Key success factors for turning a high technology startup into a commercial success

A case study of a semiconductor startup

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Acknowledgements

Abstract

Title	Key success factors for turning a high technology startup into a commercial success: A case study of a semiconductor startup
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Background	While there have been numerous research papers defining and discussing high-technology startup success, there is a lack of unity what the recipe for success is. Due to lack of market orientation being one of the most common reasons for startup failure, combined with the essentiality of having a strong technology base in a high-technology environment, there is an interest to study their intersection also due to confine previous research in this area.
Main purpose	The main purpose of this master thesis is to identify, categorize and understand key success factors of transforming a high-technology startup from a pure innovation focused firm to a market and technology focused organization to ensure a sustainable competitive advantage.
Secondary purpose	The secondary purpose of this master thesis is to develop an applicable framework, encapsulating the key success factors, to help high technology startups evaluate their commercial position.
Research questions	What are the key success factors to turn a high technology startup from a sole innovation focused firm to commercial success?
Methodology	This master thesis has applied an abductive and qualitative approach. A hypothesized framework (v1.0) is developed based on the literature review and later tested empirically through six interviews with employees at our partner company (mainly referred to *The Company* due to interests of anonymization) and external experts. The empirical input leads to a revised framework (v2.0). Finally, the latter version of the framework goes through a quality assurance process based on our own reflections, leading to a concluding framework (v3.0).
Delimitations	Firstly, due to the ambiguity concerning the definition of startup success, this master thesis will not present an exhaustive list of key success factors. Hence, the report is restricted to finding key success factors in

the intersection between the two chosen theoretical areas *market focus* and *technology-orientated competitive advantage.*

Secondly, the thesis will not consider access to capital, i.e., capital injections.

Thirdly, empirical data will come mainly from the semiconductor industry, and thus no other high-technology industry will be discussed.

Findings

By studying the intersection between two theoretical areas - market focus and technology-orientated competitive advantage (later rephrased in the quality assurance section to technology focus) – we were able to identify six apparent success factors, later compiled into a guiding framework, including the complementary, but still prepossessing, elements of revaluation over time and understanding your value proposition. The six success factors are categorized in pairs and should be studied in the chronological order as follows:

Categorization	Success factors
Soak up external intelligence	*Deploy a technological & economical audit, cherry pick time & cost-effective marketing analysis tools*
	Develop a capacity to absorb & filter external knowledge, scan the market frontier
Grasp value creation possibilities	*Identify lead customers*
	Avoid marketing and technology myopia
Internalize knowledge	*Avoid hoarding & actively spread information*
	Capture tacit knowledge & seek new learning

Keywords

High-technology, startups, market focus, technology focus, technological capabilities, commercialization, semiconductor

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Abbreviation	Description
CEO	*Chief Executive Officer*
CoB	*Chairman of the Board*
CMOS	*Complementary metal oxide semiconductor*
MEMS	*Microelectromechanical system*
SRAM	*Static random-access memory*
MECE	*Mutually exclusive and collectively exhaustive*
ICT	*Information and communication technology*
B2B	*Business-to-business*

1. Introduction

In the introduction part of this master thesis, the audience is given a brief introduction to the historical and current development in the startup sphere and the hurdles of becoming commercially successful. In addition, two case examples of technology startups; one who managed to successfully commercialize and grow rapidly while the other reached bankruptcy. Finally, fundamental concepts including problem statement, purpose, delimitations, target audience and the outline of this master thesis will be presented.

1.1. Background

At the time of composition of this master thesis, the *Commission of the European Union* proposed a new industry strategy. This proposed new strategy has been a result of ongoing discussions regarding the *European Union's* ability to compete with the U.S. and China. The *Covid-19* pandemic has further strengthened the need of a new strategy, as the pandemic exposed the vulnerability of the European economy, as it became apparent that Europe is dependent of external actors. In the commission's proposal, semiconductors were listed as one of the most critical products, therefore the strategy includes action plans to secure a stable supply of semiconductors, and as part of this a European foundry was proposed (Sveriges Radio P1, 2021).

For the authors, this sparked an interest to research the semiconductor industry, and it became apparent it is a topical matter to study.

1.1.1. A historical view on entrepreneurship & the current landscape of startups

The definition of a 'startup' is not uniformly agreed upon and researchers find it difficult to give a precise description of the concept (Cockayne, 2019). Hence, it is difficult, if not impossible, to determine when the first startup was formed. The first entrepreneurial activities most likely took place when human beings began to trade goods and supply in 17'000 B.C.E. As cities developed and money was invented as an exchangeable good, marketplaces started to form, and merchants began to stimulate economic growth (Allis, 2018).

As discussed by Allis (2018), while buyers and sellers met in local marketplaces, people began to realize the possibilities of 'innovation' and the development of better and more advanced products, and more efficient processes, which enabled the *First Industrial*

revolution to occur in the 18th century. Not only were multiple new inventions introduced to the world, i.e., the first electric generator and motor by *Michael Faraday* (Britannica, 2020), but also new ways of doing business, i.e., mass production and economies disrupting the steel, oil and automobile industries (Allis, 2018).

Even though invention and innovation occurred during the *First Industrial revolution*, the term startup is more commonly connected to the forming of Silicon Valley in California. The concentration of technology-intensive companies has impacted the world of technology since the 1970s. The name *Silicon Valley* was stated in 1971 as a consequence to most companies in the area manufacturing semiconductors due to silicon being the main element in the products (Aalto university, 2020).

However, it was not until the latter half of the 1990s when the area experienced a rapid growth in startups, referred to today as the 'dot.com boom' due to the belief that combining technology and Internet would change the world of business. The demonstrated success of companies such as *Amazon* and *Netscape* created optimism of becoming a prosperous business owner if one could create a website. However, the dot.com era turned out to be a bubble resulting in a global economic crash, demonstrating how invention might not necessarily lead to innovation and commercial prosperity (Aalto university, 2020).

Even after the dot.com bubble in the late 1990s startup ecosystems learned from its mistakes and accelerated its growth. In the early 2000s, numerous technology firms with a billion-dollar valuation only after a few years, started to emerge and capture the business opportunities created by modern technologies and the *Internet.* Firms belonging to this category include *Uber, Airbnb,* and *Tesla* among others, who all in common disrupted marketplaces and captured market shares from traditional firms. But even though the world of startups still has close ties to *Silicon Valley*, the community has spread and can today be considered global. Growth centers are nowadays present in Stockholm, London, Tel Aviv, Beijing, and Tokyo among others, with their own incubator and accelerator programs (Aalto university, 2020).

1.1.2. Barriers to commercial success for startups

Statistics show 10% of all startups eventually fail and reach bankruptcy (Startup Genome, 2019), and the failure rate seem to be consistent over industries (US Small Business Advocacy, 2012). *Shikhar Ghosh*, professor of Management Practices at *Harvard Business School*, claims 90-95% of technology startups fail, if failure is calculated as falling short of meeting a declared projection, and 70-80% if failure is defined as falling short on projections of return on investment (Nobel, 2011). While startup success rates are low, the underlying root causes behind failure can be accredited to one or many of the top 20 reasons mapped out by analysts at CB Insights (2019) as seen in Table 1.

Top reasons for startup failures	% of recipients
1. No market need	42%
2. Ran out of cash	29%
3. Not the right team	23%
4. Get outcompeted	19%
5. Pricing & cost issues	18%
6. User un-friendly product	17%
7. Product without a business model	17%
8. Poor marketing	14%
9. Ignore customers	14%
10. Product mistimed	13%
11. Lose focus	13%
12. Disharmony among team or investors	13%
13. Pivot gone bad	10%
14. Lack passion	9%
15. Failed geographical expansion	9%
16. No financing or investor interest	8%
17. Legal challenges	8%
18. Did not utilize network	8%
19. Burn out	8%
20. Failure to pivot	7%

Nine out of the top 20 reasons, and five out of the top ten reasons, for startup failure are directly related to the customers – no market needs of firm product, not meeting customer needs, nor acknowledging customer feedback. In line with the lack of customer focus is the lack of a sound business model (Patel, 2011). As discussed by Patel (2011), newly founded companies must understand their market, target customers and competition. To achieve this knowledge, companies must (1) search for a need, (2) evaluate whether this need is already being satisfied by the competition, (3) determine if the need can be satisfied while generating a profit, and (4) develop a customer offering.

1.1.3. Case examples: Successful and unsuccessful startups

In this subchapter, the story of two startups will be discussed, one designing and manufacturing technology products while the other operating in the biotechnology industry.

The first example discussed is **Apple Inc.** headquartered in California. Founded in 1976 by *Steve Jobs, Steve Wozniak* and *Ronald Wayne*, the company places itself in the top 10 list of the world's largest companies (Murphy, Tucker, Coyne, & Touryalai, 2019) with total net sales of $ 274.5bn for fiscal year 2020 (Apple, 2020). The company was initially named *'Apple Computer Company'* and their first product was a computer called *'Apple I'* which

entered the computer market with sufficient success. However, it was not until 1984 when Apple released the *'MacIntosh'* computer that the commercial success of Apple really took off (Business Checklist, 2019). While there are many reasons for Apple's success - from being a small startup in California in the 1970s to become one of the largest companies in the world - there are certain reasons which are not directly related to the quality of products. Below follows a presentation of these reasons:

- *Customer experience:* Apple's brand is based on fulfilling and catering the need of the market and thus the customer experience and service is highly prioritized for the firm. In fact, a main driver behind their sales has been the customer loyalty they have incited in consumers which they are well aware of (Business Checklist, 2019). The customer focus is partly due to the mindset behind product design. Apple engineers developed product features which they would prefer personally rather than developing features simply because they are capable to do it. Additionally, Apple religiously develops products under the idea of 'ease-of-use'. Engineers are of course striving to make the industrial design of products even better, but never at a cost of user-friendliness because then it is considered worthless (Bajarin, 2012).

- *Product improvement:* Products are only released to the market with some form of technological advancement, either in the operating system or adding new features, compared to the previous model (Business Checklist, 2019). Furthermore, Bajarin (2012) discusses Apple's idea of making products under the requisite the company can build something better than what is offered in the market. If they believe this is not achievable, they will not do it as explained by Apple's former product designer *Jonathan Ive*. Finally, Bajarin (2012) discusses the proactive development occurring at Apple. While competitors are focused on launching products for the current market situation, Apple is two years ahead, and product launches occurring in two years are already in development.

- *Dynamic business plan:* Steve Jobs constantly studied the market and enforced a market focus into the company, or as Viswanathan (2019) explains it: *"ascertains the pulse of the audience"*. Apple realized that to grow, the company must expand its product offering to not only include computers, an effect of market demand analysis (Viswanathan, 2019).

- *Partnerships:* In 1997, Apple entered an agreement with *Microsoft* worth $150m enabling *Microsoft Office* to run on Mac computers. Jobs explained that the notion of one company always benefiting from a rival's loss is outdated. Additionally, the company has also entered partnership with *Samsung* to manufacture and supply mobile parts to the competitor (Viswanathan, 2019).

The second example discussed is **Arivale Inc.** which was launched in Seattle in 2015 with the vision of creating a new wellness paradigm in the US through personalized, data-driven, and preventive coaching. By collecting data from customers, e.g., genomic, blood analytes and gut microbiome, along with behavioral science, Arivale's health coaches can develop recommendations on customers well-being (Arivale, 2019). The company received a total

funding of $52.6m (Hassan, 2019), served 5'000 customers over the firm's lifetime and employed 120 people (Bishop & Thorne, 2019).

Arivale demonstrated potential of disrupting the medical wellness industry and the technology community of Seattle voted the company as the winner of the *GeekWire Startup of the Year* in 2016 and the company was confident enough to trademark the term 'scientific wellness'. Nevertheless, to the surprise of both its customers and employees, Arivale decided to discontinue its operations in April 2019. An unexhaustive list of reasons behind the decision is the following:

- *No market demand:* As explained by ex-CEO *Clayton Lewis*, the US market is not mature enough and the average American was reluctant to invest large money into their future health. According to Lewis, people are living too much in the moment to consider optimizing their future health. Furthermore, *Paula Ladd* who founded *SNPgenomics*, a genetic testing startup founded at the same time as Arivale, stated that science has not advanced enough to offer wellness advice. The role genetic plays in overall wellness are not understood well enough by researchers, and thus not understood by the mainstream market. This is further discussed by Hassan (2019) who claims Arivale entered the market too early.

- *Offering was priced too high & wrongful go-to-market approach:* Related to the lack of market need, Bishop and Thorne (2019) explains that the pricing model was too high for customers and did not consider their price willingness. At launch their flagship service was offered for $3'500 per year but was later changed to a monthly subscription fee of $99 per month for ongoing testing and coaching, believing that the adoption rate would pick up when prices were lowered. However, the resources were limited due to high customer acquisition costs and the high costs associated with the offered services. As discussed by Hassan (2019), it would take time before Arivale could deliver services to consumers at a reasonable price point and they were not equipped to operate for an extended period at a loss. Concerning how Arivale entered the market, the company focused too much on perfecting their flagship program instead of trying to scale the business by offering lower-cost and simpler offerings (Bishop & Thorne, 2019).

- *Use of resources:* The funds for marketing spend was not used effectively. Instead of investing in digital marketing campaigns and create awareness of the offering, the firm focused too many resources on events and parties which ultimately was not effective in attracting customers. Additionally, Arivale did not balance supply with demand, leading to many health coaches having salaries without generating income (Bishop & Thorne, 2019).

- *Feedback culture:* Bishop & Thorne (2019) discusses the problems Arivale had with feedback. The executive team lacked coachability from rank-and-file colleagues on how to improve the company due to a state of renunciation that the team and the company could be improved.

To answer the question why Arivale closed, the overarching answer would be a lack of market focus and alignment. As explained by ex-CEO Clayton Lewis, some of the competing firms i.e., *23andMe,* were successful due to their relatively lower price point, one-time payment, and a more novel offering easier grasped by customers (Bishop & Thorne, 2019).

Conclusively, while Apple demonstrates a good market focus, Arivale clearly lacked market orientation before reaching bankruptcy.

1.1.4. Previous research

There have been numerous research papers investigating and identifying success factors for startups. Conducted research have identified influencing factors such as economic, social, and cultural. Social and cultural factors include among others distinctive features of the team, the innovative climate surrounding the startup and available infrastructure. Below is a selected list of papers.

In the research papers the definition of startup success varies. For instance, reports have studied the effects of open innovation and the challenges to implement it in technology startups (Carvalho Vieira, Willer do Prado, de Castro Alcântara, & de Souza Bermejo, 2015), the level of trust between an entrepreneur and the investors and how it directly affects venture success (Klabunde, 2015) and the concept of *'lean startups'* as a successful organizational structure for innovation networks and early internationalization (Stavnsager Rasmussen & Tanev, 2015). Moreover, one study investigates the growth ambitions of Finnish technology startups and concludes that team characteristics and experience, perspective on business scaling, and the complexity of the market environment influences growth opportunities (Wallin, Still, & Henttonen, 2016). While identifying the aforementioned factors Wallin et. al. (2016) also concludes that startups may have different growth patterns and thus the underlying drivers may not support growth equally.

1.2. Problem statement

While the research papers discuss relevant areas constituting startup success, there is limited focus on factors transforming technology startups from pure innovation focus to commercial success while sustaining a technological advantage. Referring to the case examples of *Apple* and *Arivale,* two major differences between the companies is the **market focus** and their **ability to create a customer demand.**

1.3. Main purpose

The main purpose of this master thesis is to identify, categorize and understand key success factors of transforming a high-technology startup from a pure innovation focused firm to a market and technology focused organization to ensure a sustainable competitive advantage.

1.4. Secondary purpose

The secondary purpose of this master thesis is to develop an applicable framework, encapsulating the key success factors, to help high technology startups evaluate their commercial position.

1.5. Research question

The following question will be answered to fulfill the purpose of this master thesis project:

What are the key success factors to turn a high technology startup from a sole innovation focused firm to commercial success?

1.6. Brief introduction to partner company

The intention of this subchapter is to give a brief introduction to this master thesis' case company. In chapter 5, a more extensive description is presented along with an explanation of the state of the semiconductor industry at the time of writing this master thesis.

The partner company (mainly referred to *The Company* due to interests of anonymization) is a semiconductor hardware IP provider founded in 2017 as a limited company. The company was co-founded by the inventor of a revolutionary hardware design based on a decade of research carried out at the *Department of Electrical and Information Technology at Lund University*. Since its founding, the firm specializes in providing highly efficient low power semiconductor design IP, which are tailored according to specific customer needs. This generates multiple benefits. Firstly, the power consumption of the complete chip is lowered by 70-90%. This implies that existing performance levels can be obtained with greatly improved energy consumption, alternatively the performance of the chip can be greatly improved, with retained energy consumption. Secondly, the tailored chip implies a chip which is physically more compact (CEO of 'The Company', 2021).

1.7. Delimitations

As previously discussed, the definition of startup success varies between research papers and is dependent on which stakeholder you ask. I.e., a financial investor might consider success according to return on investment (ROI) while a governmental stakeholder defines startup success as societal non-financial contribution. Hence, due to this ambiguity, the master thesis will not give a complete list of key success factors for a startup but rather delimit the factors to a combination of (1) becoming market focused and (2) keeping a sustainable competitive advantage through its technological capabilities.

Furthermore, the research will not consider the access to capital, e.g., raising capital from outside investors. Even though capital injections are vital for startup growth, the research will study factors focused on how the startup can set itself up towards the market it intends to serve.

Finally, the empirical study is restricted to one sample company only and data from external experts.

1.8. Target audience

The research is conducted together with the *Division of Production Management* under the *Department of Industrial Management and Logistics* at the *Faculty of Engineering at Lund University (LTH)*. Thus, personnel and students at the division can be inspired and take value from the thesis.

Furthermore, this master thesis is written in collaboration with a semiconductor startup and the research aims to provide insights to the company concerning their current commercial focus and which factors to consider when increasing market focus.

Finally, the concluding statements from this master thesis could bring value to current and aspiring technology entrepreneurs who are interested in knowing how to manage a commercially focused high technology startup.

1.9. Disposition

The master thesis contains seven chapters according to the following outline:

1. Introduction: The reader is given background information concerning the area of study and previous research followed by a problem statement, purpose, research question, delimitations, and target audience.

2. Methodology: In this chapter the reader is given an overview of potential research methodologies followed by a presentation of the selected methodology and the rationale behind the decision.

3. Literature review: The chapter explains academic theories and frameworks originating from two theoretical areas; market-orientation and technology strategy.

4. Hypothesized framework (v1.0): A proposed framework (v1.0) including key success factors to become commercially successful is presented. The framework presents factors in the intersection of the theoretical areas in the literature review.

5. Empirical results: Data collected from applying the hypothesized framework to *The Company* is presented along with feedback from external experts. A total of six interviews were conducted.

6. Discussion & framework revision: This chapter is two-parted. Firstly, an analysis is conducted based on insights from the empirical data to develop a revised model (v2.0). Secondly, the revised framework is quality assured, leading to a concluding framework (v3.0).

7. Conclusion: The findings from this master thesis are discussed in connection to the purpose. Moreover, the chapter ends by presenting suggestions for improvement, further research and the contribution to academia and *The Company.*

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2. Methodology

In the following chapter the applied research methodology is described in an exhaustive manner, with the pronounced objective of providing a holistic and transparent depiction of the research process. A description, motivation, and explanation of the chosen methodology, approach, and data collection is provided. This substantiates the reliability of the findings from this research.

2.1. Research structure

'The research onion' is a model interpreting research methodology, depicted in Figure 1 (Saunders, Lewis, & Thornhill, 2009, pp. 107-109). When conducting research, the researcher starts in the very outer layer of the onion, the philosophy, to determine how the researcher interprets knowledge and research. From the upper layer the researcher approaches the center of the onion methodically, one layer at a time. In each layer of the onion, the researcher must decide on an approach which answers the question in each layer. By doing this, the researcher ensures that the chosen method is thorough in all the six aspects covered in the onion's layers (Saunders, Lewis, & Thornhill, 2009, ss. 107-109).
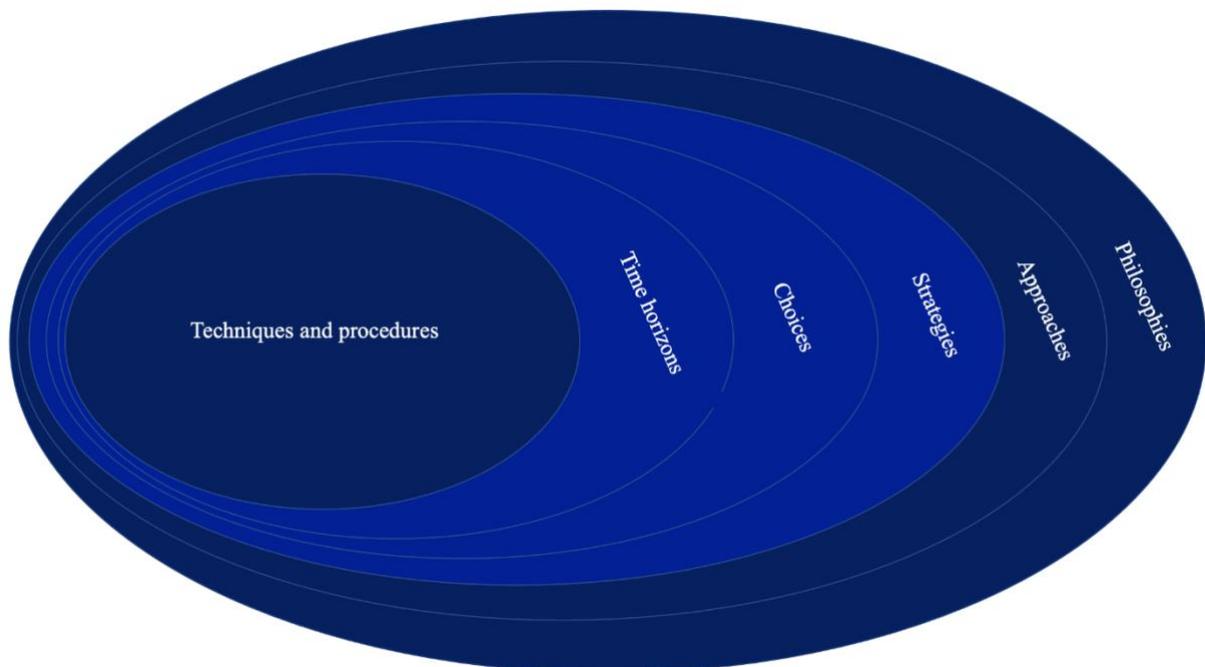
Figure 1: The research 'onion' (Saunders, Lewis, & Thornhill, 2009)

2.1.1. Research philosophy

The first layer of '*the research onion*' is research philosophy. The aim of this layer is to clarify the researchers' views on the nature and development of knowledge. Every researcher has a unique bank of experiences, which influence the way in which she views the world. This has influence on the assumptions, both conscious and unconscious, the researcher makes when conducting research. In the end it will affect the result of the research, and thus research philosophy is something every researcher should be aware of. According to Saunders et. al. (2009), there are four main movements within research philosophy, namely: pragmatism, interpretivism, realism and positivism. Below, each of the mentioned research philosophies is explained.

Firstly, *pragmatism* is characterized by its flexibility, it does not simply limit the researcher to a single way of perception of knowledge and the development of knowledge. According to pragmatism, it is perfectly possible to work with a variation of the other three research philosophies. The researcher who follows a pragmatic philosophy is not restricted to one philosophy and may alternate between philosophies during course of work (Saunders, Lewis, & Thornhill, 2009, p. 109).

Interpretivism is characterized by the perception that human beings, to a large degree, are influenced by their social setting in which they are a part of. Therefore, the interpretivism advocates the importance to distinguish the difference of conducting research on humans rather than objects. The interpretivist philosophy emphasizes the importance of the researcher to understand the research object's point of view. Due to the nature of business and management research, interpretivism is often viewed as an appropriate research philosophy when conducting research in this field (Saunders, Lewis, & Thornhill, 2009, pp. 115,116).

