus on possibility, not profitability. Harvard Business Review.


APPENDICES

Appendix 1. Interview questions

COMPANY INFORMATION:

1. Company name
2. Person and position
3. Year of foundation
4. Start-up / Spin-off
5. Location
6. Number of personnel
7. Business infrastructure
8. Vision
9. Mission
10. Values
11. Turnover
12. Export %
13. Ownership

INNOVATION INFORMATION:

1. What problem you are solving?
2. What is your innovation?
   a. Existing product / technology with improvement
   b. New product / technology
   c. Other _____________________
3. How have you protected your innovation?
   a. Patent
   b. Utility model
   c. Design
   d. Trademark
   e. Domain
   f. Other______________________  (continues)
4. In which stage is your innovation?
   a. development
   b. introduction
   c. growth
   d. maturity
   e. decline

5. Do you have one product only or several? Are you able to develop your product offering?

6. What is your time to market?

7. Describe your innovation team.

COMMERCIALIZATION PLAN:

1. Do you sell B2B or B2C?
2. Is there a product push or market pull for your innovation?
3. Who are your competitors?
4. What is your strategy about the timing of entry?
   a. first mover
   b. early follower
   c. late entrant

5. Have you launched your product? If yes, when and do you consider the timing successful? Why?

6. What is the importance of reference customer for you?
7. What are your core competencies and competitive advantages?
8. Do you target to international markets? Where are your main target markets? Mass/niche markets?
9. What is your strategy to commercialize the innovation? Why?
   a. sell a product - what kind of distribution channels you plan to use?
   b. sell a manufacturing line - what kind of distribution channels you plan to use?
   c. subcontract/outsourcing
   d. sell a patent or trade secret
   e. license a patent or trade secret
   f. other
10. What are your growth expectations?
11. Is your product price elastic?
12. How do you plan to scale-up?
13. When do you expect your business to be profitable, if not yet?
14. What are your main challenges and how do you plan to overcome them?
15. What are the risks and how to mitigate them?

FINANCING:

1. What is company’s capital amount? How many funding series you have conducted?
2. What has been the role of external and public funding in your business development?
3. Have you used the services of Business Finland? Did you find them useful in commercialization?
Appendix 2. Summary of interviewees, dates and modes

<table>
<thead>
<tr>
<th>Company</th>
<th>Position of Interviewee</th>
<th>Interview Date</th>
<th>Interview Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>CIO</td>
<td>11.6.2018</td>
<td>Meeting</td>
</tr>
<tr>
<td>No. 2</td>
<td>CEO, Co-founder</td>
<td>7.6.2018</td>
<td>Skype</td>
</tr>
<tr>
<td>No. 3</td>
<td>CEO, Founder</td>
<td>28.6.2018</td>
<td>Skype</td>
</tr>
<tr>
<td>No. 4</td>
<td>CEO</td>
<td>15.6.2018</td>
<td>Meeting</td>
</tr>
<tr>
<td>No. 5</td>
<td>Sales Director</td>
<td>24.8.2018</td>
<td>Skype</td>
</tr>
<tr>
<td>No. 6</td>
<td>CEO, Founder</td>
<td>11.7.2018</td>
<td>Phone</td>
</tr>
<tr>
<td>No. 7</td>
<td>Innovation Director, Co- founder</td>
<td>14.6.2018</td>
<td>Meeting</td>
</tr>
<tr>
<td>No. 8</td>
<td>Managing director</td>
<td>16.6.2018</td>
<td>Meeting</td>
</tr>
</tbody>
</table>