Realism is characterized by the perception that the world is what the researcher sees, and objects have an existence which is independent of the researcher's mind. Objects should be studied without being affected by the researcher's views. In the realist approach there are two main movements: direct and critical realism. The direct realism suggests the world shall be studied exactly as the researcher perceives it, as this would be the most accurate portrayal of reality. Also, the direct realism perceives the world as static, and that every research should be conducted at one level only (organization, group, individual, etc.). However, the critical realism does not agree with the idea that the world is an exact depiction of what the researcher sees. Instead, critical realism argues that what the researcher sees is only an image of the actual world and not the actual world. Critical realism argues everything the researcher sees has been distorted by her senses. Also, critical realism, in contrast to direct realism, does not perceive the world as static but rather as something which is in constant change, and that research must be conducted at all levels (organization, group, individual, etc.), as every level may provide the researcher with different insights which in the end may change the researcher's conclusions (Saunders, Lewis, & Thornhill, 2009, pp. 114,115).

Lastly, *positivism* is characterized by its structure and lack of bias. It is favored by many natural scientists. The philosophy revolves around a hypothesis which is based on known knowledge, the hypothesis will then be tested, and confirmed or discarded. The research should be straight-forward for another researcher to replicate. The result of a study conducted in the positivist philosophy will often be in line with law-like generalizations, which is common in natural sciences (Saunders, Lewis, & Thornhill, 2009, pp. 113,114).

Due to the nature of this master thesis, with the purpose of finding principles for commercial success in a high technology start-up, the research is conducted as a case study. Collected data will consist mainly of qualitative data, but to some extent also quantitative data, giving the research a multifaceted and complex character. With this considered, we decide to work according to the interpretivist philosophy.

2.1.2. Research approach

The second layer of the *'research onion'* is the research approach. The aim of this stage, or layer, is to clarify how the researcher shall work with hypotheses and theory. There are two main approaches: the *deductive* and the *inductive* approach (Saunders, Lewis, & Thornhill, 2009, p. 124).

The *deductive approach* is often associated with natural sciences. It is based around a theory and a hypothesis which is formed at the start of the research, there after a research strategy for how the hypothesis might be evaluated is formed. The deductive approach requires a structured methodology to enable a high degree of replication. It is also important that the studied phenomenon can be measured quantitatively. The results derived from a deductive study shall be of a general character, and therefore the sample size must be of a sufficient size to be statistically reliable. The deductive approach is often associated with the positive research approach.

If the deductive approach is centered around a theory and a hypothesis, the *inductive approach* is quite the opposite. If this approach is used, the researcher starts by gathering data and studying the environment. Hypothesis and theory are thereafter developed from the recorded patterns. Inductive research is often favored when the deductive approach is considered too rigid, the deductive approach may overlook alternative explanations or oversimplify complex problems. Due to this, induction is often the favored research approach in social sciences (Saunders, Lewis, & Thornhill, 2009, pp. 125,126).

A third approach is a mix between both the inductive approach and the deductive approach, namely an *abductive approach*. It allows the researcher to continuously work with both theory and empirics, and therefore new theories may be developed through iterations. The researcher forms a hypothesis based on the available theory, and thereafter she challenges this hypothesis with empirics, with the goal of finding a general solution (Saunders, Lewis, & Thornhill, 2009, pp. 127,128)

Since this master thesis bases a hypothesis on literature, later testing the hypothesis empirically and iteratively modifying the framework based on empirical and theoretical findings, the thesis applies an abductive research approach.

2.1.3. Research strategy

Moving on to the third layer of the onion, we approach the research design. The first layer of the research design is the development of a *research strategy*. When developing a research strategy, the most decisive aspect is the problem, and how the problem shall be addressed. Apart from this, research philosophy, the researcher's current knowledge in the field, the research objectives and the available resources also comes in to play when deciding on a strategy. Saunders et. al. (2009) mentions seven research strategies: *experiment, survey, case study, action research, grounded theory, ethnography*, and *archival research.*

The experimental strategy is commonplace in natural science, but also frequently used in social sciences, especially in psychology. An experiment is used to examine relations between variables and answers the questions "why" and "how". When conducting experiments an experimental group and a control group is assigned, the objects which are selected for each group is selected at random to avoid sample errors. The experimental group is then exposed to an experiment, whereas the control group is not. The results from the experiment are compared to the results of the control group to draw general conclusions of the impact attributed to the experiment. Experiments are however in many cases not suitable for research in a business or management context (Saunders, Lewis, & Thornhill, 2009, pp. 142-144).

Survey studies are commonly used due to its ability to gather large quantities of data, in a simple and affordable manner. However, the analysis of survey results is often time consuming. The survey strategy is commonly used in conjunction with a deductive research approach due to its ability to answer questions such as: "who?", "what?", "where?", "how much?" and "how many?". Due to the survey's ability to collect large amounts of data, which often is used for explanatory or descriptive purposes, surveys have found popularity in areas within business and management research (Saunders, Lewis, & Thornhill, 2009, pp. 144,145).

Case studies stands in stark contrast to the experimental strategy. A case study is used to investigate a specific occurrence in a factual setting, through empirical studies of the setting. When conducting case studies, the boundaries between the occurrence which is studied, and the setting in which the occurrence happens, is at sometimes vague. Therefore, case studies are appropriate when the aim of the research is to understand context and the processes in the organization of interest. Case studies are appropriate to answer the following questions: "why?", "what?" and "how?". The data collection is often a mix of different techniques, usually interviews, observations etc. It is common to use triangulation to ensure that the conclusions drawn are correct. Triangulation refers to the use of multiple data collection techniques to validate conclusions (Saunders, Lewis, & Thornhill, 2009, pp. 145,146).

Action research is an iterative strategy where the emphasis lies on transformation, and follows a process of diagnosis, planning, acting and evaluation. Saunders et. al. (2009) describes it as: *"the action research spiral commences within a specific context and with a clear purpose. This is likely to be described as an objective".* The action research strategy differs from other research methods in that it explicitly studies action, often in the guise of change within organizations. It is therefore a common research strategy within consultancies but may be lacking when applied to develop new theories. Action research is often useful when answering the question "how?" (Saunders, Lewis, & Thornhill, 2009, pp. 147,148).

Grounded theory is a useful method when developing new theories to explain and predict behaviors or phenomena. It combines induction and deduction to generate theory. When conducting a study using grounded theory, data is collected without the researcher forming a hypothesis prior. The collected data is then used to develop a theory. Theory and predictions are tested through multiple observations, which leads to confirmation or rejection of the hypothesis. It is an iterative process were observations relation to theory leads to further development of theory (Saunders, Lewis, & Thornhill, 2009, pp. 148,149).

Ethnography is commonly used within social studies; a way to describe the social environment in a way which the research subjects, as a part of this environment, would describe it. However, it is time-consuming as the researcher must become part of the social world which is studied to be able to describe it in an accurate way. Also, the researcher needs to have an open mind to be able to respond to changes of thought as the researcher constantly gains more insight. Most ethnography research involve participant observation, as many methods of data collection would risk oversimplifying complex matters which occur in a social setting (Saunders, Lewis, & Thornhill, 2009, pp. 149,150).

The last of the seven strategies is *archival research.* This research strategy is built around a data collection primarily from documents and administrative records. One important aspect of archival research (i.e. literature research) is that the documents which are used for data collection have not been collected for a research purpose, but rather they are interesting to analyze as a part of an organization's ongoing operations. The archival research method is appropriate when the researcher wants to study the past or historical changes. However, the research may be constrained by the available documents and the level of detail of these documents (Saunders, Lewis, & Thornhill, 2009, p. 150).

Due to the nature of the research, we apply the *case study strategy*. The purpose of our research is to find essential growth foundations for start-up businesses in a high technology environment. The questions which are characteristics of a case study were found to be applicable for the purpose of this research.

2.1.4. Choice of method

In this setting, the choice of method refers to the type of data which will be collected during the research. That is, quantitative data or qualitative data, which in turn may be divided into subgroups. It also concerns whether data should be collected through a *mono method,* that is by using only one method of data collection, and thereby only obtain one type of data, or if data should be collected using *multiple methods.* By using multiple methods, the conclusions will be based upon the findings from multiple research methods, and therefore minimizing the sources of error. If applicable it may therefore be useful to gather data through multiple methods (Saunders, Lewis, & Thornhill, 2009, pp. 151-155).

Due to the nature of this thesis being conducted as a case study, multiple types of research methods will be used, and the collected data will mainly be qualitative, originating from interviews with employees at *The Company* and external experts.

2.1.5. Time horizon

When conducting research, one must decide on whether the research should have a snapshot character or a representation of a longer time period. The snapshot approach is known as *cross-sectional studies* and is useful when describing a phenomenon in a given time frame. The other approach, where studies shall represent a longer time period, is known as a *longitudinal study.* This is a useful method when studying changes over time (Saunders, Lewis, & Thornhill, 2009, pp. 155,156).

Due to this research studying a phenomenon in a limited time frame, the authors have chosen to use a *cross-sectional time horizon.*

2.1.6. Techniques & procedures

In the following subchapter follows a description of how the research for this master thesis were conducted. An explanation of literature review, case study, data collection and the analysis of these findings will be the focus of this subchapter.

2.1.6.1. Literature review

One of the first steps we took when working on this thesis was to conduct a literature review. The purpose of this was to establish a theoretical understanding and context for the construction of the thesis. The main part of studied literature was in the fields of start-up growth, innovation, marketing, and technology strategy. These fields were by us assumed to be the most relevant fields when studying important factors for start-up growth.
Some of the relevant literatures were already known to us. However, most literature was found through recommendations from our academic supervisor and through searches in

academic databases. The most frequently used databases were Lund University's own data base *LUBSearch*, and *Google Scholar.* When searching in these data bases key search terms were e.g., startup growth, strategy, and hardware marketing. We also had some luck, when a peer from *The Royal Institute of Technology*, *Lucas Molin*, informed that he recently had written a thesis in the field of growth in hardware electronic start-ups, providing us with a good insight of relevant literature as well as inspiration (Molin, 2020). We also found some usefulness of the *"subject pearl growing",* a method where the researcher finds topics related to a search result, which is useful when the database includes subjects in the search result (Hansson, 2019).

2.1.6.2. Selection of case company

Due to the specific delimitations of this master thesis, in combination with the thesis being written as a task assignment for *The Company,* it is reasoned that due to the comprehensive nature of this study, further studies of another company within this industry would not provide us with additional insights. I.e., one case company, along with the comprehensive 'deep dive' into the startup, gives enough insight to draw adequate conclusions compared to having multiple case companies with limited 'deep dive' research.

2.1.6.3. Data collection

The empirics used for this master thesis was collected mainly through interviews and archival studies. When collecting data through interviews, we applied a semi structured approach. A semi structured interview is structured in the way that the interviewer has a set of prepared questions related to the topic of interest, however the interviewer has the option to ask unprepared follow up questions, change the order of questions or skip questions. The structured interview also uses a set of predetermined questions, but the interviewer is not allowed to depart from the interview guide (Saunders, Lewis, & Thornhill, 2009, p. 601). The unstructured interview is informal in its nature and lacks structure, resembling a chat between the interviewer and the interviewee (Saunders, Lewis, & Thornhill, 2009, p. 603). The structured interview is used to collect quantifiable data, the unstructured interview is used to collect in depth qualitative data related to a subject of interest and, the semi-structured interview is used to collect qualitative data related to a variety of predetermined subjects (Saunders, Lewis, & Thornhill, 2009, pp. 320,321). The semi structured approach is well adapted when conducting a case study, as this gives flexibility to the interviewer, and enables a broader scope for the interviewee's answer with possibility of follow up questions (Lekvall & Wahlbin, 2014, p. 271).

Another important aspect of interviews is the number of participants in each interview. The most obvious approach are personal interviews, with one interviewer and one interviewee. An alternative to this is group discussions, with multiple interviewees discussing. This method takes use of group dynamics, which may lead to participants expressing opinions which may not have been expressed in a personal review (Lekvall & Wahlbin, 2014, pp. 265, 269, 270).

The interview may be conducted in several ways; in person, through the Internet or by telephone (Lekvall & Wahlbin, 2014, p. 261). The one-on-one interview is generally considered to be superior in terms of the quality of the collected data, however it is harder to recruit interviewees and a more expensive method when compared to the alternative methods of internet and telephone interviews (Lekvall & Wahlbin, 2014, pp. 265-269).

Even though the *Covid-19 pandemic* was raging at the time of writing this master thesis, which for many researchers complicated the matter of interviewing, we were lucky, as we had the possibility to interview the employees of *The Company* in person. Moreover, we had the opportunity to interview one of the external experts in person, while the second expert interview was conducted through live cam due to locational differences. In total, six interviews were conducted when developing the framework and further three interviews were conducted as part of a technological audit. The interviews were later validated by presenting the empirical notes to all respondents. Due to the authors becoming a natural part of the office team at *The Company*, this further simplified the task of getting employees to volunteer for interviews and making the interviewees more relaxed, and hopefully more honest, when interviewed. As we had a neutral relationship with the company, this helped us with the task of staying objective when analyzing our findings. Secondary data was used to complement the collected first-hand data. Secondary data was collected through multiple sources, e.g., research articles, news articles and web pages.

The authors conducted interviews both to implement a technology audit, which can be found in the appendix, and to challenge the hypothetical framework. However, interviews were not conducted to form a *"marketing audit"*, as this was not deemed necessary. Data was available internally at *The Company*, and in combination with informal discussions with the CEO and CoB, it is deemed satisfactory to provide an overview of this area.

2.1.6.4. Analysis

Our research was conducted as an in-depth case study, where our hypothesized framework (v1.0) was applied to *The Company*. We began by discovering and evaluating relevant theory, which was later used as a base for the empirical research. The empirical findings were structured according to the theoretical findings. This was later used to reflect upon the subject in the discussion chapter. This was concluded in the revised framework (v2.0) which was based on the first framework, although with the empirical findings applied. For the final revision of the framework (v3.0), an internal quality assurance was conducted to make the framework even more applicable and forceful. For this process, we utilized the seven evaluation criteria presented by *David Gray* in his article *What Makes Successful Frameworks Rise Above the Rest.*

2.1.6.5. Reliability of research

To minimize the risk of faulty or misleading research results, the researcher should always keep reliability and validity in mind. However, the researcher can never be completely sure that the research findings are true, but by focusing on reliability and validity the probability of the findings being true greatly increases (Saunders, Lewis, & Thornhill, 2009, p. 156).

Reliability means the research is conducted in such a way that the results are consistent. If the findings are replicable by other researchers, and the interpretation of data is transparent, it is likely that the research has been conducted in a reliable manner. However, there are several threats to reliability which must always be considered. The threats of participant error and participant bias is a real threat when performing interviews or surveys. Participant error suggests the interviewee's answers are influenced by e.g., the interviewee having a bad day. Participant bias means the interviewee adjusts the answers to fit an agenda, e.g., due to loyalty to an organization. To mitigate the risk of participant error and bias possible solutions are to conduct research in a neutral setting and ensuring that results are anonymized. To achieve anonymization, we and the case company mutually agreed upon, that the presentation of each interviewee will be restricted to their work title. Moreover, each respondent will be given a reference, i.e., IP1, which is allocated in chronological order and is thus not connected to his or her respective job title. Another risk is that the researcher, due to bias or error, interpret collected data in a faulty way. These risks are possible to mitigate by conducting research with a high degree of structure, and by designing the research in a way which minimize researcher bias (Saunders, Lewis, & Thornhill, 2009, pp. 156,157). Validity, on the other hand, means the research studies what is meant to be studied, and that it has been studied in an appropriate way. Threats to validity are often related to different happenings during the time of research which may affect the results, e.g., participants dropping out of a study before it has been finalized, or interviewees having a negative approach toward questions regarding *Volkswagen* shortly after *"Diesel Gate"* (Saunders, Lewis, & Thornhill, 2009, pp. 157, 158).

We have aspired to ensure both planning and implementation of the research are described as transparently as possible to safeguard a high degree of reliability. To guarantee a high degree of validity, a variety of research methods were used. When conducting interviews, the researchers interviewed employees with different roles and relations to the case company. After compilation of data, the interviewees were allowed to validate the findings to avoid errors.

2.1.6.6. Authors' contributions

As part of a master thesis written by two engineering students at *the Faculty of Engineering at Lund University,* a presentation of who was responsible for what content should be given. *Gustav Christensen* was responsible for the *Introduction* chapter and the subchapter *Market focus: A literature review of concepts & frameworks*. *Alexander Bengtsson* was responsible for the *Methodology* chapter and the subchapter *Technology-oriented competitive advantage:*

A literature review of concepts & frameworks. Remaining chapters have been the outcome of joint efforts.

2.2. Summary of research method

As stated in the previous chapter, we choose to apply an *interpretivist philosophy,* in conjunction with an *abductive research approach.* The research was conducted as a *case study*, as a deduction from this data was collected through multiple methods. The research was conducted during a specific time, and the time horizon was therefore *cross-sectional.* The used methods for data collection were *literature studies, a case study, interviews, and archival research.* Figure 2 illustrates the chosen research method.
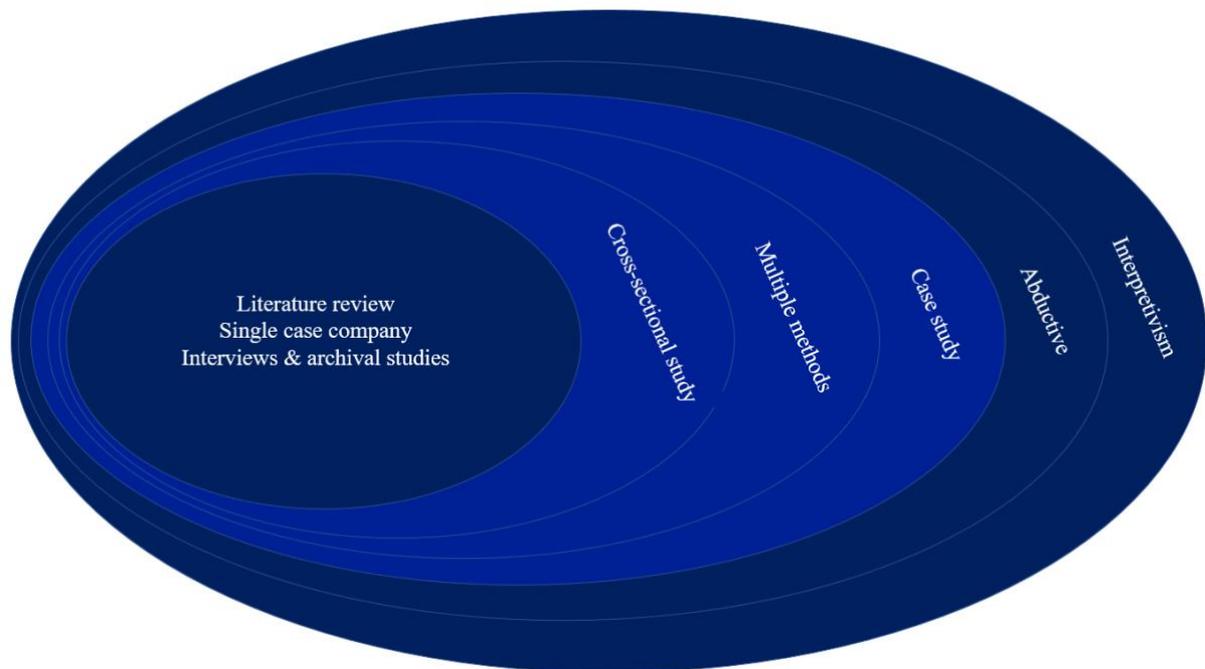
Figure 2: The researchers' chosen research structure (Saunders, Lewis, & Thornhill, 2009)

3. Literature review

In the following chapter, the theoretical foundation, including key concepts and frameworks from the literature, will be discussed. Based on the introduction, this master thesis defines drivers for technology startup success as (1) creating a market focused organization and (2) keeping a sustainable technology-orientated competitive advantage. Thus, the review will cover ideas concerning market focused organizations and technology strategy, which will act as a knowledge base for the master thesis' development of key success factors of startup commercialization.

3.1. *Market focus:* A literature review of concepts & frameworks

3.1.1. Defining invention, innovation, entrepreneurship & intrapreneurship

Before discussing concepts and frameworks concerning market focus it is necessary to understand the difference between invention and innovation as well as intrapreneurship and entrepreneurship. *Invention* is a process of generating new ideas and making sure these ideas are practically working, not only in theory (Roberts, 2015). According to Roberts (2015), the inventor, similar to an artist or poet, starts with a 'blank piece of paper', but with his or her training, experiences and intuition is able to create a solution or a problem. However, due to strict rules in patenting, a solution to a problem must fulfil two requirements (Potts, 1944). Firstly, the inventor must show newness in how things is currently being done and secondly, must show newness in the shape of novelty, meaning that the solution requires to some extent mental exertion. Furthermore, as discussed by Potts (1944), there is a difference between (1) improvements which could be achieved with prior knowledge from a person 'skilled in the art' (e.g., a biochemistry scientist if the solution is in biochemistry) and (2) inventions which are not obvious for a person skilled in the art and thus considered as 'a dignity of invention'. While the invention process includes all activities when creating a new idea and making sure the idea practically works, Potts (1944) describes that is does not embrace the commercial perspective. Hence, this is the factor separating innovation from invention which can be seen in Figure 3:
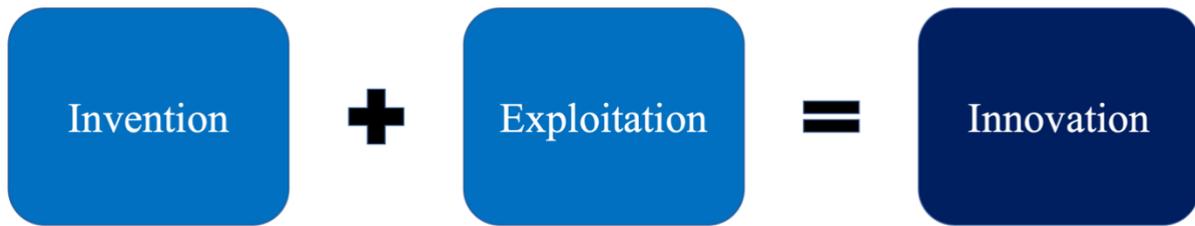
Figure 3: The difference between invention and innovation

Innovation includes aspects of invention, with addition of commercial activities and an application of the invention. E.g., developing the invention towards specific objectives, evaluating, the broad utilization of the invention among consumers, disseminating the outcomes of the technology. Technological innovations can be either radical or incremental; adjustments of existing products or entirely new products; embodied in products, services, or processes; targeted toward end customers or the government. All in all, innovations are focused on how the invention can make a difference for the market it intends to serve (Potts, 1944).

With the definition of innovation, it now makes sense to discuss the two practitioners of innovation: *entrepreneurs and intrapreneurs*. In a world ever more affected by technology, it is no longer sufficient to only be driven by the notion of staying ahead of competition but instead bring innovation to the market. Hence, this is where entrepreneurs and intrapreneurs have an essential function to help either established or newly found companies utilize new business models or capture value from new markets (Maier & Pop Zenovia, 2011). Similar to the definition of startup success, the academic definition of *'entrepreneurship'* varies widely. E.g., it has been described as a way of carrying out new combinations of firm organization in terms of new products and services, markets or forms of organization (Schumpeter, 1934), or a mindset of thinking which is focused on opportunity, innovation and growth (Allen, 2006). Based on the various definitions throughout the 20th and 21st centuries, there are four commonalities of entrepreneurship (Dollinger, 2008):

1. *Creation and innovation:* Creation implies the founding of a new entity which disqualifies the acquisition of an existing organization or a transfer of new owners, and innovation referring to the definition by Schumpeter (1934).

2. *Resource management:* Focuses on the identification, acquisition, and mobilization of resources. The resource-based view describes how entrepreneurs can create a business with the resources and capabilities they have at hand or can realistically acquire. The theory argues that competitor, industry, and economics analysis is insufficient to ensure startup success. Instead Dollinger (2008) suggests choosing the right resources for the startup, manage these resources according to a consistent strategy and refining them are essential parts of the entrepreneurial act.

3. _Economic organization:_ Implying an organization with a purpose to allocate scarce resources either as a standalone company, a business unit, or a not-for-profit organization.

4. _Risk & uncertainty:_ Focuses on the opportunity for gain or increase in an ambiguous environment. As explained by Dollinger (2008), there is a distinction between risk and uncertainty. Risk refers to the real outcome out of multiple hypothetical outcomes. Hence, in a risk-free environment there is no upper bound for growth due to the impossibility of negative outcomes. In reality, the risk factor is a limitation of ever-expanding entrepreneurship. Uncertainty connects to the entrepreneur's confidence in his or her own estimates of how the world works and their understanding of cause-and-effect mechanisms. Without the uncertainty especially present for entrepreneurs, everyone would know the future, leading to unsustainable profits. The combination of risk and uncertainty is, according to Dollinger (2008), what signifies entrepreneurship.

Intrapreneurship, similar to entrepreneurship, relates to innovation but in a different setting. Instead, intrapreneurship is characterized by entrepreneurship in an organization relating to behaviors of an organization which seeks to avoid the habitual practices. It refers to the development of new ventures but also innovative actions e.g., new product development, technologies, and strategies (Hisrich & Antoncic, 2003). Furthermore, Maier and Pop Zenovia (2011) discusses how intrapreneurial activities are pursued by a group of staff members under the supervision of a manager, also known as the intrapreneur. The objective of the intrapreneurial activities is to improve firm economics by utilizing resources which previously have been used ineffectively. In essence, as argued by Hisrich and Antoncic (2003), intrapreneurship can be seen as a form of 'corporate entrepreneurship'. A comparison between entrepreneurship and intrapreneurship can be seen in Table 2.

Table 2: Comparison between entrepreneurship & intrapreneurship (Maier & Pop Zenovia, 2011)

Entrepreneurship	Intrapreneurship
Advantages	
Independency and the opportunity to be your own manager	Being part of a well-known environment
Opportunity to be original by creating, e.g., a new product, service, or technology	Practicing tasks under lower risk and uncertainty
Part of an adventurous business journey which brings excitement	Utilizing company resources, brand, and knowledge base
Freedom to make decisions, e.g., salary	Access to customers and established infrastructure
Disadvantages	
Monetary uncertainty and giving up on certainty of regular paychecks	Rewards may not live up to expectations
Long working hours	Innovation could risk not being fully appreciated

Missteps are detrimental for the business, and you receive limited support in decision making	Freedom to innovate is restricted due to interest of your manager

3.1.2. Prerequisites & tools of forming a market-oriented organization

In its simplest form, market orientation can be described as a business philosophy suggesting that long-term company profitability is a consequence of a firm's ability to satisfy the needs of a target market segment by coordinating firm activities (Deng & Dart, 1994). A real-world example of achieving a better market orientation is the case of *General Electric,* who shifted its new product development process by initiating it through studies of consumer needs (Gotteland, Haon, & Gauthier, 2007). This strategic change ensured General Electric did not invest in product development processes which did not bring any value to the consumer, a decision in line with the theory of marketing myopia suggesting that companies should focus on meeting customer needs rather than selling products to ensure continued growth (Levitt, 2004). Levitt (2004) suggests industries who first experience growth enthusiasm, and later awaits a decline, is not the result of a saturated market, but rather a management failure. *Levitt,* professor emeritus in marketing at *Harvard Business School,* argues there are five factors to consider ensuring market orientation, whereof the latter four factors relate to an undetected growth decrease. These five factors are presented and exemplified in Figure 4.
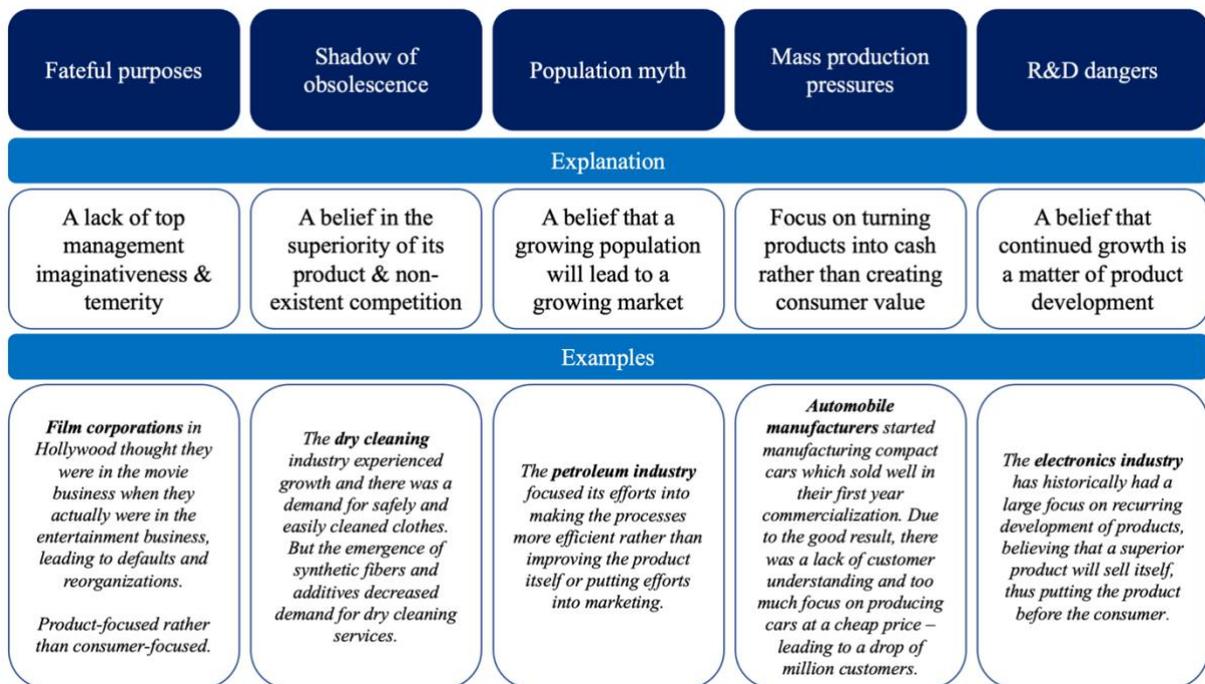
Figure 4: The five factors of marketing myopia by Levitt (2004)

An alternative description of being a market orientated organization is in its essence about collecting, sharing, and using information about the market – including customers, competitors, partners, technology, and trends – to take decisions which will lead to superior

customer value (Mohr, Sengupta, & Slater, 2010, p. 104). Furthermore, Mohr et. al. (2010) illustrates a market-orientated business by the following four dimensions as seen in Figure 5.
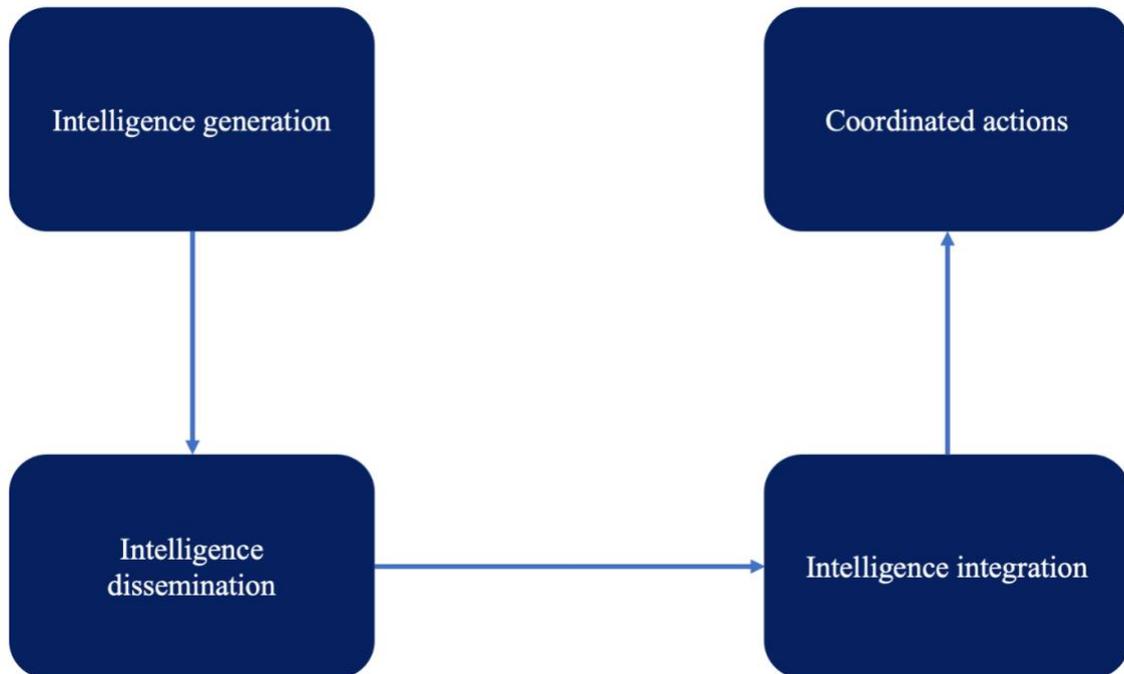
Figure 5: The four dimensions of market-orientation (Mohr, Sengupta, & Slater, 2010)

3.1.2.1. Intelligence generation

Intelligence generation concerns the collection of a wide array of knowledge about market forces including (1) current and future consumer needs, (2) capabilities and strategies of the direct and indirect competition and (3) emerging technologies both inside an industry and externally. Depending on whether the firm is either customer or competitor orientated suggests their type of innovation. A competitor focused firm is connected to a firm's ability to put investments into existing products – leading to incremental innovations – while consumer orientated firms focus investments on new knowledge and skills which more likely lead to radical innovations (Mohr, Sengupta, & Slater, 2010, p. 106). Not dependent on the type of innovation is the firm's strategy of collecting market data, which can be achieved either by having a *responsive or proactive market orientation,* as illustrated in Figure 6.

While Friedman (2007) argues current market intelligence is of importance to understand consumer behaviors and needs, he also suggests that listening too carefully to consumers can subdue firms' innovativeness and limit ideas in the boundaries of customers' own articulation of their needs. This limitation was already highlighted by the automobile innovator and founder of the *Model T, Henry Ford*, in the following rumored quote: *"If I had asked people what they wanted they would have said faster horses"* (Vlaskovits, 2011). Responsiveness may lead to marketing myopia and ideas of solving consumer current needs with existing technologies. Although seen as a safe strategy, in the longer perspective it can be detrimental as disruptive innovations arise. An imminent example of this trap happened with the *5.25-inch disk drive,* a technology introduced in the first half of the 1980s, which was closely

connected to the emerging personal computer. Consumers of these discs showed limited interest in new technologies associated with the disc which led to leading manufacturing firms not allocating resources to new technologies. Consequently, this allowed for industry disruption by new entrants gaining industry leadership, illustrating the risk of being too responsive to current market needs (Mohr, Sengupta, & Slater, 2010, p. 107).

On the other side of the continuum are corporations categorized as proactive and actively trying to identify future trends and consumer demands. Firms with a proactive market orientation are concerned about latent needs which are not apparent to the competition, meaning these needs exist but are not yet known to consumers themselves. Also connected to market proactiveness is the idea presented by Day & Schoemaker (2005) in their article concerning the scanning of the firm's periphery. They suggest the greatest threat to an incumbent are the companies you do not see coming and who swiftly penetrates the market. By having a strong peripheral vision and quickly identify these threats and anticipate the potential damage is an essential skill needed to foresee competitive threats (Day & Schoemaker, 2005), as seen in Figure 6. Putting further emphasis on the notion of scanning the market for threats, *Clayton M. Christensen* discusses how great companies fail to remain on top when they confront disruptive changes in markets and technologies initiated by emerging competitors (Christensen, 1997). While consumers must not be dissatisfied with the current offering, they will be pleased once they are aware of the new-to-the-world offering. E.g., post-it notes by *3M* satisfied a latent need of quickly and easily take notes and organize thoughts, but it had not been expressed by the consumers themselves before the product was commercialized (Mohr, Sengupta, & Slater, 2010, p. 107). Referring to the quote by *Henry Ford*, the consumer needed a faster horse because they had no clue what a car was and how it could replace horses as a mean of transportation.
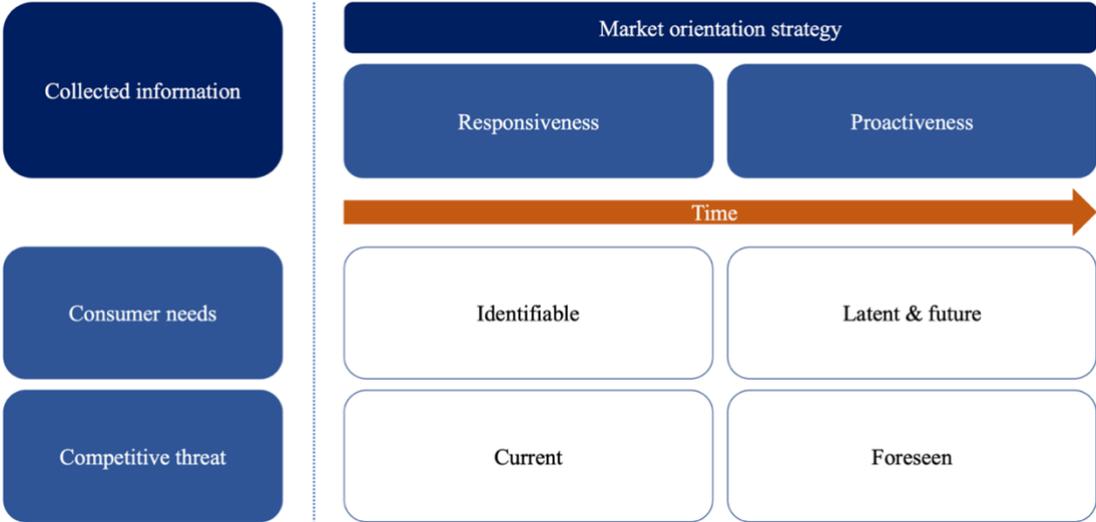
Figure 6: The continuum of current & anticipated market data (Friedman, 2007)

3.1.2.1.1. Methods for collecting customer data in a high technology environment

Collecting market data in high technology environments is not always as substantial as in other less innovative-driven industries due to consumers unawareness of new technologies and their understanding of how these might satisfy current needs. Depending on the nature of the data collected, as presented in Figure 7, various intelligence gathering methods can be applied and hence be aligned with the type of innovation (Leonard-Barton, Wilson, & Doyle, 1994).

| Incremental innovation | | Breakthrough innovation |
| The consumer need is known | | The consumer need is not known |

| Traditional market research | | Market intuition |

Concept tests	Customer visit programs	Customer-driven innovation
Conjoint studies	Empathic design	Biomimicry
	Lead users	
	Quality function deployment	
	Prototype testing	
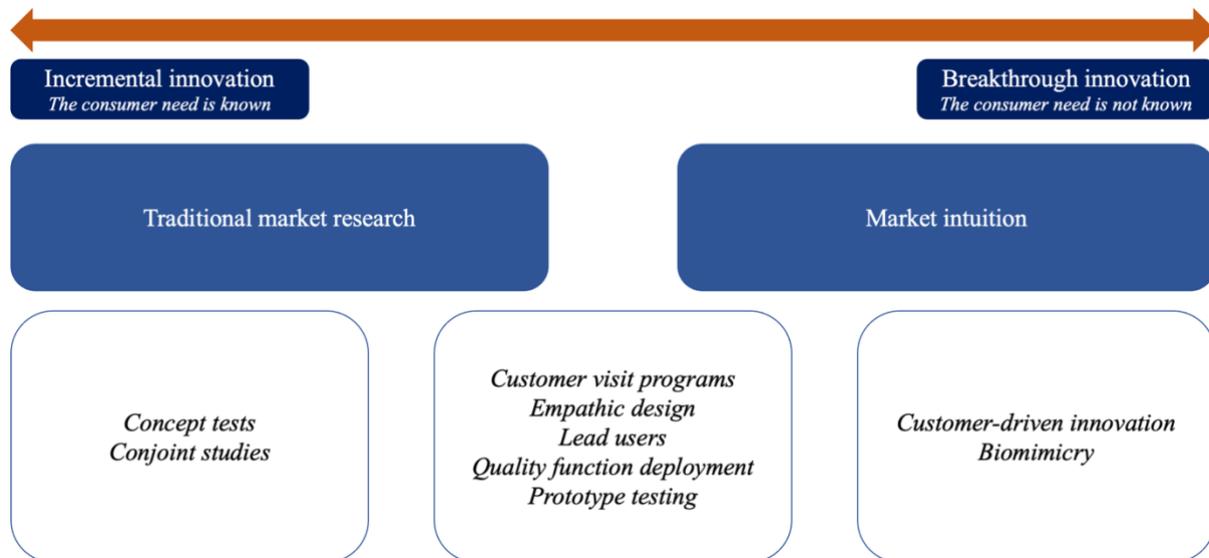
Figure 7: Methods for collecting market data (Mohr, Sengupta, & Slater, 2010, p. 191)

3.1.2.1.1.1. Concept testing

The idea behind concept testing is to either estimate how a new product or innovation will be accepted by the consumers before investing substantial money into the idea or to determine potential target segments of the market and identify areas of improvement (Moore W. L., 1982). While concept tests are based on a concept, Moore (1982) argues it does not per se test 'concepts', but rather whether a 'concept statement' is accepted by the market or not. The distinction is important to make because a concept is simply an idea in someone's mind, and it does not test aspects such as positioning or execution – which are also important components in the consumer's evaluation.

A new product development project typically starts with generation of ideas of how known consumer needs may be addressed with the objective of listing as many ideas as possible due to the low percentage of ideas which eventually become profitable. Table 3 lists some approaches when generating ideas.

Idea generation approach	Description
Brainstorming	Employees from different business departments (engineering, sales, marketing, manufacturing) have a structured discussion through a series of creativity exercises
Focus groups	Consumers from the target segment are questioned about how certain products or services can satisfy their needs
In-depth interviews	Target consumers are interviewed one-on-one in a longer session about current (and latent) needs and potential products or services which could meet these expressed needs

A concept test is then used to evaluate all ideas generated during the generation phase with the main objective of finding one or two ideas with the highest probability of commercial success. R&D and marketing resources are then allocated to the selected ideas. Before filtering ideas, each idea is briefly described in two paragraphs commonly including product name and price, and then presented to potential target consumers for assessment. Consumers give each idea a score based on parameters such as interest of testing product, uniqueness, and perceived value (Mohr, Sengupta, & Slater, 2010, p. 192).

3.1.2.1.1.2. Conjoint analysis

Conjoint analysis is a research tool to investigate product and pricing preferences of target consumers to help organizations select features and predict market adoption (Conjoint.ly, 2021). The analysis can be used to statistically predict various combinations of product attributes to determine which combination consumers most likely prefer to purchase. Each respondent in the conjoint analysis answers a survey where they make a judgment about their preferences (e.g., price, brand, warranties, and technical service) which can be scored on a scale. The collected data assists organizations in understanding the trade-off mechanisms of consumers, thus leading to a product offering aligned with consumer preferences (Mohr, Sengupta, & Slater, 2010, p. 193).

3.1.2.1.1.3. Customer visit programs

A customer visit program is a systematic plan of visiting customers (or inviting customers to your office location) with the purpose of understanding their needs and greeting the customer with a cross-functional team. Complementary to the usefulness of a customer visit program when commercializing new products, it can also be used to study customer satisfaction and determining new market segments (Mohr, Sengupta, & Slater, 2010, p. 194). While there is no clear format of a customer visit program, one alternative is to invite the customer for a 30-

minute discussion where employees from different parts of the organization get an opportunity to meet the consumer and understand how they use the company's product(s) (Hipsman, 2017). Hipsman (2017) suggests a few alternatives to incentivize the customer to sign up for a customer visit session. E.g., it is suggested that your own firm calls up the customer to develop an agenda and decide on the details followed by your marketing team booking the room, inviting the right people, and ordering lunch.

3.1.2.1.1.4. Empathic design

One argument against the aforementioned methods lays in the customer's inability to formulize and describe possible innovations themselves, and how can firms describe these needs if the customer cannot do it themselves (Leonard & Rayport, 1997). For these reasons, the idea behind empathic design was developed. In Layman's terms, you observe consumers use the products or services you offer, but dissimilar to traditional market research, e.g., focus groups, the observations are taking place in a normal everyday life setting. Hence, traditional marketing practices gives useful information from the customer when the product in question is well understood, but for high-tech products which are new-to-the-world, the customer is usually so accustomed to the current situation that they are not able to see new solutions. Leonard et. al. (1997) argues that consumers sometimes are indoctrinated and forced to accept a "non-optimal" solution to a problem, thus unable to explain the real need to marketers. The process of empathic design can follow the five-step approach presented in Figure 8.
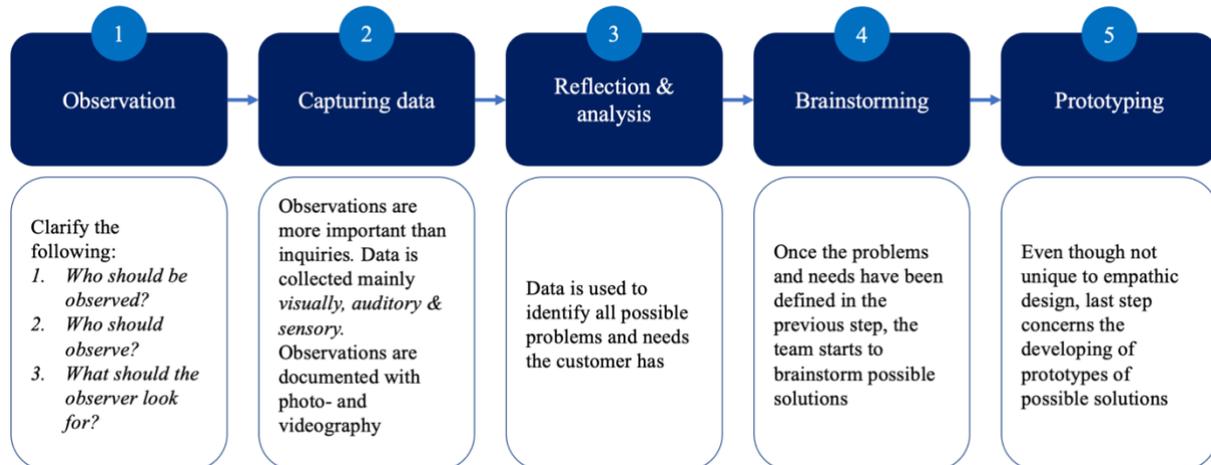
Figure 8: The five-step process of empathic design (Leonard & Rayport, 1997)

3.1.2.1.1.5. Lead users

Von Hippel et. al. (1999) argues in their article that companies want to have a constant stream of breakthrough products, but in reality, most innovations happening in firms are merely incremental improvements of already-existing products – which in a fast-paced environment eventually leads to sales decline. The reasons behind this are mainly the following two: (1) companies tend to focus short-term and put larger efforts into being competitive today than the efforts put to long-term growth and profitability, (2) product developers lack know-how of

how to create breakthrough innovations. As aforementioned, traditional market research methods collect data from the core of their target market by looking into sales data, conducting focus group interviews, and studying customer request. This information is then used to develop a product, mainly relying on inhouse creativity, which will satisfy the identified need. A *lead user* approach is different since both the need and solution is collected from the leading segment of the market or from markets with similar, but more extreme, problems. The challenging part is to track the lead users and adapt their solutions to the company's business (von Hippel, Thomke, & Sonnack, 1999). Von Hippel et. al. (1999) presents that 59% of all minor functional improvements and 63% of major functional improvements in the semiconductor industry are developed by the users themselves, which compares to the computer industry where user innovation constitutes 25%.

As presented in Figure 9 lead users are small in numbers but create a solution to their own problem which is not yet available on the market.
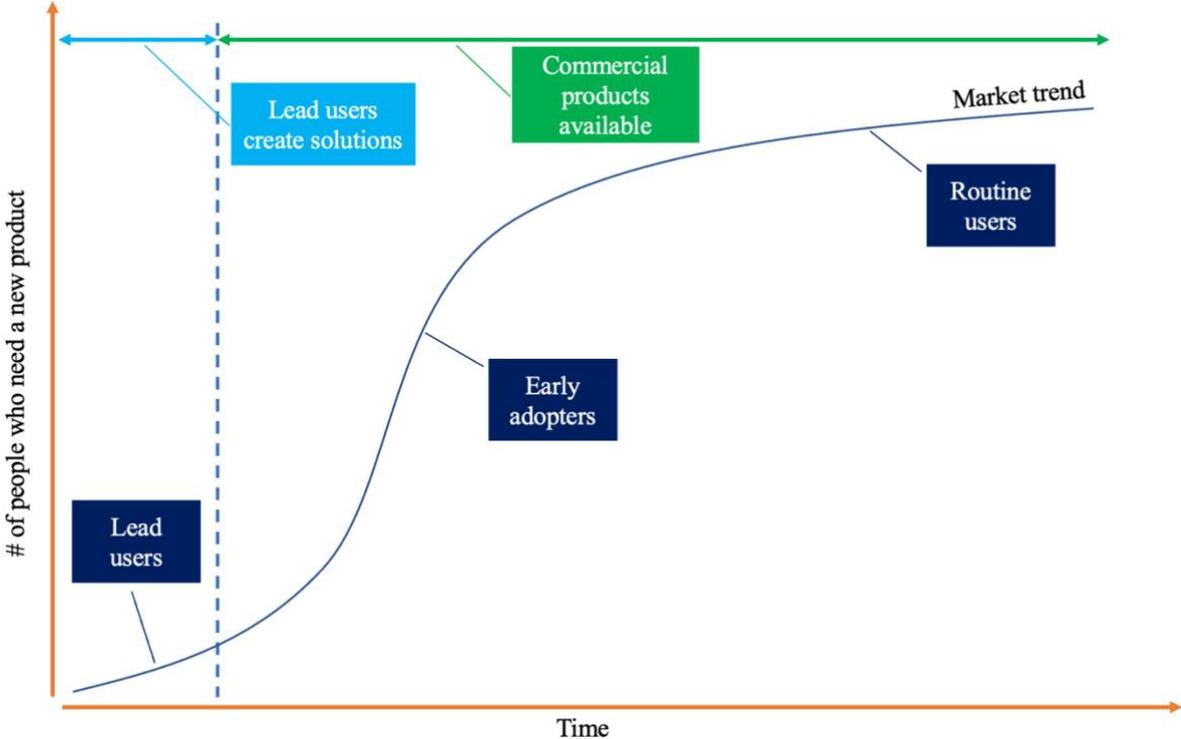
Figure 9: The lead user curve (von Hippel, Thomke, & Sonnack, 1999)

Even though the process of innovating with the help of lead users might differ from firm to firm, von Hippel et. al. (1999) suggests a four-step process to develop breakthrough products as seen in Table 4. The team responsible for the lead user innovation process should preferably be cross-disciplinary and consist of four to six employees.

Steps	Description
Lay out the foundation	The team determines target markets and defines the type and level of innovation which is sought after by decision-making units in the organization. The team needs to have these key stakeholders onboard to achieve credibility and decisiveness.
Determine trends	Lead users are already one step ahead of the main market and thus the trend. However, the team needs to understand what the trend is by interviewing experts in the fields of emerging and leading-edge technologies.
Identify lead users	The innovation now begins a series of networking activities where they interact with leading-edge technology users in the designated target market. The team collects information about promising ideas and concepts which could lead to breakthrough innovations. While collecting data from lead users, the team should simultaneously assess the alignment of the ideas with the overall company and their commercial opportunities.
Develop breakthrough products	The objective of the final phase is to turn selected concepts into complete offerings ready for commercialization. This is done by hosting a workshop consisting of the marketing team, product development team and the lead users themselves. The purpose of combining these stakeholders is to refine the concept and finalize a product which is aligned with the company needs. The product is then presented by the lead user innovation team to senior management.

3.1.2.1.1.6. Quality function deployment

The idea behind quality function deployment, or *QFD,* was first introduced in Japan as a strategy for making sure quality was built in into newly developed products. The technique was first used in 1972 by *Kobe Shipyard* of *Mitsubishi Heavy Industries Ltd,* but the name QFD was not defined at this point in time but was rather referred to as quality tables (Zairi & Youssef, 1995). Although quality function deployment primarily has been used in when developing new products in manufacturing industries, its principles can also be applied in non-manufacturing industries and in the reviewing of existing products, services, and processes.

Organizations who have implemented QFD become more proactive in their efforts of serving customers since it allows the firm to early-on detect product quality problems before instead of reacting to customer complaints. Additionally, Zairi et. al. (1995) suggests that quality function deployment can be used to compare its product quality standards to its competitors, thus helping the company sustain a competitive advantage. The QFD tool has three main

objectives: *(1) identifying who the consumer is, (2) clarify what the need of the consumer is and (3) how we as an organization can satisfy these needs.*

According to Mohr et. al. (2010), the implementation of a quality function deployment tool is a multistage process including the following steps:

1. *Collect customer voice:* This is achieved through methods such as customer visit programs or empathic design and the goal is to identify the needs of the consumer in his or her own words. Assuming a homogenous market segment, asking ten to twelve consumers will yield 80% coverage of market needs. The data can then be utilized to prioritize features of the new product.

2. *Collect consumer perceptions of similar products on the market:* Customer surveys can assist how well current products satisfy customer needs and act as a tool to identify gaps and opportunities in the market.

3. *Transform insights into product design requirements:* Also referred to as *customer requirements deployment,* the objective of this final step is to determine product attributes which will meet consumer needs. The process studies interrelations and encompasses the alignment between consumer requirements, products from the competition and design parameters.

3.1.2.1.1.7. Prototype testing

The idea behind a *prototype* is to create an early edition model of the 'end product' or service which a company intends to commercialize. Since the prototype is an early edition model it only includes core features of a product while disregarding smaller or supporting functions. The initial step in *prototype testing* is to ensure technical specifications meet the requirement. If not, these must be adjusted accordingly before it can be evaluated by potential consumers (Mohr, Sengupta, & Slater, 2010, p. 205).

As briefly aforementioned, the idea behind prototype testing is to gather feedback and learn from target consumers, refine the prototype, and then iterate until you have developed a product which aligns with consumer demand. One important principle when testing the prototype is to test it on the right consumers, and Friis Dam et. al. (2020), argues extreme users give more valuable feedback compared to regular users. E.g., extreme users are consumers who would use the product every day or only a few times a year. The rationale is that extreme users, even though fewer in numbers, more commonly express their likes and concerns over a product compared to a regular user (Friis Dam & Yu Siang, 2020). The relation between extreme and regular users can be seen in Figure 10.
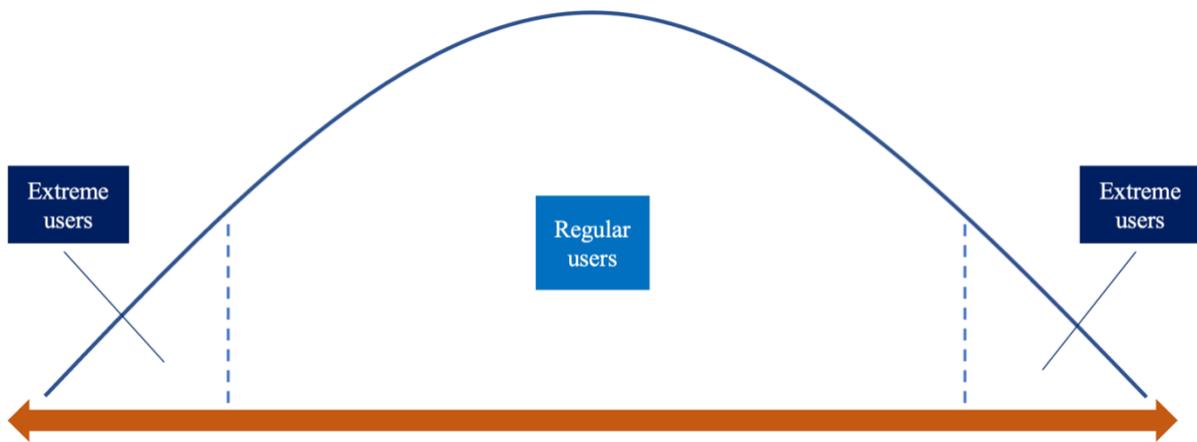
Figure 10: Extreme & regular users (Friis Dam & Yu Siang, 2020)

Moreover, Friis Dam et. al. (2020) suggests using the tool *Feedback Capture Grid* which is illustrated in Figure 11. The grid helps you organize the feedback during the testing sessions or afterwards to sort all gathered feedback. The quadrants represent the following:

- *'Likes'* gathers all positive feedback given by consumers about the prototype.
- *'Criticisms' gathers* all negative feedback given by consumers about the prototype.
- *'Questions'* which represents all questions consumers have asked about the prototype and additional questions which arose in the prototype testing.
- *'Ideas'* where new ideas are noted down which sparked during the testing sessions.
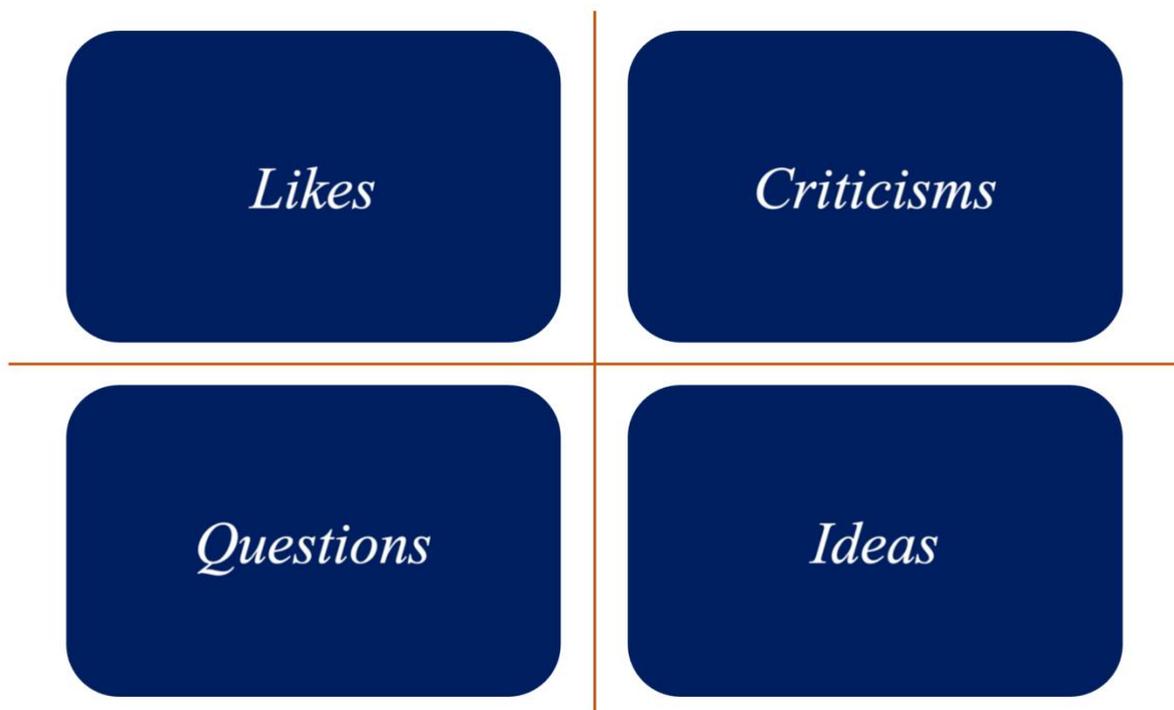
Figure 11: The feedback capture grid (Friis Dam & Yu Siang, 2020)

Preferably, all quadrants should include multiple notes, and conversations in the prototype testing can be steered towards the quadrants where there is a lack of material (Friis Dam & Yu Siang, 2020). The same idea is applied in a *beta test* where potential customers agree to test a new product to allow for adjustments before commercial release (Mohr, Sengupta, & Slater, 2010, p. 205).

3.1.2.1.1.8. Customer-driven innovation

In competitive marketplaces, companies are realizing the need to transform its innovation practices from *'innovation for customers'* to *'innovation with customers'* meaning consumers are becoming an increasingly larger part of firms' product and service innovation. Innovation comes from how firms engage with customers by *(1) identifying, analyzing, and communicating with target consumers, (2) involve them in current innovation processes by changing their business process and (3) encourage consumers to improve current products and services* (Desouza, et al., 2015).

Referring to the aforementioned step-by-step process, innovation concerning how customers are **identified** is a question about customer segmentation. The segmentation is done by separating customer segments, categorize each segment and classify them based on predefined features which will allow for market targeting. If these features are managed correctly, they will lead to improved products and services. E.g., as discussed by Desouza et. al. (2015), if disposable income is used as a separating feature, and by analyzing tendencies such as willingness to purchase, companies can more easily position products and improve marketing campaigns.

In a second sub step, you want to **analyze** information from the potential customer, and with the assistance of modern information and communication technologies (ICTs), the possibility of analyzing in real time is made possible. The customer analyzing activities happens in most industries, from the financial markets to the local grocery store, mostly collected through electronic equipment such as store cards and radio frequency identification (RFID). Furthermore, while data is collected in larger volumes, information is also shared between stakeholders in a larger volume then before, mostly through the Internet.

In a third sub step, an organization must find alternatives for **communicating** with customers which is achieved through different types of channels, e.g., email, chat rooms and forums. By integrating a *Customer Relationship Management (CRM),* companies can track their interaction with customers through the aforementioned channels and thus improve its products and services communication. Desouza et. al. (2015) argues that companies have embraced Internet to transmit product documentation, repair manuals and other support material. Additionally, while firms assist customers online through chat rooms other firms have taking the real time communication one step further and have integrated interactive Web-based applications to handle customer assistance.

When a firm has identified, analyzed, and set a strategy for communicating with target customers, it is then time to **integrate them into current business processes.** Historically, customers have not been part of firms' business processes (excluding eventual feedback on products and services), but this has changed. E.g., airline companies allow passengers to book their tickets, pick seats and check-in online without the need of help from airport personnel. Consequently, due to the integration of customers into business processes, there is a trend of value chain disintermediation, which can be seen with online flight booking (no need of travel agents) and in other industries such as securities trading and automobile purchasing. Additionally, this allows for better chances of discovering customer needs, which happened for *Dell Computer Corporation* and its 'direct model'. *Michael Dell*, the founder, saw the demand for computer customization and therefore developed a business model where the firm could interact directly with customers and customize their orders (Desouza, et al., 2015).

Finally, the **customer should be encouraged to be part of the improvement of the firms offering.** This is achieved by firstly studying how the customer interacts with the products and services, and in today's technology-intensive society, means every customer rarely uses the same technology in a similar manner. This is due to the level of customization and personalization. However, by understanding how customers choose to engage in these customizations can generate insights on possible enhancements and innovations (e.g., by tapping into lead users and discover new behaviors). One way of studying customer interaction is to personalize their shopping experience which can be done by analyzing data from their shopping journey. The development of ICTs has opened possibilities to study the customer journey and manage data generated from their transactions, but in addition to this, it has also allowed for experimentation of product offerings. Desouza et. al. (2015) discusses how customers want to test a product before committing to a purchase which has evoked suppliers to offer 'free trial' samples, like *Amazon* who offers the possibility to read a few pages of a book before deciding on purchasing it or not. Additionally, *Google* uses 'Google labs' as a test ground, where consumers can download beta products and test them for free and afterwards give feedback. This data is then used by Google to refine the product before commercializing it to Google users. By allowing customers access to experiencing the product without releasing the entire product, firms can openly share with and receive data from customers to better understand how they interact with products (Desouza, et al., 2015).
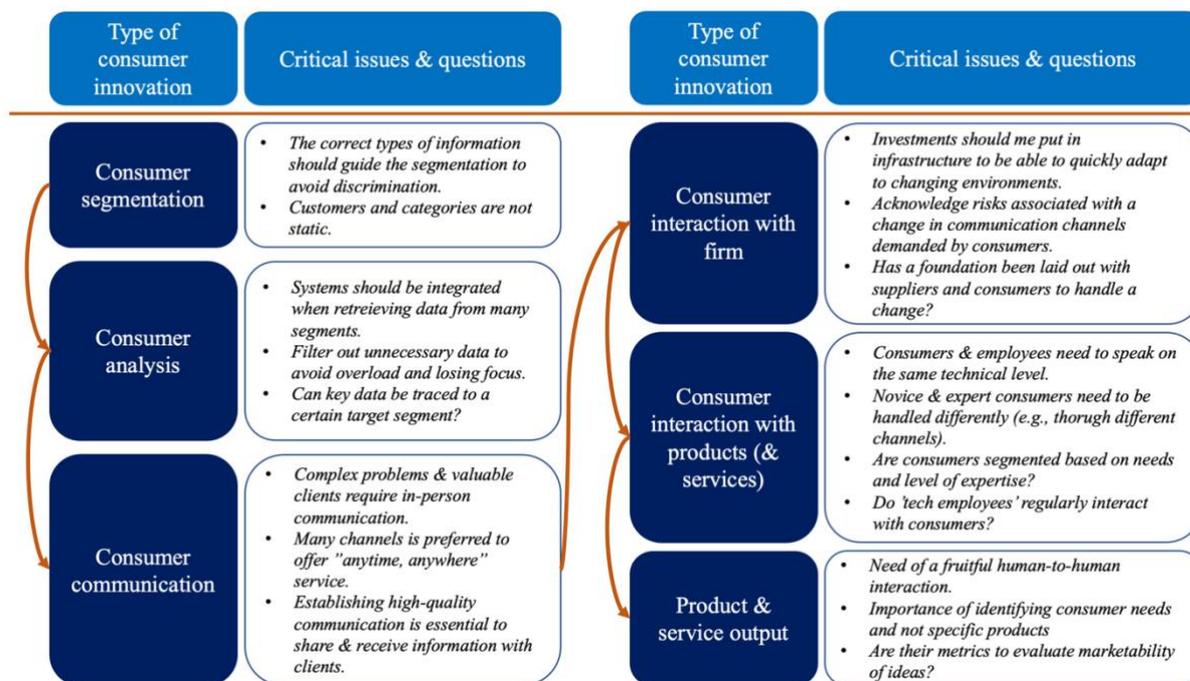
Figure 12: Types of consumer innovations (Desouza, et al., 2015)

Based on aforementioned knowledge from and about target customers, firms should then engage in innovating activities. The knowledge gained from customers include insights and thoughts about either the product, trends, future needs, or potential innovations. The different types of customer innovations are presented in Figure 12. Conclusively, customer-driven innovation builds on the idea of designing, manufacturing, or selling a product which consumers want instead of having to convince them to purchase a product which where they have no previous engagement (Desouza, et al., 2015).

Besides the different types of consumer innovations seen in Figure 12, Desouza et. al. (2015) presents a framework for how organizations can structure their consumer innovation activities which is presented in Figure 13. Figure 13 builds on what is presented in Figure 12.
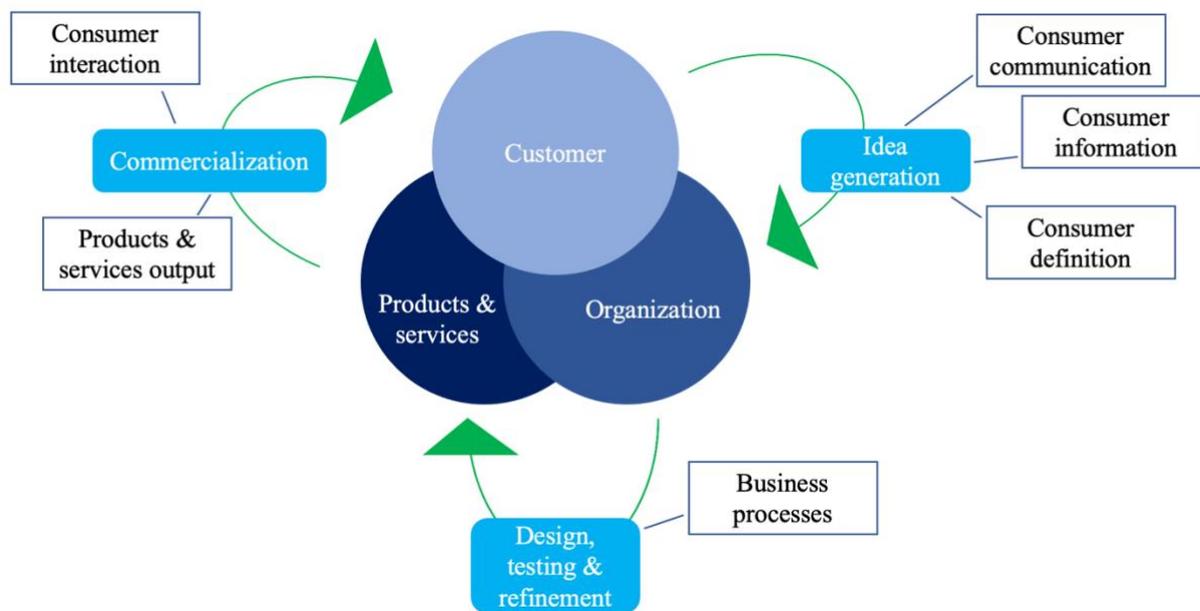
Figure 13: Consumer innovation activities based on interactions between the organization, products, services & consumers (Desouza, et al., 2015)

An effective consumer innovation program is built on systematic interactions between three key stakeholders: (1) consumers, (2) the organization itself and (3) its products and services. Through a series of events which are (1) idea generation, (2) design, testing and refinement and (3) commercialization (Desouza, et al., 2015).

3.1.2.1.1.9. Biomimicry

While customers can act as an important source of innovation, there are other inspirational sources for companies to utilize, such as the nature itself. *Biomimicry* is a learning method of studying and copying biological forms, processes and ecosystems which have been battletested by the environment and adapted through evolution (Kennedy, Fecheyr-Lippens, Hsiung, Niewiarowski, & Kolodziej, 2015), and it can be used to solve any form of technical or social problem (Benyus, 2002). Ever since prehistoric times mankind has studied nature and learned from it, e.g., built spears made with teeth from predators or adapted the 'sneak-and-pounce' hunting technique. Nevertheless, Kennedy et. al. (2015) argues that the idea of translating biological strategies into innovation design elements is newly found.

According to Mohr et. al. (2010), the biomimicry approach is constituted by seven steps seen in Table 5.

The biomimicry steps	Description	Questions to ask
1. Identify which problem should be solved	The objective is to find the root cause to the problem which is achieved by asking "why?" enough times.	• What problem do I want to solve?
2. Interpret problem in nature's terms	"Biologize" the issue by identifying functions that must be performed to solve the problem. To ensure alignment between the biomimicry process and the innovation outcome, a design brief is created to bridge the gap between businesspeople and naturalists.	• How does nature perform this function? **Design brief** • What does the design need to do? • Who is involved with the problem & solution respectively?
3. Discover the natural models which best resolves the problem	Identify as many solutions as possible from organisms in nature (e.g., by brainstorming together with biologists).	
4. Find patterns in the solution examples generated in the previous step & create a taxonomy	Build a structure for all ideas and find a strategy which all organisms have in common and target those strategies which seems most promising given the elements in the design brief.	• What are the common patterns in nature that accomplishes the desired function?
5. Copy nature & apply the solutions to the designated challenge	Development of concepts which apply lessons from nature to solve the problem (e.g., by applying R&D approaches as long as they are aligned with the design brief). There are three types of biomimicry solutions: (1) mimic of nature's *forms,* (2) mimic of nature's *processes,* (3) mimic of nature's *ecosystems* (see questions in the right column).	• What does nature do in terms of the shape of the organism? • How does nature manufacture such a shape? • How does the interrelationships of nature's organisms look like?
6. Evaluate if proposed solutions compare well with the principles of nature	The objective in this step is to study if the proposed solution by the organization is consistent with nature's solution and where the innovation can be improved. New "why?" questions may be asked concerning packaging, manufacturing,	• Is our innovation consistent with nature's solution?

	marketing or transportation of the product.	
7. Iterate the biomimicry process with a new identification step	Nature is constantly learning from the environment and evolving, and high-tech innovators should therefore also adapt this thinking by observing and adjusting throughout the design exploration process.	

3.1.2.2. Intelligence dissemination

The generated intelligence about markets and innovation possibilities is only of limited value unless it is shared in the organization and combined with other information, hence the importance of intelligence dissemination. As Mohr et. al. (2010) describes it, the knowledge-based competitive advantage – or the know-how of a firm – only creates value if it is shared and used in and across the organization. Moreover, the valuable knowledge of employees is an enabler for economic power and value, and if the knowledge is not shared among other employees it may result in a loss of competitive advantage (Huselid, Jackson, & Schuler, 1997). Additionally, competitive abilities cannot be achieved without managing performance while constantly developing employee skills and capabilities (Adhikari, 2010).

While dissemination of knowledge is interlinked with keeping a competitive advantage, employees are generally reluctant to give away knowledge due to job security. This act of not wanting to share insights by employees, while also being suspicious of colleagues asking them for advice, is referred to as *knowledge hoarding*. To mitigate the hoarding effect organizations should integrate the ideas of *performance support* and *knowledge management* (Caruso, 2017).

Most organizations believe that informal workplace learning should be documented and turned into teaching material which is later shared with different functions of the organization, and the employees possessing the necessary knowledge should teach less knowledgeable colleagues. However, this method of learning is not always the most efficient and the access to Internet has enabled new ways of learning (Caruso, 2009). Caruso (2009) argues that the access to Internet has reinvented the options for workplace learning and thus employees do not need to enroll in formal training programs to become experts in certain field. The use of web technology simplifies creating and sharing of content, leading to better organizational communication.

Caruso (2017) defines knowledge management as a practice of extracting knowledge and capabilities from employees who have it to employees who need it. Modern knowledge management is based on technological tools and the Internet, and the *Web 2.0* has today become an integral part of teaching solutions. E.g., screencasting (recording movements on a

computer) can be recorded and later uploaded on a collective platform and shared among employees (Caruso, 2017).

No matter if performance support and knowledge management practices are in place or not, Mohr et. al. (2010) argues there is still a cultural need of employees wanting to share information, where team success does not come at the expense of personal success.

3.1.2.3. Intelligence integration

Once a company has created a culture of information sharing, a third factor of being market-oriented is to integrate the collected intelligence and create knowledge assets (Mohr, Sengupta, & Slater, 2010, p. 111). Each division of an organization has a different perspective of what a piece of information means for the company and hence how the company should react. Thus, there is a need to integrate the collected knowledge in the organization to achieve a mutual understanding.

Mohr et. al. (2010) further discusses how the idea of intelligence integration is relevant for companies in high-tech environments due to the high complexity and volatility of these industries. However, before a consensus can be reached a firm might benefit from disagreements when interpretating the collected piece of information. The disagreements will lead to comparisons between alternatives, checking the validity of each alternative and assessing the effect it has on firm objectives and competitive strategy. *Andrew Grove,* former Chairman and CEO of *Intel Corporation,* explains in his 1999 book *Only the Paranoid Survive* that all opinions cannot prevail in a debate but are equally important to form the right answer (Grove, 1999). Eventually a company must reach an agreement but to capture the full value of the knowledge from the collected information, the firm should actively facilitate debates, discussions, and dialogues between employees (Mohr, Sengupta, & Slater, 2010, p. 111).

The dynamic workforce in a high-tech environment puts pressure on companies to retain knowledge when employees switch between companies. Mohr et. al. (2010) suggests asking three questions and act based on the answers:

1. *What knowledge will be lost if employee X leaves the company?*
2. *What is the business consequence of losing that knowledge?*
3. *How can we prevent or mitigate the damage?*

By asking the aforementioned series of questions firms can locate where there most valuable knowledge is and furthermore develop a strategy of keeping the knowledge in the organizational memory. Mohr et. al. (2010) suggests different strategies need to be implemented depending on if the knowledge is explicit or tacit. *Explicit knowledge* can be stored in databases, blueprints or manuals as the knowledge is easily extracted and documented (Inkpen & Dinur, 1998). A more difficult task is to extract and store *tacit*

knowledge which is non-codified and disembodied knowledge gained informally through unstructured or semi-structured ways (Howells, 1996). Tacit knowledge is interlinked with experience and cannot easily be reproduced or shared (Sampath, 2018). A representation of tacit knowledge is seen in Figure 14.
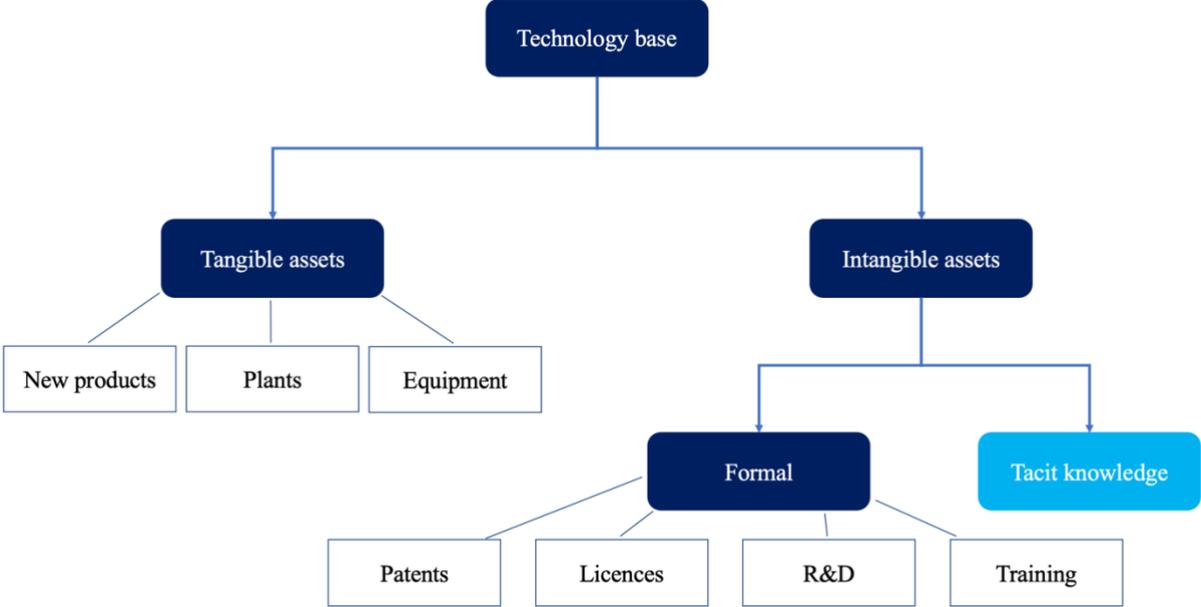
Figure 14: The technology profile of a high-tech firm (Howells, 1996)

According to Mohr et. al. (2010), tacit knowledge must be transferred from person to person, and in line with this claim Sampath (2018) suggests eight alternatives which organizations can capture tacit knowledge as seen in Table 6.

Table 6: Eight alternatives to capture tacit knowledge in a firm (Sampath, 2018)

Alternatives to capture & keep tacit knowledge	Description
Organizational culture	• Instate incentives to create a knowledge-sharing culture • Set up recurring meetings, presentations, town halls, scrums, and one-on-one interviews with key stakeholders • Reduce attrition rates and retain senior colleagues
Mentorship programs	• Encourage senior level colleagues to train new hires • Establish a routine of having continuous discussion sessions between mentor and mentee
Workplace collaboration	• Promote a culture of teamwork and encourage employees to share and document knowledge and informal discussions
Documentation	• Use technology and information systems to document knowledge in a easily accessible and structured manner • E.g., user guides, policies, how-to-books, and guides

Meetings	• Conduct debriefs after completion of projects to learn about improvement areas • Conducting analysis meetings before and after projects helps firms collect best practices
Forums & informal groups	• Create firm internal forums with the purpose of discussing work-related problems
Training	• Include experiential learning in employee training sessions, e.g., on-the-job training, demonstrations, and simulations • E.g., workshops, events, and conferences
Professional & social networks	• A network with the purpose of teaching, where each employee on a recurring basis writes and shares an article about his or her work tasks or teaching about their area of expertise

3.1.2.4. Coordination of actions

The final step in Figure 14, after intelligence has been collected, disseminated, and integrated, market focused firms must take actions on generated insights by coordinating departments. Unless a coordinated action plan is implemented based on generated insights there will be no value-add to the firm (Noble, Sinha, & Kumar, 2002). The actions needed from generated market intelligence include market segment selection, product, and service development (addressing current and future customer needs), production, supply chain management and marketing of firm offering to achieve consumer satisfaction and loyalty (Kohli & Jaworski, 1990). All organizational functions – not only marketing - should be engaged with meeting market needs. Thus, pursued activities should have joint responsibility of multiple functions in the business (Cooper & Kleinschmidt, 1991). Mohr et. al. (2010) argues that an interfunctional collaboration leads to a closer connection to the market issues and if employees working with the implementation is also part of the decision-making, they will be more committed to the work. However, a danger when coordinating different firm function is organizational politics (Leonard D. A., 1992). Leonard (1992) argues that engineers and technical personnel are often given higher status compared to customer-focused employees in high-tech companies – often leading to disregarding of customer information.

3.1.2.4.1. Interaction between R&D and marketing

One of the more important interdepartmental collaborations in a high-technology firm is the one between research & development and marketing. Technological advancements alone are insufficient for successful product launches, there must also be a market demand. Oftentimes technically oriented employees become luscious about a new idea and disregards the commercial applicability, while the marketing team misreads consumer needs and resource investments are wasted. (Gupta, Raj, & Wilemon, 1985).

Gupta et. al. (1985) suggests a list of factors preventing effective collaboration between the R&D and marketing departments. Firstly, there is a misalignment regarding the involvement and information sharing between the two departments in a product innovation process. R&D lacks interest in getting involved with marketing nor does it expect significant contribution from the marketing team, while both department managers are dissatisfied with their current level of integration. Secondly, while R&D and marketing managers disagree on the required level of integration Gupta et. al. (1985) argues managers agree on which areas requires departmental integration. Thirdly, the five most common barriers to lack of integration relates to (1) lack of communication, (2) insensitivity to the other part's point of view, (3) lack of willingness to integrate from senior management, (4) different personality traits of employees between the departments and (5) a lack of market knowledge of both the R&D and marketing managers (Gupta, Raj, & Wilemon, 1985).

In 1986, Gupta, Raj and Wilemon presented a conceptual framework for studying the interface between R&D and marketing as presented in Figure 15.
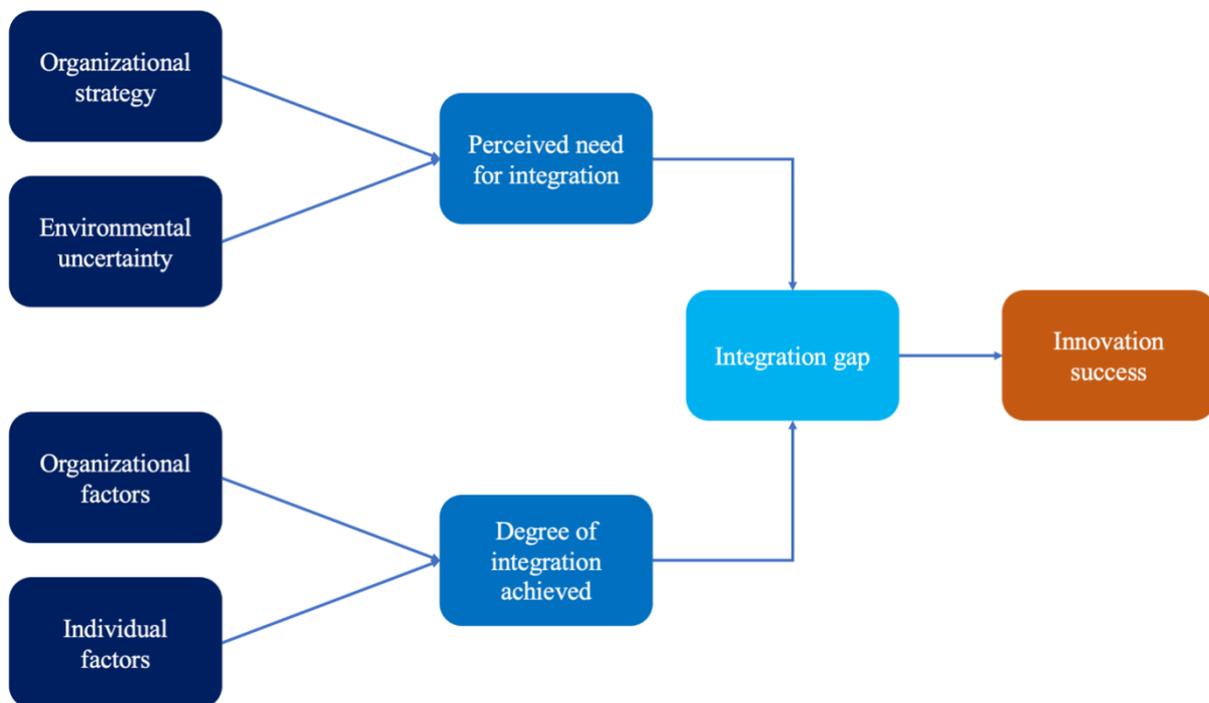
Figure 15: A framework for studying the interface between R&D and marketing (Gupta, Raj, & Wilemon, 1986)

The model is constituted of four factors which determines both the need and level of integration between the two departments. There are four types of *organizational strategies*, namely *Defender, Prospector, Analyzer and Reactor* which are described in more detail below:

Defender: A firm applying a Defender strategy tries to maintain a stable market environment by isolating a portion of the total market and thus create a stable domain. The stability is achieved by producing only a limited set of products targeted toward the isolated market

domain and actively blockades competitors from entering by lower prices or offering high-quality products (Miles, Snow, Meyer, & Coleman, Jr., 1978).

Prospector: Unlike Defenders, Prospectors are on the opposite side of the spectrum and rather than efficiently serving an isolated and stable market segment, the Prospector is trying to find and exploit new product and market opportunities. Hence, it is important for a Prospector to be recognized as an innovator (Miles, Snow, Meyer, & Coleman, Jr., 1978).

Analyzer: Considered as a combination of the aforementioned adjustment strategies, an Analyzer tries to minimize risk while simultaneously tries to maximize profits. It is difficult to find a balance when adapting this strategy, especially in rapidly changing markets, i.e., high technology markets (Miles, Snow, Meyer, & Coleman, Jr., 1978).

Reactor: Each of the aforementioned strategies are proactive to changes in the environment but in different ways. I.e., Defenders continually tries to develop greater efficiency in existing operations while Prospectors search for opportunities of new opportunities given a change in environment. No matter the type of action taken as a consequence to market changes, over time they develop a pattern which is consistent and stable. On the contrary, Reactors have a pattern of taking inconsistent actions and lacks response mechanisms to put into effect during changes (Miles, Snow, Meyer, & Coleman, Jr., 1978).

Gupta et. al. (1986) proposes the needed level of R&D-marketing integration declines along the *'Prospector-Reactor' continuum* as follows: Prospector, Analyzer, Defender, and Reactor.

The *perceived environmental uncertainty*, like the organizational strategy, directly affects the level of needed R&D-marketing integration and is a biproduct of a firm's ability to anticipate changes in consumer's new product requirements, technologies, and the competitive landscape. Gupta et. al. (1986) argues that a higher environmental uncertainty leads to a greater need of information systems and integration among different departments and subsystems. Thus, it is proposed that a higher level of perceived environmental uncertainty consequently leads to a higher demand for R&D-marketing integration.

The *organizational factors*, such as the organizational structure, are essential when collecting and processing information from the environment since it determines the information processing potential between firm departments and with the environment itself (Gupta, Raj, & Wilemon, 1986). According to Gupta et. al. (1986), organizational structure can both hinder and facilitate R&D-marketing integration and suggests organizational structure is constituted by the following three determinants:

- *Complexity:* Is a function of the number of specialists in an organization. The more experts you have in an organization, the higher the innovation success rate is, but also the organizational complexity, hence added difficulty to integrate departments and functions.

- *Formalization:* Determines the emphasize on following policies and rules when completing work tasks which could lead to eloignment and passivity among employees while it concurrently avoids role ambiguity. Whether formalization facilitates or hinders integration is debatable, where one study found less formalized firms better utilize market research data (Deshpande, 1982) while another study found that the utilization of a marketing plan output increased when the degree of formalization increased (John & Martin, 1984).

- *Centralization:* is determined by the degree of hierarchical authorization and employee decision-making participation. It is argued that hierarchy of authorization restricts firm innovativeness by encouraging employees to provide only positive performance feedback while employee participation can increase commitment by increasing employees' feelings of ownership (Zaltman, Duncan, & Holbek, 1973).

Additionally, Gupta et. al. (1986) includes the influencing role of senior management in organizational factors namely (1) encouragement of risk-taking and entrepreneurialism and consideration of both short and long-term firm objectives, (2) implementation of joint reward systems for R&D-marketing and (3) promotion of R&D-marketing integration need. Consequently, Gupta et. al. (1986) presents propositions seen in Table 7.

Individual factors, which Gupta et. al. (1986) exemplifies with the role of sociocultural differences between R&D and marketing professionals, and it is argued that the set of values is different based on their expectations of management behavior (Gibson, 1981). Moreover, marketing professionals have a different way of thinking, in a different discipline less focused on exact data and more focused on qualitative data (Clarke, 1974). Based on the sociocultural differences between R&D and marketing, Gupta et. al. (1986) presents four factors for determining integration:

- *Professional & bureaucratic orientation:* Professional orientation is a person's desire to be part of a network of similar equal professionals which extends beyond once own firm, which is an orientation relegated to R&D professionals. There is a high commitment to their capabilities and skills and R&D professionals seek assistance from people both inside and outside their own organization. Bureaucratic orientation, which is relegated to marketing professionals, means employees, rather than having a desire to be identified with the professional colleagues, want to be identified with the they are employed by (Miller & Wager, 1971). Ideally, there should not be a gap between R&D and marketing managers regarding their professional and bureaucratic orientation (Gupta, Raj, & Wilemon, 1986).

- *Tolerance for ambiguity:* Working in an entrepreneurial environment implies uncertainty and depending on how R&D and marketing professionals handle this ambiguity is a determinant of the effectiveness of their collaboration. R&D managers often seek objective and concrete data while marketing managers often show comfortability with ambiguous data and make "gut feeling" decisions (Souder, 1977), and thus Gupta et. al.

(1986) suggests that the greater the similarity between R&D and marketing the greater the integration.

- *Time orientation:* R&D managers oftentimes have long-term project time perspectives while marketing managers see it from a shorter perspective, and it is argued that this time difference may have negative implications for the departmental integration (Lawrence & Lorsch, 1969), thus the time gap should be closed to achieve greater integration (Gupta, Raj, & Wilemon, 1986).

- *Preferred types of projects & products:* Gupta et. al. (1986) suggests that R&D and marketing professionals prefer to work on different types of products or projects, where marketers prefer to work with potential commercial successes while R&D employees prefer to work with breakthrough projects and new-to-the-world products. Thus, it is suggested that teams should be aligned concerning their project and product goals to achieve R&D-marketing integration.

Table 7: A summary of determining factors for R&D-marketing integration by Gupta et. al. (1986).

Influencing factors	Propositions
Organizational strategy	Needed level of integration is higher in the following order: *Reactor, Defender, Analyzer & Prospector*
Perceived environmental uncertainty	Higher level of perceived environmental uncertainty leads to a higher demand for R&D-marketing integration.
Organizational factors	**Organizational structure** The lower the degree of *formalization* the greater the degree of integration between R&D and marketing. The lower the degree of *centralization* the greater the degree of integration between R&D and marketing. The higher the degree of *employee participation in decision-making* the greater the degree of integration between R&D and marketing. **Role of senior management** The more encouragement of risk-taking from both R&D and marketing managers the greater the degree of integration. The more managers perceive they are jointly rewarded the greater the degree of integration.
Individual factors	Greater similarity between R&D and marketing managers concerning *professional and bureaucratic orientation* implies greater integration.

	The greater the similarity between R&D and marketing in terms of *tolerance for ambiguity* the greater the integration.
	The greater the similarity concerning the *time perspective* the greater the integration between R&D and marketing.
	The greater the similarity between preferred products and projects the greater the integration.

However, while the determining factors mentioned in Table 7 positively influence the firm innovation and startup success, Gupta et. al. (1986) proposes that the R&D-marketing integration should be balanced with the organizational strategy and take into consideration the perceived environmental uncertainty as seen in Figure 15. Hence, rather than trying to maximize the integration level between R&D and marketing, it is suggested that firms must first assess the need of integration and later minimize the gap between the level of integration required and the current integration to ultimately reach innovation and startup success (Gupta, Raj, & Wilemon, 1986).

3.1.3. Understanding high technology customers

Becoming commercially successful and being market oriented implies having a good understanding of who you are selling your products or services to. The following subchapter will discuss concepts and frameworks for understanding high-tech customers.

3.1.3.1. Customer purchase decision journey

The purchase decision journey as suggested by Mohr et. al. (2010) can be seen in Figure 16 and consists of five steps.
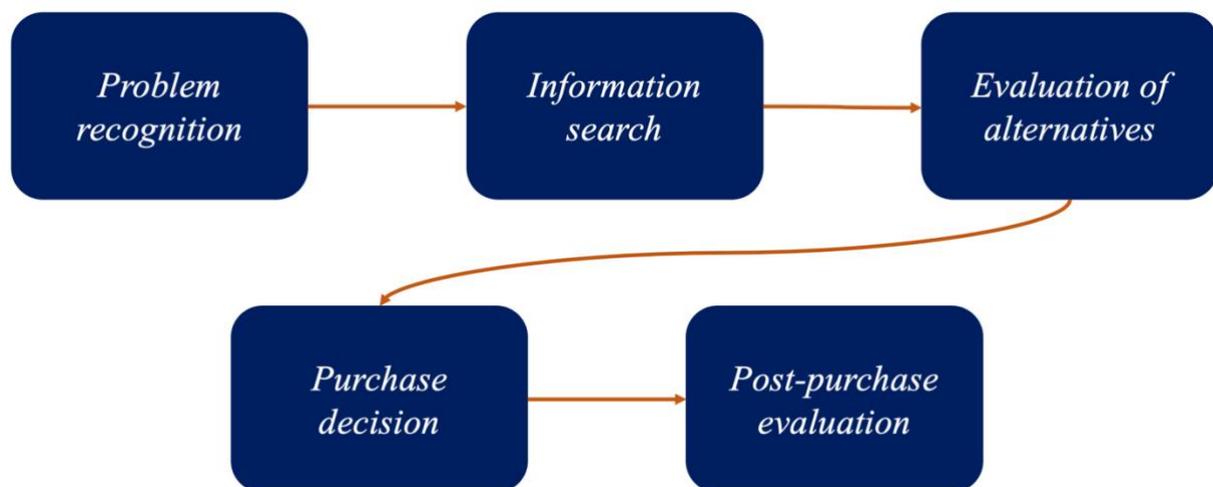
Figure 16: The purchase decision journey of a high technology customer (Mohr, Sengupta, & Slater, 2010)

The customer starts the journey by *recognizing a need, in the form of a problem or an opportunity*, which can be triggered by an internal need (e.g., in B2B when a customer needs to solve a bottleneck issue at the manufacturing site) or an external need (e.g., awareness of a new technology through advertisement).

In the second stage of Figure 16, the buyer tries to *find information about how to solve the problem* and the required amount of information needed by the customer depends on the type of customer and product category. Mohr et. al. (2010) suggests customers search for information by utilizing personal contacts such as friends or colleagues, discuss the topic with a vendor or, most commonly for high technology customers, attend trade shows and product demonstrations (e.g., the International Consumer Electronics Show). Moreover, a typical factor for information search in high technology markets is time sensitivity due to their fast-paced characteristics. Thus, as time pass the value of the collected information by the customer decrease in value and ultimately become obsolete (Mohr, Sengupta, & Slater, 2010, p. 232).

Thirdly, customers initiate a process of *evaluating different solutions* to find the best personal or organizational fit. It is a risk filled decision for a customer to adopt a new technology and the cost of making wrong decisions are significant (e.g., switching costs and training needs). Consequently, it is important to understand determinants which affect high technology customers' evaluation of new products and technologies. Besides the methodologies to collect market intelligence, Mohr et. al. (2010) discusses the importance of design elements for customers when evaluating technology solutions. The design consulting firm *IDEO* in California, USA suggests that one of three key points when designing a solution is to integrate the needs of the people, seen as 'desirability' in Figure 17, along with business 'viability' and technological 'feasibility'. Therefore, designers' focus on customer emotions and being user centric allows to influence customers by communicating new ideas in a visually appealing way (Mohr, Sengupta, & Slater, 2010, p. 235).
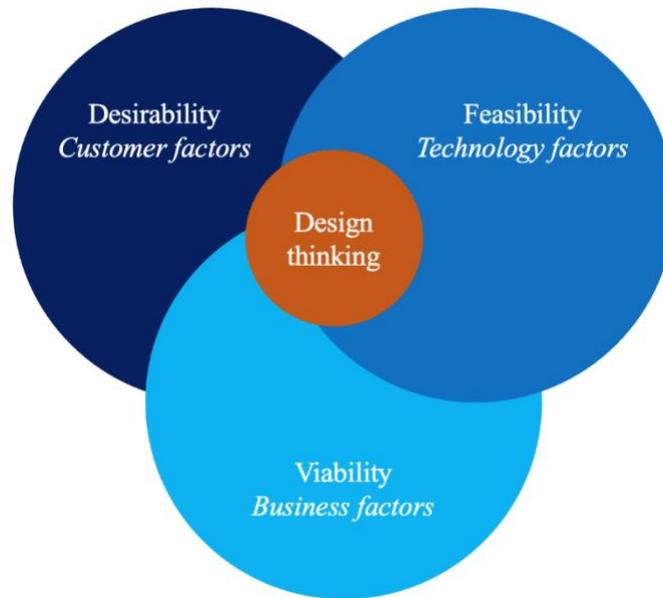
Figure 17: The three elements of design thinking (IDEO, 2021)

Fourthly, as seen in Figure 16, *the customer commits to a purchase* after having formed an opinion about the alternative which best suits his, her or the organization's need depending on the type of customer. In this stage, the buyer and the seller reach an agreement concerning the terms of the purchase.

In the final step, the customer *makes a judgment whether the product lived up to expectations* by, e.g., asking the following questions:

- *Was I able to use the technology solution in an efficient and effective manner?*
- *Did the technology perform as promised?*
- *Did any hidden costs appear when using the technology?*

E.g., in B2B, hidden costs can be constituted of extra training to use technology, customization and integration into current systems. To ensure customer loyalty and positive word-of-mouth advertisement, it is therefore vital to follow-up with customers and sustain a good long-term customer relationship (Mohr, Sengupta, & Slater, 2010, p. 235) Additionally, as part of the long-term relationship, firms must manage technology improvements and consequently migrate customers over to succeeding technology generations to tap into the value of future opportunities (Shih & Venkatesh, 2004). In the paper by Shih and Venkatesh (2004), they differentiate four types of customers based on their level and variety of usage of personal computers as seen in Figure 18.
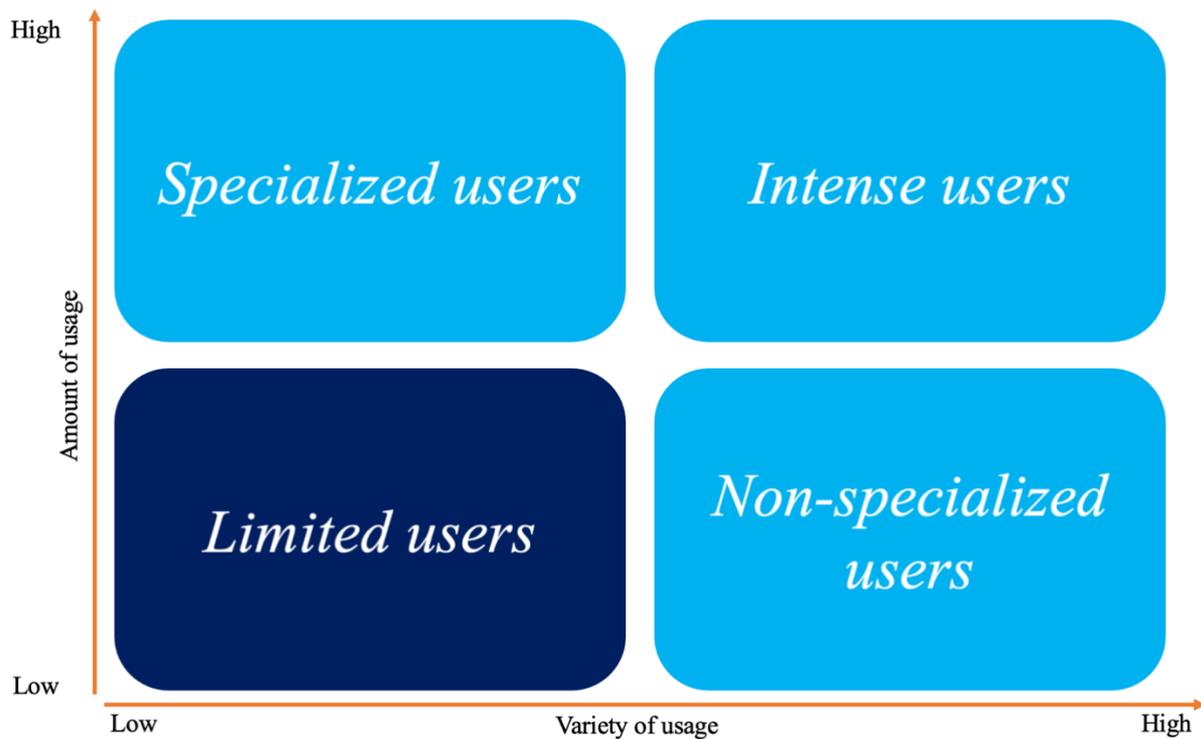
Figure 18: Categories of customers based on their amount and variety of usage (Shih & Venkatesh, 2004)

The level of satisfaction and intention to use succeeding generations of innovation increases from limited users to non-specialized users to specialized users and finally to intense users. Strategically it means firms should focus on having a good customer relationship with non-specialized, specialized, and intense users since they most likely are recurring customers due to experience of technology usage and level of satisfaction (Shih & Venkatesh, 2004).

3.1.3.1.1. Steering the customer journey

In November 2015, *David C. Edelman* and *Marc Singer* from *McKinsey & Company* published an article discussing how customers today, due to the explosion of digital technologies, oversee their own purchases, being experts in the search of product information and decide which firm offers the most appealing product or service. In response to this shift of power, companies try to collect large amounts of data and analyze customer behaviors to win back control and become less depend on trying to position themselves where customers will find them (Edelman & Singer, 2015). To accomplish this, firms must lead the customer through the purchase journey rather than follow by making the journey compelling, personalized and open-ended to earn loyalty. This means the firm is moving away from the classical customer journey, where customers complete an extensive consideration and evaluation pre-purchase, to the new journey, where the consideration period is shortened and the possibilities for evaluation are eliminated, as seen in Figure 19.
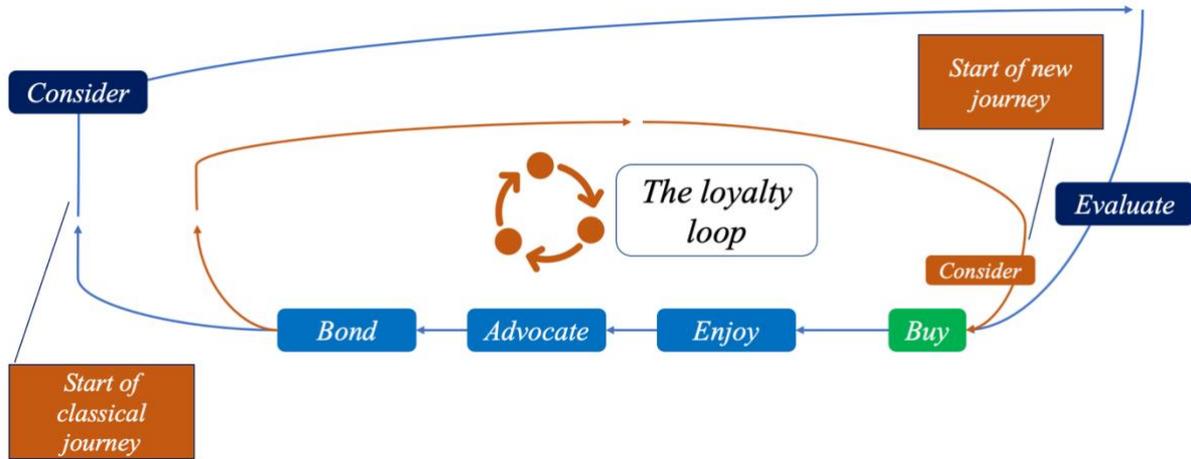
Figure 19: The classical & new customer purchase journey (Edelman & Singer, 2015)

The strategy of moving over to the new customer journey, discussed by Edelman & Singer (2015), is to include four capabilities; *automation, proactive customization, context-based interaction and maintain an ongoing journey innovation* and treat the customer journey as a product by having a cross-functional team responsible for its business performance. A description of the four capabilities follows in Table 8.

Table 8: The four capabilities needed to create a new customer journey (Edelman & Singer, 2015).

New customer journey capabilities	Description	Practical example
Automation	Processes which were previously done manually are streamlined and, if possible, digitized.	*Depositing a check:* By photographing the check with a smartphone and deposit though an app, instead of physically going to the bank.
Proactive customization	Utilize data from previous transactions or up-to-date sources to instantly personalize the customer journey by building on the automation capabilities.	*The L'Oréal Makeup Genius app:* The app lets customers test products through the smartphone camera. The app makes recommendations.
Context-based interaction	Utilize knowledge about where the customer is located physically or virtually in the purchasing journey to steer him or her in the direction the firm wants.	*Flight boarding pass:* The airline app shows your boarding pass once you enter the airport.
Ongoing journey innovation	Keep experimenting and utilize customer data to analyze needs and technologies to strengthen the relation	*A/B testing:* Software companies continually uses A/B testing to

	ship with the customer and create new value.	enable open-ended testing and compare alternatives.

3.1.3.2. Adoption, diffusion & bringing new technologies to the market

Once a technology solution has been introduced to the world it will not instantly be adopted by customers but rather it takes some time before it will be accepted by the mass market if it will be accepted at all. The notion of technology adoption and diffusion is discussed in the book *Diffusion of Innovations* by *Everett M. Rogers* where he presents a framework which explains six influential factors of customers' adoption of new-to-the-world technologies which can be seen in Table 9.

Table 9: The six factors influencing customer adoption rate of a new technology or product (Rogers, 2003)

Influencing factors	Description of customer adoption rate
Relative advantage	Customers must see additional benefits by adopting the new technology compared to current technology solutions and the benefits must outweigh the costs.
Compatibility	The new technology should ideally not diverge too much from existing ways of completing tasks and cultural norms.
Complexity	The difficulty of using the new technology negatively affects customers adoption rate.
Trialability	Could the new technology be tested out on a limited basis before deciding on purchase? If yes, then adoption rate increases.
Possibility to communicate technology or product benefits	The easier it is to describe and communicate the benefits of owning the new technology solution the faster the adoption rate.
Observability	If the benefits are observable to customer than the adoption rate will be faster.

No matter how well adapted the six aforementioned factors are for a new technology product, the diffusion of all new innovations will look identical to the curve by Geoffrey A. Moore in 1991 in his book *Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers* seen in Figure 20.
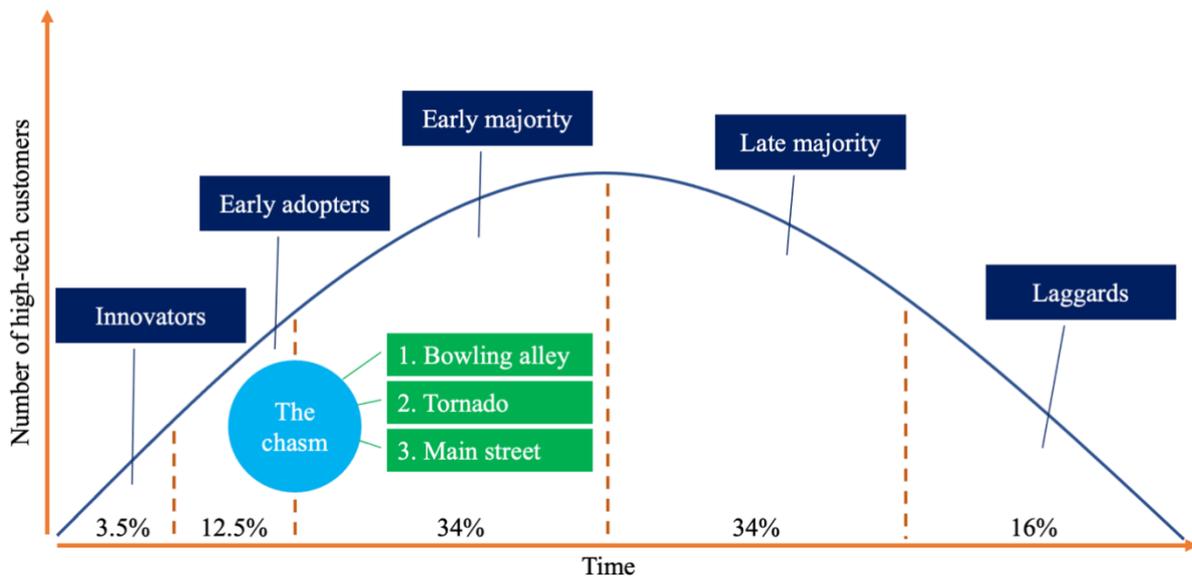
Figure 20: Diffusion of innovations and the chasm (Moore G. A., 1991)

With Figure 20 in mind, a high technology market can be defined as a set of actual or anticipated customers (for a given technology product or service), who all share similar needs and reference each other when committing to a purchase (Linowes, 2021). Rephrased, if you convince one set of customers to buy your technology product, they most likely will positively affect other anticipated customers to commit to a purchase. Nevertheless, firms must identify the different customer categories presented in Figure 20 and their motivations or reluctance to commit to a purchase (Mohr, Sengupta, & Slater, 2010, p. 239). The characteristics of each category of adopters are as follows:

- *Innovators:* known as 'technology enthusiasts', are keen on the idea of being part of a network of first testers. Innovators accept technology glitches should they occur (and occasionally might even try to develop a makeshift solution to these glitches). Even though this group does not constitute a large part of total revenue, they allow access to subsequent groups of adopters and their opinions concerning a new technology are listened to by others (Mohr, Sengupta, & Slater, 2010, p. 241).

- *Early adopters:* Also known as visionaries, are interested in adopting and using a new technology to gain a competitive advantage in their industry and are consequently attracted to take high-risk, high-reward decisions. While this group is not price sensitive, they commonly demand good service and customized solutions. Another characteristic factor of early adopters, stated by Mohr et. al. (2010), is that they communicate across industry and professional boundaries.

- *Early majority:* If early adopters are looking for revolutionary technology changes, early majority is rather looking for evolutionary changes to gain, e.g., productivity increases at their manufacturing sites. This group of adopters, also known as pragmatists, are risk averse, meaning that they generally look for track record and reliable service due to their unwillingness for disruption of operations. Mohr et. al. (2010) argues early majority follow three principles when adopting new technologies: (1) when adoption occurs everyone adopts concurrently, (2) they all pick the same vendor to lead them to the new paradigm and (3) the transformation occurs quickly due to the group's unwillingness of being in a transition stage. Therefore, there is a dilemma in reaching this group since no pragmatist will make a move without having a reference from another pragmatist, also known as 'the chasm'.

- *Late majority:* Also known as conservatives, are risk averse and skeptical toward new technologies; they are price sensitive and in need of preassembled and 'bulletproof' solutions. Their motivation for adopting new technologies is to remain competitive and they often rely on advisers to guide them (Mohr, Sengupta, & Slater, 2010, p. 242).

- *Laggards:* This group is the most skeptical and are keen on avoiding industry disruption. Their motivation for adopting new technologies and products is if there all other alternatives are worse and the cost-benefit analysis makes most sense (Mohr, Sengupta, & Slater, 2010, p. 242).

3.1.3.2.1. Crossing the chasm and achieving full diffusion

The difficulty for firms in reaching full diffusion of a new technology is to reach the early majority due to aforementioned reasons. It is therefore in the interest of firms to find a strategy for penetrating the pragmatist market segment and reaching the mainstream market, and *Geoffrey A. Moore* suggests such a step-by-step strategy in his succeeding book *Inside the Tornado* from 1995, which is partly summarized in green colors in Figure 20. Moore (1995) suggests the first step is to gain attraction in niche markets within the mainstream market, namely *the bowling alley*. The technology product has not yet achieved market wide
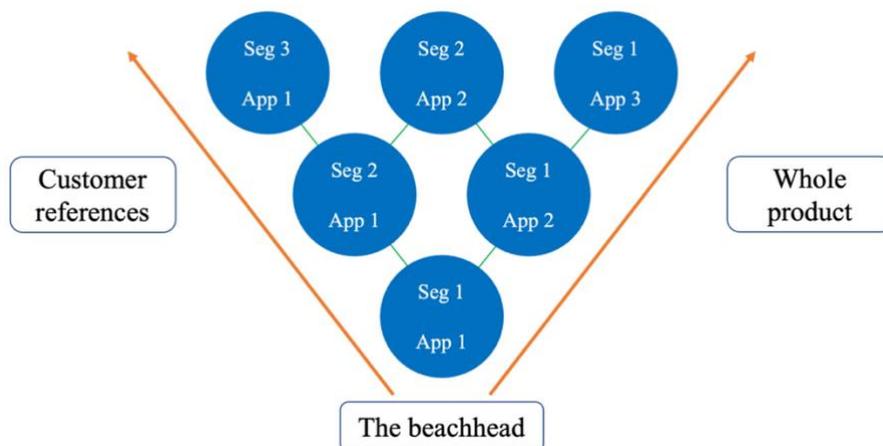
Figure 21: The bowling alley market development (Moore A. G., 1995)

acceptance and the market is not large enough to support many firms, thus the successful firm will establish itself as the market leader. The strategy during this market development state is illustrated in Figure 20. Firstly, the company must identify a 'beachhead' – an isolated market segment from which it later can penetrate the mainstream market (Moore G. A., 1991). The characteristic of a good beachhead is (1) a customer base with a compelling reason to purchase which aligns well with the skills and capabilities of the firm and (2) provides contiguity to closely related markets to enable further market penetration. Examples of compelling reasons could be that the purchase of the new technology provides a significant competitive edge in previously unavailable domains in an essential market, seminal productivity improvement on a well-understood critical success factor (and there are no alternatives which achieves a comparable result) or a momentous and verifiable reduction in overall operating costs (Mohr, Sengupta, & Slater, 2010, p. 244). The contiguity provided by the beachhead should result in proactive identification of new market opportunities by utilizing knowledge about technologies or segments. The adjacent market opportunities are characterized by either (1) new segments where the company can sell current technological solution, represented as 'Seg' in Figure 21, or (2) incumbent segments where the firm can sell new technological solutions, represented as 'App' in Figure 21.

Alternatively, instead of finding new market segments, firms can penetrate deeper into a current segment by developing complementary products or services related to the main offering, i.e., *Microsoft's Office* package as a complement to the firm's operating system (Mohr, Sengupta, & Slater, 2010, p. 245).

Moreover, contiguous markets segments (seen as Seg 2 and Seg 3 in Figure 21) should have two characteristics, namely *word-of-mouth relationships* and *similarities in whole product needs* (Moore G. A., 1991). Firstly, since communication between pragmatists is vertical (within the same industry) word-of-mouth should occur between two segments to allow for easier diffusion. Secondly, Moore (1991) argues pragmatists, in opposite to visionaries, do not accept incompleteness in product offerings and thus it is the responsibility of the vendor to offer a complete and end-to-end solution satisfying pragmatists needs, the whole product. Furthermore, these adjacent segments should have similar whole product needs, and if needed, create partnerships to ensure a complete offer. In other words, the vendor must adapt a system thinking (Mohr, Sengupta, & Slater, 2010, p. 246).

The second step in crossing the chasm suggested by Moore (1995) is known as *the tornado* which represents a transition period when the general market is switching over to the new technology. The tornado is driven by the development of an application of the new technology which attracts a mass market and can be reckon as a commodity – suggesting it can be manufactured and distributed at lower prices (Mohr, Sengupta, & Slater, 2010, p. 248). Consequently, the firm should now adapt a strategy of operational excellence and standardize processes to allow for cost decreases and meet a larger demand.

Thirdly, *main street* is known as the subsequent step and refers to a period when growth in the early majority market stabilizes. At this point, the underlying technology have been grasped

by the whole market and the objective now is to capture all value created through the technology deployment by selling product extensions to current customers rather than attracting new customers. Finally, if the firm wants to reach the late majority and laggards it must make the product even more convenient and simpler (Moore A. G., 1995).

3.1.3.2.2. Alternative theories for bringing new technology to the market

3.1.3.2.2.1. Network of incumbents

As the possibilities to connect with one another, more markets are changing nature and becoming part of networks, and Bhaskar Chakravorti (2004) argues this trend makes it harder for firms to bring new innovations to the market. Innovators need to develop new strategies for commercializing products by understanding how social, commercial, and physical networks behave. Chakravorti (2004) suggests markets seek equilibrium – meaning every incumbent believes they are making the best possible choice and that every other incumbent is doing the same – and when new innovations disrupt the market it creates uncertainty in decision making, leading to innovation hostility (Chakravorti, 2004). The hostility intensifies when incumbents are interconnected in a network, and to overcome the obstacle of commercializing new technology products Chakravorti (2004) suggest the following four step approach:

1. *Reason back from anticipated end result:* Meaning that the incumbent should envision the new market equilibrium it wants to create and initiate only the strategies which are in line with crating the new status quo.

2. *Complement the power incumbents:* Position the new product as a complement to the product offered by the most influential incumbents in the designated network to instantly reach other incumbents.

3. *Offer coordinated switching incentives:* Turn around the behavior of incumbents who would add value to your innovation, channel partners and anticipated adopters by aligning their incentives to switch over to your technology solution.

4. *Remain flexible:* Your product and marketing plans should be easily adjustable to meet changes in the market.

3.1.3.2.2.2. The psychological aspect of customer technology adoption

Even though billions of dollars are invested in new product development, between 40-90% of all innovations, determined by industry, fails. E.g., the hard drive for storage *TiVo* had received enthusiastic review from industry experts, but instead of taking the market by storm experienced an operating loss of $600 million by 2005 (Gourville, 2006). The reason for this can be referred to the differing mental stance toward innovation between customers and

companies. Customers find comfort in products they are familiar with and are hesitant to change behavior when using a new product, despite noticeable advantages in the new product, while companies overvalue the benefits from its own innovation and naively assumes customers will buy their innovation without hesitation, which Gourville (2006) refers to as *the 9x Effect* seen in Figure 22.
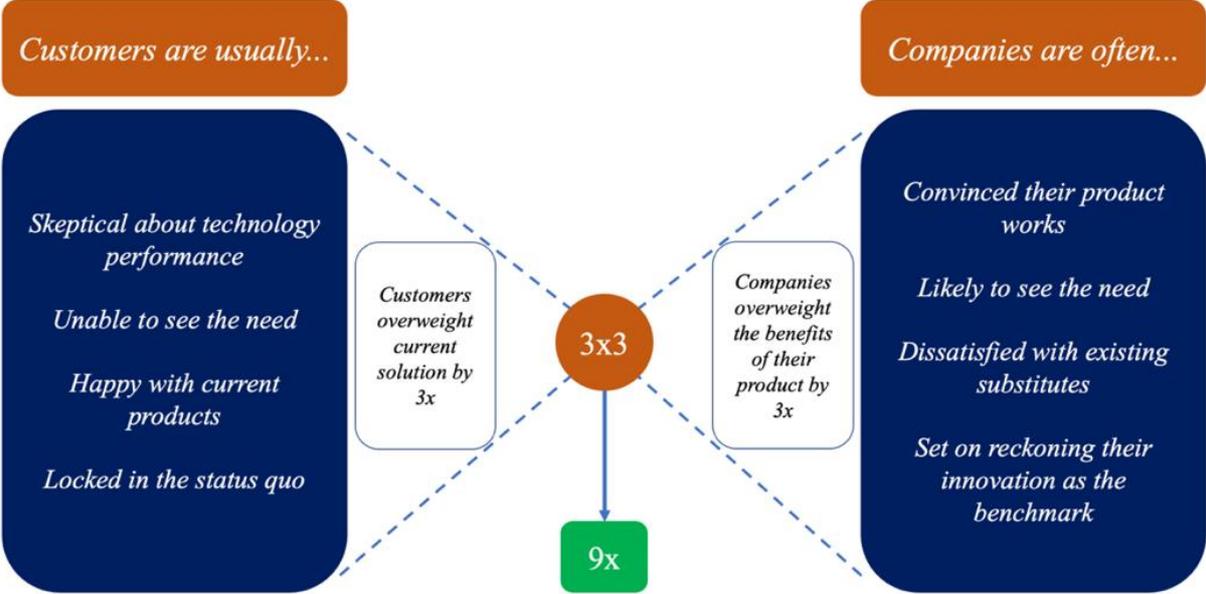
Figure 22: The 9x Effect explaining the mismatch between customers and firms (Gourville, 2006)

To overcome the mismatch and ensure adoption, Gourville (2006) suggests three approaches. Firstly, the firm must *gauge potential customer resistance* by categorizing the degree of behavioral change required by the customer as seen in Figure 22.
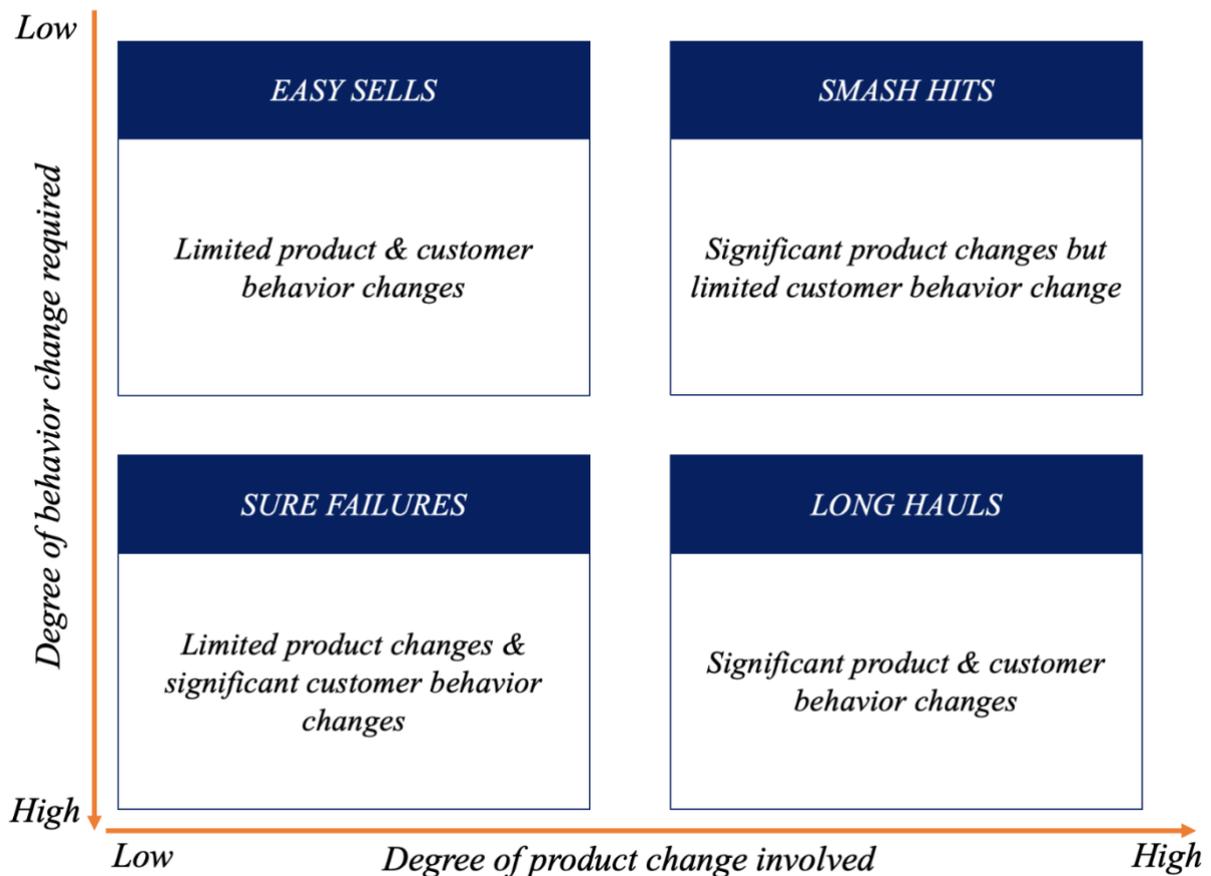
Figure 23: Four types of innovation categories (Gourville, 2006)

When the firm has categorized its innovation and thus got an understanding for the anticipated customer resistance, it must then try to minimize this resistance, and Gourville (2006) proposes the following three strategies:

1. *Develop behaviorally compatible products:* The incumbent can try to minimize, or eliminate, the behavioral change required by customers and thus push the innovation to become a smash hit as seen in Figure 23. E.g., Toyota introduced the Prius model which enabled drivers to drive using either the traditional combustion engine or an innovative electric solution which meant drivers could retain the benefits of the intrenched gasoline alternative while concurrently enjoy increased driving length (Gourville, 2006).

2. *Focus on customers who are not yet using entrenched products or services:* Incumbents can try to attract customers who have not yet been acquired by current product offerings. Gourville (2006) exemplifies by referring to Burton Snowboards who manufactures snowboards and other winter equipment. The company targets young winter sport enthusiasts who have not yet established themselves as skiers, and by having created a distinguished culture through marketing, managed to outgrow the number of snowboarders over skiers in the United States.

3. _Find believing customers:_ Identify customers who see great value in the benefits provided by the innovation or see only marginal value in incumbent products. E.g., island car owners might value zero-emission cars higher than a mainland car owner since they are less dependent on the mileage capacity, and vice versa when it comes to having a network of gas stations since island car owners are less dependent on having an extensive gas station network. Consequently, Reykjavik in Iceland was first with introducing a hydrogen-filling station and the capital has installed a network of commercial hydrogen-powered buses travelling its streets (Gourville, 2006).

While it is possible to minimize customer resistance, for _Long Hauls_ firms must handle an irremovable resistance, and thus the following two actions are suggested:

1. _Accept slow adoption rates:_ Do not use up resources too quickly by trying to market a product too fast even though it is a Long-Haul innovation (Gourville, 2006).

2. _Assure benefits of the innovation are 10x greater than incumbent products:_ E.g., MRIs offer a significant improvement compared to X-rays which leads to consumers accepting a new behavior of lying in a tube for longer period (Gourville, 2006).

3.1.3.2.2.3. The value brought to customers

Whether customers decide on purchasing a product or not comes down to whether they gain any value from using the product. This notion has been picked up by _Clayton M. Christensen et. al._ in their article _Know your customers' "Jobs to be Done"_ from 2016, where they introduced the concept of _'jobs to be done'_. Christensen et. al. (2016) suggest that marketing and product development activities focus too much on the characteristics of target consumers and correlations between sets of data rather than understanding what the consumer is trying to achieve in a certain situation – the jobs they are trying to get done. Hence, product innovation should be centered around the notion of solving an issue the consumer is experiencing concerning a specific 'job' in their day-to-day life. E.g., _Hershey's Reese's Minis_ was brought to the market after the company realized that the original sized peanut butter cup was too large and messy when driving the car or standing in a crowded subway – making it difficult to open the package. The mini version solved the issue at hand and led to €235 million in sales in its first two years (Christensen, Hall, Dillon, & Duncan, 2016).

Moreover, the value created for customers is also discussed by _Eric Almquist, John Senior_ and _Nicolas Bloch_ from _Bain & Company_ in their article _The Elements of Value: Measuring – and delivering – what consumers really want_ from 2016. They argue that customers take two factors into consideration when evaluating a product or service, namely the _perceived value_ and the _price_. While firms generally focus efforts on price, pinpointing the customer value is oftentimes of less interest due to the (psychological) complexity. Almquist et. al. (2016) suggests companies should strive to find the right combination of values delivered to the customer, and their research found that the right combination of values implies customer loyalty, greater willingness to test a specific brand and a sustainable revenue growth. Their

research has resulted in 30 fundamental elements of value to pick from when finding new combinations of values in a customer offering, which can be seen in Figure 24.
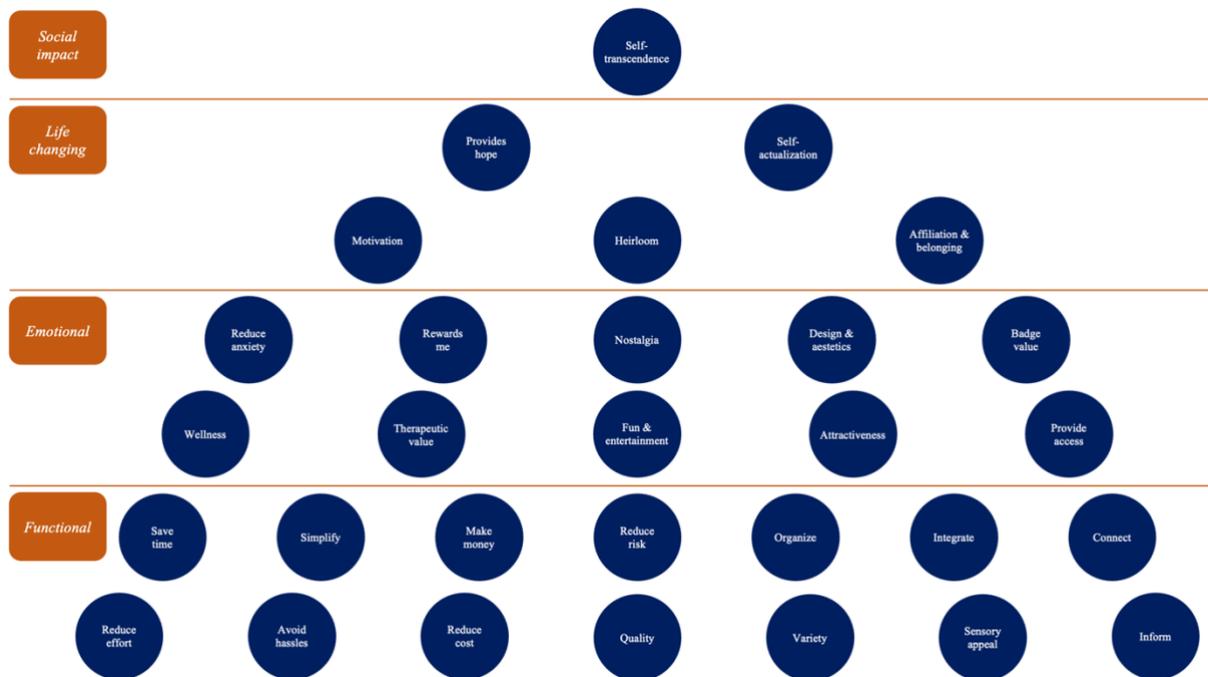
Figure 24: The 30 fundamental elements of value (Almquist, Senior, & Bloch, 2016)

The presented value in Figure 24 can act in a firm's best interest when managers recognize them as a growth opportunity and hence make customer value a priority instead of only focusing on pricing, cost, and customer loyalty. Almquist et. al. (2016) suggests the following three areas should prioritize value:

1. *Product development:* The elements of value can promote new ideas to offer customers or add features to current products.

2. *Pricing:* Even though pricing is considered as one of the most important levers when steering demand, changing prices also affects the customer value equation. Hence, discussions about raising prices should not come without adding value elements to compensate for the higher price point (Almquist, Senior, & Bloch, 2016).

3. *Customer segmentation:* Firms oftentimes have a pre-determined procedure of segmenting customer groups, based on parameters such as demographics or behavior, to identify what each segment values. Once an opportunity arises to improve value, firms should collect information from current and potential customers through surveys. By doing this, the firm learns about the status of the value elements it is, or is not, delivering (Almquist, Senior, & Bloch, 2016).

3.1.4. Becoming a market-oriented firm

Aforementioned subchapters presented why having market focus is essential for turning high technology startups into commercial successes along with frameworks and tools connected to the concept of market orientation. Though, the logic of being market orientated is compelling, Mohr et. al. (2010) argues few firms master the skill. The weak market focus is an implication of lacking the four facilitating conditions seen in Figure 25.
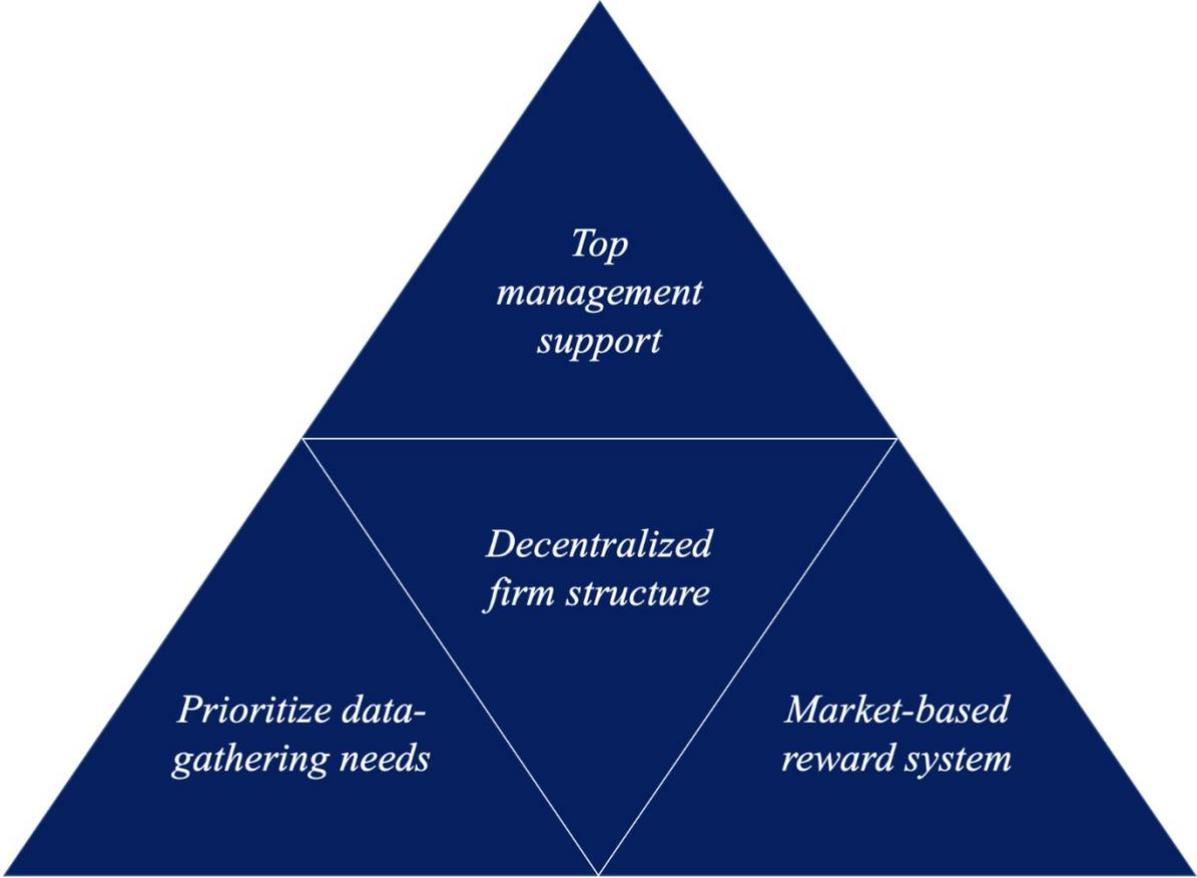
Figure 25: Facilitating conditions of market focus (Mohr, Sengupta, & Slater, 2010, p. 115)

Firstly, firms must *prioritize its data-collecting focus* and concurrently match it to its strategy. Resource constraints along with the complex nature of high technology markets implies difficulty for the firm to scan its market exhaustively, thus scanning activities should be restricted to market forces which are closely connected to the firm strategy (Day & Nedungadi, 1994). Depending on company strategy the firm will collect and utilize data differently as seen in Table 10.

Company strategy	Description	Data focus
Product leader (Prospector)	Introduce new technology solutions to meet customers' expressed and latent needs. Target segments are *Innovators* and *Early adopters*.	Priority on understanding unarticulated needs. Should ideally stay ahead of the technology development.
Fast follower (Analyzer)	Develop improved or lower-cost versions of products marketed by product leaders while concurrently defending core markets.	Studies of customer adoption of product leader offerings and learn about actual customer preferences. Information should be limited to product introductions to categories which already show marketplace potential.
Operationally excellent (Low-cost defender)	The goal is to provide products and services to the lowest possible cost. Utilizes technology innovations to make manufacturing and operations activities more efficient.	Incumbents must monitor external data about competitors to benchmark against prices and costs.
Customer intimate (Differentiated defender)	The goal is to maintain position with established *Early & Late majority segments*. Incumbents value proposition is based on a gradate customer knowledge.	Customer satisfaction and opportunities to increase share of wallet. Reasons for customer churn and assessment of customer profitability.

Secondly, by having a *decentralized firm structure* Mohr et. al. (2010) argues that firms will develop a market-focused behavior with unconstrict responsibilities and lateral communication. Consequently, employees recognize their interdependence and thus their willingness to share market intelligence and effective intelligence dissemination, but it requires that bureaucratic constraints concerning behavior and information processes are removed (Mohr, Sengupta, & Slater, 2010, p. 117).

Thirdly, the *compensation system in a firm should be market-based* to incentivize employees to generate and share market intelligence, increase customer satisfaction rates and customer loyalty. A market-based reward system has the greatest impact on becoming market focused out of the organizational factors (Jaworski & Kohli, 1993). Consequently, market orientated

firms focus less on short-term profitability and sales goals compared to financially focused competitors (Mohr, Sengupta, & Slater, 2010, p. 117).

Fourthly, seen as the top segment in Figure 25, is *the commitment and support from top management* (Mohr, Sengupta, & Slater, 2010, p. 115). If top management is not visibly committed to the firm's customers and support the initiative to collect market-based data, the aforementioned conditions for becoming market focused will not be successful.

Ultimately, establishing a market-orientated culture means going through a four-step process, namely (1) initiation, (2) reconstitution, (3) institutionalization and (4) maintenance. The process goes as follows: employees recognize an external threat, and as a result, a group of managers forms a coalition to mobilize the whole organization by reconnecting firm employees with the market. By interacting more directly with customers, employees gain experience and build consensus which is later formalized in the firm to embody the cultural shift and sustain the market orientation (Gebhardt, Carpenter, & Sherry, 2006).

3.2. *Technology-oriented competitive advantage: A literature review of concepts & frameworks*

3.2.1. Defining technology strategy

When defining technology strategy, there will be as many definitions as there are researchers within the field, however they all point in the same direction. Some definitions are broad, while others are narrower. In the coming paragraph some of the more common definitions will be described.

Professor *David Ford* can be considered as the founder of the concept *technology strategy,* which he defined in the article *Develop your technology strategy*. In this article, Ford defines technology strategy as the strategy related to what a company can do and what knowledge a company has internally. Ford states that what a company can do, and what a company knows is the very foundation which a company is based upon, rather than believing that a company is defined by its product offerings. Technology Strategy is the plans, approaches, and guidelines for a company to acquire, manage and exploit knowledge and abilities. Ford also stresses that it is important not to confuse technology strategy with R&D-strategy, as the latter only focuses on technology acquisition through internal activities (Ford, 1988, p. 85).

Matheson and *Matheson* define technology strategy to ensure that the technology related decisions within a company are made with high integrity and with the best possible outcome for the company in mind. It should focus on acquisition of technology, how products, both existing and future, can be generated and supported. It should also consider which technologies must be developed and maintained to stay competitive. Like Ford, they also state that this is a process which must be continuous, on all levels within the company. Matheson and Matheson define technology strategy to ensure that the technology related decisions within a company are made with high integrity and with the best possible outcome for the company in mind. It should focus on acquisition of technology, how products, both existing and future, can be generated and supported. It should also consider which technologies must be developed and maintained to stay competitive. Similarly, as stated by Ford, they also state that this is a process which must be continuous, on all levels within the company (Matheson & Matheson, 1998).

Another, even more concise definition is the one by Rieck and Dickson: *"Technology strategy is the process by which firms utilize their technological resources to achieve corporate objectives"* (Rieck & Dickson, 1993).

3.2.2. Why technology strategy is important

When discussing the term technology strategy, there are two types of technologies involved: *product technology* and *production technology.* However, one of the most important learnings is that the technology a company possesses can not only be exploited internally for the company's own products, e.g., the technology may be licensed or franchised. Also, the procurement of technology is not limited to internal development, it may also be acquired through licensing or outsourced R&D. As stated by Ford: *"Technology Strategy is that aspect of strategy, which is concerned with exploiting, developing and maintaining the sum total of the company's knowledge and abilities"*. The scope of the technology strategy should be long-term, as a short-term perspective comes with the risk of neglecting long term technology issues within a company in exchange for short term profits (Ford, 1988, pp. 85, 86).
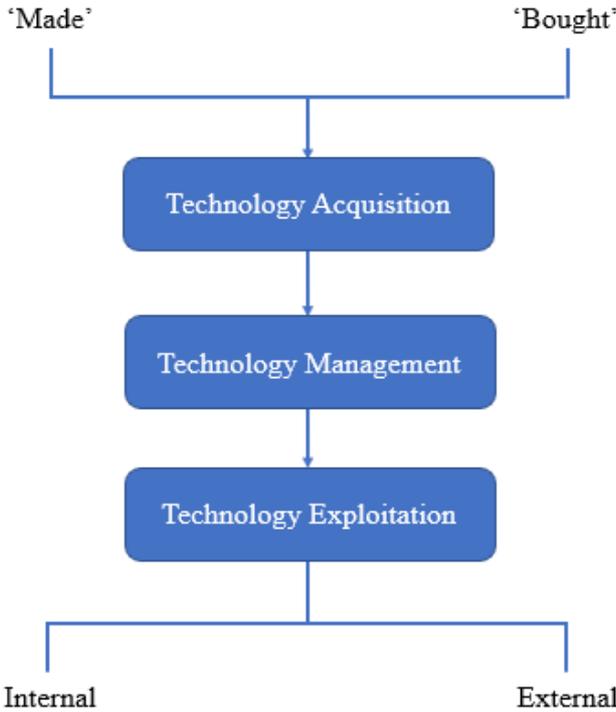
Figure 26: The elements of technology strategy (Ford, 1988)

Technology strategy is important for all companies, as it forces the company to reflect over product and production capabilities, which is the very core of a company's operations. It is a way to mitigate the imminent risk of limiting the company's strategy to only include market related functions. An important question when developing a technology strategy is whether a technology is used to an optimum degree or have a share of possible exploitation of a certain technology not been taken advantage of. Figure 27 illustrates the need of both commercialization and technology exploitation. (Ford, 1988, p. 86).
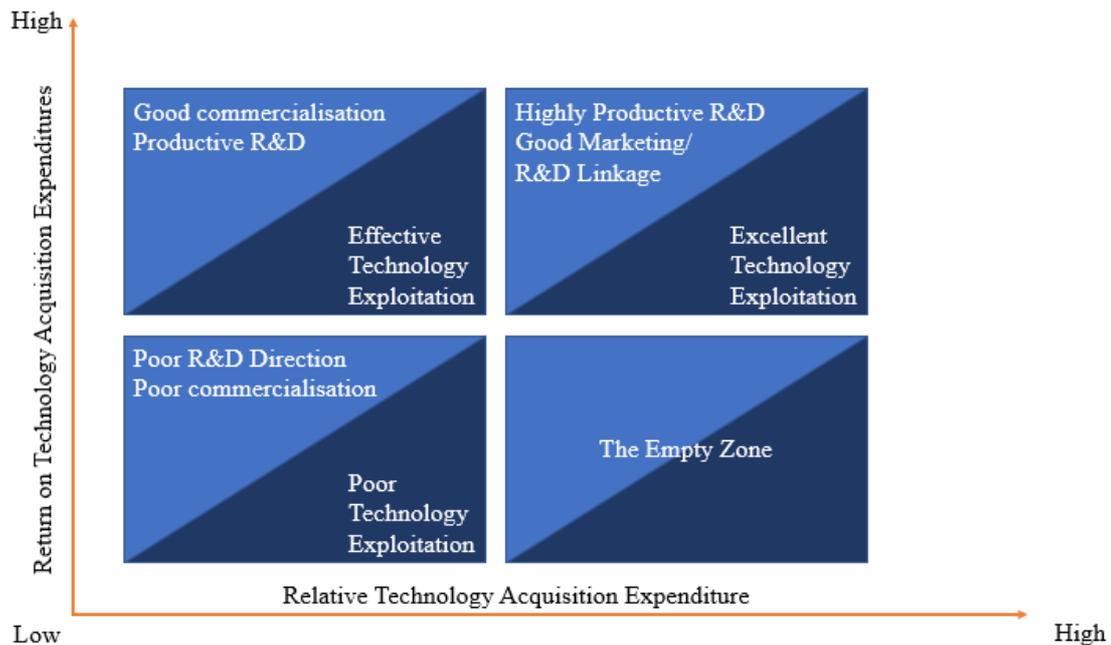
Figure 27: Relative technology acquisition expenditure (Ford, 1988)

However, the technology strategy is not limited to maximize the output of a certain technology, it also focuses on ensuring that the technology within a company does not fall into oblivion. If a company has some success with a product, it must not become "comfortable", but instead it must reinvest in technology acquisition not to slip behind competitors. Otherwise, the company will be helplessly left behind if a competitor launches a new generation of this product. A speaking example of this from Ford´s article is: *"...striking in the United Kingdom are the examples of British Leyland and Dunlop - both licensed their technology to Japanese corporations only to have to acquire later technology from their erstwhile customers when their own technology had declined."* The British companies lacked a well-established technology strategy, and because of their once technological superiority, did not realize the need of extensive technology acquisition. A well-established technology strategy is a useful tool to safeguard against slipping behind competitors, this is illustrated in Figure 28. This illustrates technology sub-cycles within an industry, if our company gains success in the first generation of sub-technology, it must not lean back and only reap the profits from previous technology acquisition. It must continue to invest in technology acquisition, or it will be left behind when the competitors launch second-cycle technology (Ford, 1988, p. 87).
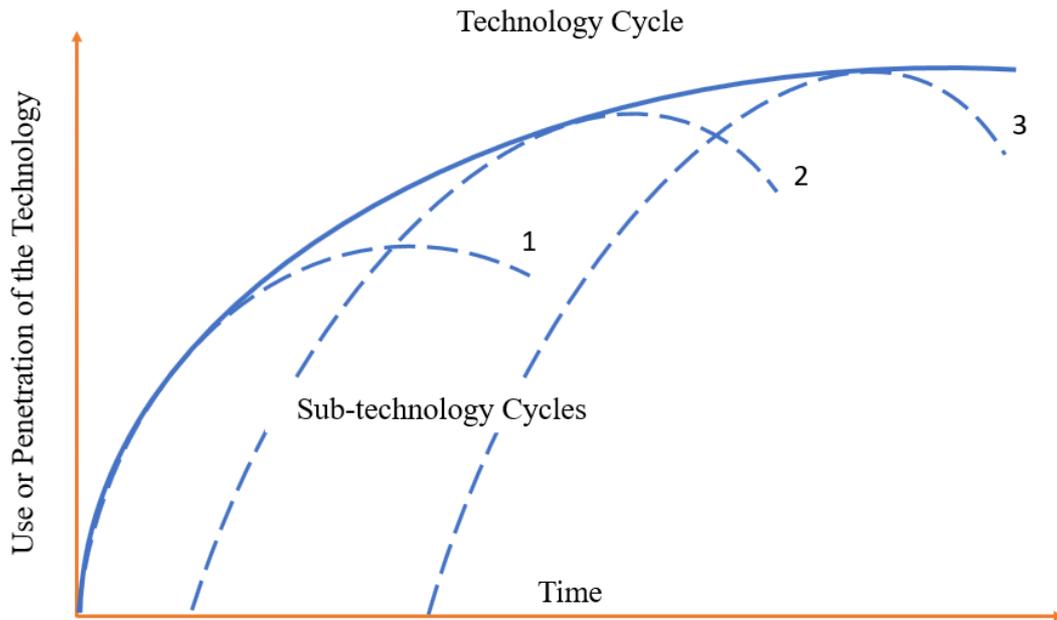
Figure 28: Technology cycle and sub-cycles (Ford, 1988)

3.2.3. Technology Audit

Ford (1988) states: *"Technology Strategy is much like any form of strategy. It is only as good as the analysis on which it is based".* Also, Rieck and Dickson emphasise the importance of a good background analysis on which to base the strategy upon. To ensure that the analysis covers all the important aspects of technology strategy it is wise to go through with a technology audit.

The term technology audit was introduced by Ford in the article *Develop your technology strategy.* The technology audit is the analysis on which the technology strategy is based upon. The technology audit should be a continuing process within a company, by reevaluating the company's technology base occasionally the risk of falling behind competitors from a technological perspective can be mitigated. Also, this gives an opportunity to reconsider and reframe the technology strategy. However, the first audit should be meticulous as this is the first step in the process of developing a technology strategy. When conducting a technology audit the following questions should be evaluated and answered (Ford, 1988, pp. 88, 89).

3.2.3.1. What are the technologies and know-how on which our business depends?

This question should reflect upon the company's technological situation regarding the market and the competitors within the field. Is our company proactive when it comes to introduction of new technology, or is our company most of the time reacting to competitors introducing new technology to the market, in other terms, is our company leading or following? When

answering this question, our company must also reflect upon the sources of the technology on which the business depends. In what way is our company's technology acquired, is it developed in-house, licensed, or bought in? If a large share of the technology which the company depends on is acquired from the outside, the company may face problems in the future. Also, when conducting this analysis, Ford stresses the importance of dividing the technologies into three categories, to easier visualise the state of technology within the company. The technology can be divided into. *Basic technologies*, which work as the admission ticket to the market in which our company is operating. Without the basic technology the company would not have access to the market. *Distinctive technologies*, these are the technologies which distinguish our company from the competitors, and this should be the technology in which our company focuses its efforts. Lastly, *External technologies*, are the technologies which are bought in. When buying technologies which are not in our company's expertise, it is a way to ensure that the company focuses its operations on what it is best at. A visual interpretation of the three technologies is illustrated in Figure 29 (Ford, 1988, p. 89).
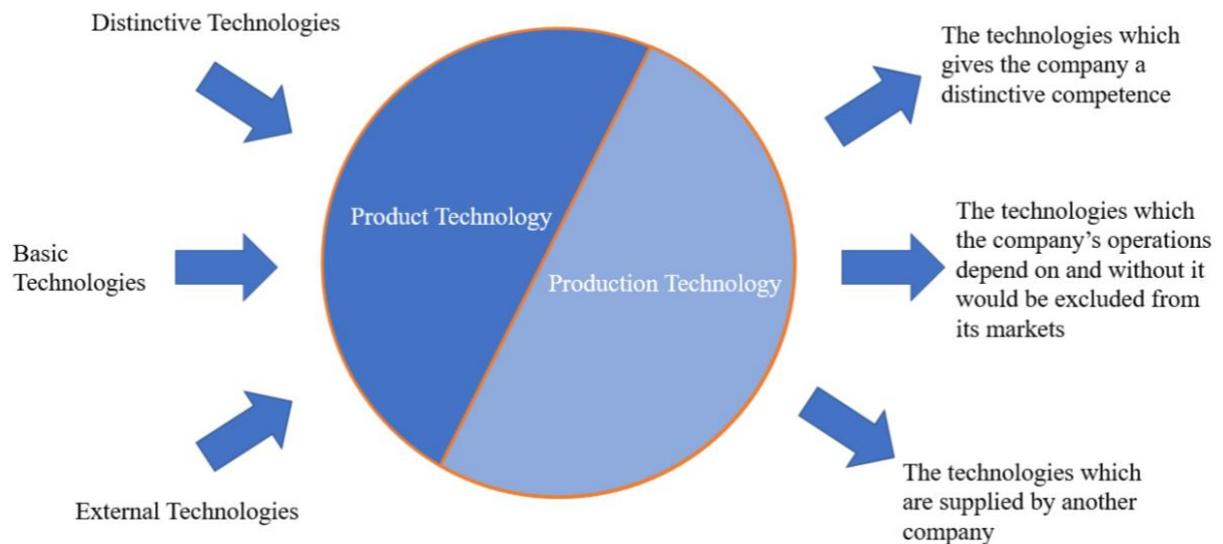
Figure 29: The tree types of technology, each arrow corresponding to the opposite arrow in the same vertical (Ford, 1988)

3.2.3.2. Do we have a poor record in bringing 'home-grown' technologies to market?

If there is a record of poor performance when bringing technologies to market, is this due to a discrepancy with the market? Is the market research of our company not up to standards? It could also be that the developed products do not live up to the expectations, which could indicate a problem within R&D. Another credible reason for failure when bringing technologies to market is inadequacies in relation to commercialization. If it is found that there is a poor record of bringing technologies to the market, which would be the best way for our company to solve this? Could the lacking performance be improved, or should our company try to acquire this technology externally? (Ford, 1988, p. 89)

3.2.3.3. How does our technology position compare to that of our customers?

When a new technology is launched, most of the times there is a gap in knowledge between our company, as a supplier, and the customer. This gives our company an opportunity to charge a high price, as the customer lacks the technology internally. However, over time, in many cases the customer gains knowledge of the technology through experience, development and possibly by recruiting personnel with the desired knowledge. When the customer acquires knowledge of the technology themselves, the customer is unlikely to keep paying the higher prices. In a worst case the customer will source the technology in-house instead of purchasing from our company (Ford, 1988, p. 89).

3.2.3.4. What is the life cycle position of the technologies on which we depend?

If our company is dependent on old technologies which may become outdated, this should serve as a wake-up call. On the other hand, if our company is trying to be in the forefront of a wide array of technologies this could lead to fatigue of the R&D-department. It may be wiser to focus on the core technologies of our company, to avoid this. Also, in many cases it may be advisable to acquire some technology externally, to focus the in-house R&D efforts where the core competencies lie.

3.2.3.5. What are the emerging or developing technologies both inside and outside our company which could affect our current or prospective markets?

If our company want to stay competitive it must keep an eye on both what is happening internally, but also on what is happening externally. This does not only put light on the product offering, but also on the production technology. If our company's production technology is becoming outdated, this will probably first be noticed by the marketing department rather than the R&D department as our company is unable to match the prices of the competitors which have access to better production technology. By bringing this question up, the general awareness of the importance of technology may be broadened within the company as it becomes obvious that the marketing department is closely linked to both production and R&D (Ford, 1988, pp. 89, 90).

3.2.3.6. Are the company's strengths in product or production technologies or both?

Do our company's core competences lay in development and design of products, or in the production of the goods? In some cases, companies are involved in manufacturing simply because of historical reasons. It may also be that our company once had an efficient production process, but due to neglection of production technology it has become outdated. If the production technology does not add value to our company, it might be better to produce

externally and focus on investments in product technology. If our company has a core competence within production processes, but the gains of this cannot be realised due to ageing production technology, this would be a waste of skills which could be addressed by investments in production technology (Ford, 1988, p. 90).

3.2.3.7. Does the company achieve the optimum exploitation of the technologies we have?

This question relates to the fact that companies often forget to utilize technologies maximally. Technologies which are not in use in our company may be of interest to other companies, this could generate revenue from sales or licensing of the technology which may seem useless internally. Also, technology should be used internally wherever it can be of value. It is not uncommon in larger organizations, especially if they are organized divisionally, that a problem which needs solving in one division has already been solved in another division (Ford, 1988, p. 90).

3.2.3.8. Does the company have technological assets, which are no longer of use to us, but which may be of value to other companies?

When technology becomes outdated it may happen that the technology is forgotten, but this technology may be marketable in less sophisticated markets. This opportunity to make revenue from technologies which does not require any further development should not be overlooked (Ford, 1988, p. 90).

3.2.4. The nine principles of Smart R&D

Matheson & Matheson (1998) has defined nine principles of R&D with the aim of helping organizations to achieve high-quality strategic decision. Each principle consists of a theory which organize several beliefs and behaviours, which in turn leads to better decisions. The nine principles are broken down into three subgroups organized after their function within an organisation. Figure 30 illustrates the nine principles and their corresponding subgroup (Matheson & Matheson, 1998, p. 110).
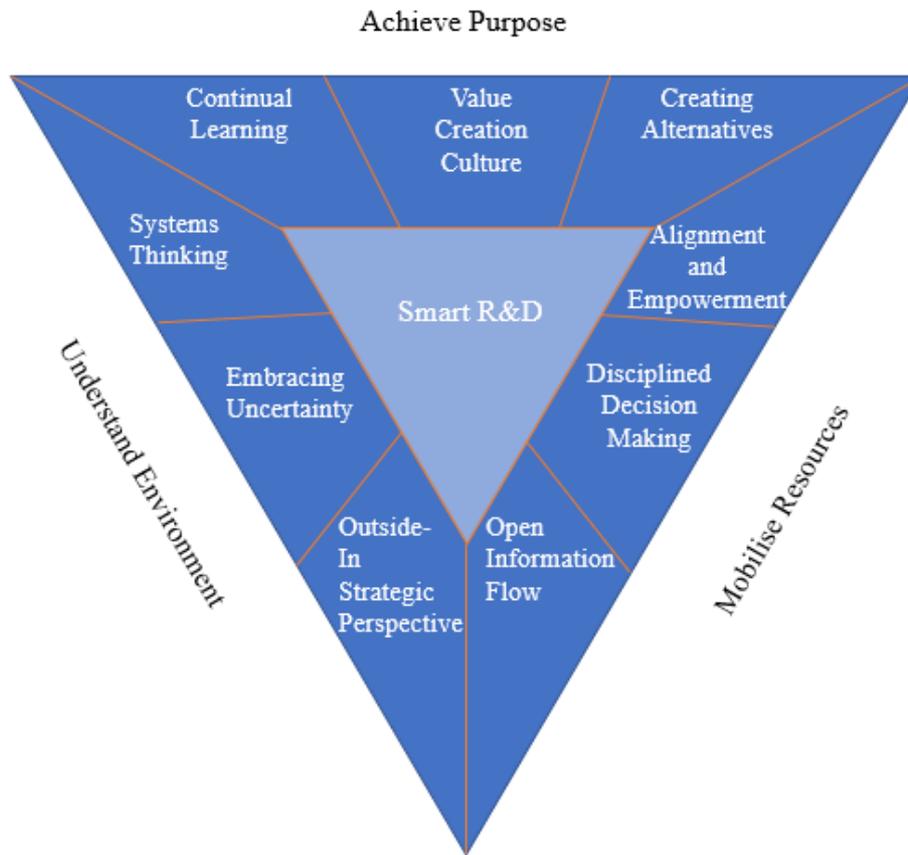
Figure 30: Nine Smart Principles of R&D (Matheson & Matheson, 1998)

3.2.4.1. Value creation culture

This principle should be natural in a commercial organisation. The very core of the organisation should be to maximise the value which it creates. When taking decisions, the answer should always be the alternative which yields the most value creation. In an organisation which favours value creation, every individual should see the job as a quest for creating the most value. If organisational rules impede the creation of value, the individual should request a change to the rules. The organization on the other hand must be open minded and support the individuals who create value, even if this means rule breaking. Also, the organisation should facilitate cooperation across functional borders to foster further value creation. However, the complexity in this principle lies mainly in the measure of "value". The most applied measurements are net present value of cash flow from development and commercialisation, and Economic Value Added, which measures operating income after tax less the cost of capital in operations. Also, there are some other ways to measure value creation. However, the conclusion is that all ways to measure value creation should be applied carefully, and that only a few measurements should be used, as a multitude of metrics may lead to misleading conclusions and wrong decisions (Matheson & Matheson, 1998, ss. 112-115).

3.2.4.2. Creating alternatives

Creating alternatives means that for every decision within an organisation, there should be multiple *good* alternatives. Based on this the best alternative should be selected. If an organization is to promote alternatives it must favour creativity, also whenever a decision is made the organisation must require multiple alternatives before evaluation begins. If this is not in place, the organisation makes it risky and awkward for employees to propose multiple alternative solutions to a problem. An employee who suggests several alternative solutions may be viewed as indecisive and uncommitted by others, however this would hamper innovation as employees become wary. Also, the organisation should never decide upon an alternative if the rejected alternatives are not known. By always creating multiple alternatives the chances of finding new solutions which may revolutionise the value creation. The good alternatives which are not applied in favour for even better alternatives, would generate a database of ideas which can be pursued later, when resources are available. The drawback of a "multiple alternative decision process" is that it requires effort in creating an evaluation process which is adequate to sorting the best ideas from the good ideas (Matheson & Matheson, 1998, ss. 116-118).

3.2.4.3. Continual learning

The organisation must always keep learning about what creates value, i.e., have an *absorptive capacity*. As the world is changing in an ever-higher pace, organisations must be able to keep up with this not to fall behind competitors and customers' changing demands. When technology and demands keep changing, the only constant is the need of continual learning. For an organisation to promote continuous learning it should formally appoint time slots for learning, if employees are asked to take responsibility of their own learning, the risk is that learning is not prioritised when compared to getting on with the daily work. Also, the organisation should embrace change and learning as something which is profitable and routine. To evaluate the learning, benchmark-based training can be implemented (Matheson & Matheson, 1998, ss. 119-122).

3.2.4.4. Embracing uncertainty

In any organisation one cannot foresee everything, there will always be uncertainties, both external and internal. To mitigate the threat of uncertainties having fatal consequences, the organisation must try to understand all sources of uncertainty when making decisions. It is important to understand that decisions can be controlled, however the outcome cannot be controlled. Therefore, it is important to always communicate the uncertainties related to a decision. To promote this the organisation shall give rewards according to what can be controlled, not only according to actual results. To better facilitate the communication of uncertainties one should strive to communicate these as ranges or probability (Matheson & Matheson, 1998, ss. 123-129).

This is also one of the reasons there are more successful start-ups in Silicon Valley than in Europe. In Silicon Valley entrepreneurs are judged after the quality of decisions and how well the entrepreneur tries, it is considered that the entrepreneur cannot control all aspects which are required for success. However, in Europe the fact that the entrepreneur cannot control all success factors is often not considered. If an entrepreneur fails in Silicon Valley due to factors out of her control, it is likely that she will be hired by another company or receive funding for her next venture. On the other hand, if this happened in Europe it is very likely that she would have a hard time, as she might be viewed as a failed entrepreneur. This leads to European start-ups more often sticking to safer but less profitable business, out of fear of going bankrupt (Matheson & Matheson, 1998, s. 130).

3.2.4.5. Outside-in strategic perspective

This principle relates to the fact that organisations must see the big picture before taking decisions. All planning within the organisation should start from the outside perspective, if the organisation does not understand the industry and the customers in the market in which it operates, it is likely that the outcome will be unsatisfactory. The product which the organisation delivers must satisfy the end customer. To be able to satisfy the customer the planning must begin with the end customer to understand how their needs evolve, and how the industry change to meet the customers' demand. From there the organisation can analyse the value chain downstream and gain understanding of what is required to stay competitive. With this knowledge the organisation is better equipped when reflecting on whether it already is in the right position to succeed in serving customers or whether it needs to revaluate the strategic position. If the organisation does not have an outside-in perspective it will always be following competition, on the other hand an organisation which sense the external environment have an opportunity to become a leader (Matheson & Matheson, 1998, pp. 132-135).

3.2.4.6. Systems thinking

An organisation should always try to understand the full implications of its actions and events. System thinking relates to an approach were everything is interconnected, and that actions have far-reaching and, in some cases, counterintuitive consequences. To be successful in system thinking it is needed to understand the organisation, its operations, and the market as one organic body. By doing this it is easier to observe cause-and effect relations from the perspective of the entire organisation. System thinking try to identify the root cause of a situation and not obvious shallow symptoms. As written by Matheson & Matheson (1998): *"It is consistent with Deming's advice to ask 'why' five times to get to the root cause. This deeper understanding overcomes the tendency to oversimplify"* (Matheson & Matheson, 1998, pp. 136-140).

3.2.4.7. Open information flow

If information is available to everyone in an organisation, this information can be used to create value in new and creative ways. To reach a state of a free information flow, information should flow over functional boundaries, and information should routinely be shared with the organisation. By doing this the risk of "information hoarding" is better mitigated. If an organisation strives after efficient value creation, everyone in the organisation needs information to be able to work efficiently. It is often that employees do not know which piece of information is known to whom, and thus all information should be shared with every other employee. Studies have shown that organisations with a free information flow are more productive than their competitors. Open information flow is especially advantageous in organisations with a culture of continual learning and outside-in perspective. The open information flow also helps to bridge misunderstandings between different functions in an organisation. Finally, an important aspect of free information flow is to codify "tacit knowledge", so that this knowledge is not lost if people leave the organisation (Matheson & Matheson, 1998, pp. 141-145).

3.2.4.8. Alignment & empowerment

In an organisation all members should have a mutual understanding of the strategy and how value is created. When strategic decisions are made a participative process, where both horizontal and vertical dialogue is used to foster alignment within the organisation, is implemented. When the organisation is properly aligned, it can react swiftly to change without going through hierarchical processes, as the individuals in the organisation are empowered and aligned in accordance with strategy. A way for the organisation to promote this is by structuring compensation after what is best for the customer. However, a decision can never be better than the information on which it is based, and the information can be divided into subgroups which "linked" together form a decision chain: *The Chain of Decisions* which is illustrated in Figure 31. This chain can never be stronger than its weakest link, and therefore it is crucial that all the links are of the highest possible quality (Matheson & Matheson, 1998, pp. 146-153).
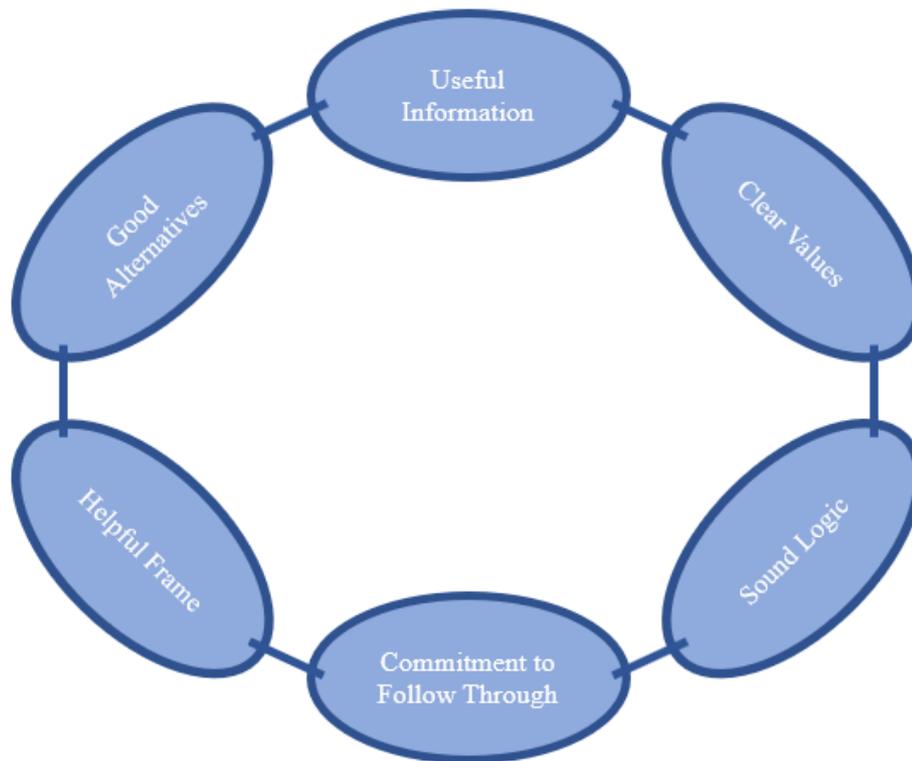
Figure 31: The chain of decisions (Matheson & Matheson, 1998)

3.2.4.9. Disciplined decision making

The final principle relates to the process of making decisions. A smart organisation has an established process for decisions. The process cannot differ from time to time, and it cannot allow for the people with the loudest voice to direct the future of the organisation. By implementing a set of objectives and logical steps, the outcome of the decision process is likely to be the best possible. This process should be improved whenever an improvement can be made. By following an established process, the generated value is maximised, and studies have shown that this also shortens the time to market for projects. This process should be applied to every decision related to technology strategy (Matheson & Matheson, 1998).

3.2.5. Developing a technology strategy

In 1993 the two researchers Rieck and Dickson developed a framework with the aim of concretising the process of developing a technology strategy which is aligned with the overall strategy within the organisation. The framework has a time horizon of approximately 20 years which ensure that the long-term strategic focus is not lost in the process. The framework is based around six timeframes and their related activities within the 20-year time horizon. The six timeframes will be described in the following paragraphs, and the framework is illustrated in its entirety in Table 11. To maximise the value of the technology strategy, the process should be an ongoing and iterative process (Rieck & Dickson, 1993).

Table 11:The six tasks of technology strategy (Rieck & Dickson, 1993)

Task	Time frame	Decisions
Setting horizons	*20+ years*	*Choice of industrial sector; technological implications of this choice*
Industry forecasting	*10-20 years*	*Future direction of industry; industrial revolution versus evolution*
Technology positioning	*5-10 years*	*Core technologies of firm; position relative to frontiers of science and technology*
Determining technology availability	*2-5 years*	*Information sources on technology; technology acquisition, internally and externally developed*
Appropriating technology	*1-2 years*	*Effective use of technology; getting new technology into operation*
Managing technology	*0-1 years*	*Efficient use of technology; continuous improvement of technology*

3.2.5.1. Setting the horizon

When developing a technology strategy, the first step is to reflect upon which industry the company will be competing in over the coming 20 years. Will the company be active in the same industry, or may there be a change of direction during this time? Are there obvious strategic benefits which can be achieved by entering new or related sectors, and what technological adaptions would be required by this change? To find new sectors which may be favourable, an analysis of both the company and its environment is necessary, and for this *Michael Porter's Five Forces Framework*, illustrated in Figure 32, is well suited to this. This step of the process is on a company-wide strategic level, and the most important question to answer is whether the company will be able to sustain healthy profits in the industry in which it is presently operating in? If not, the company must find new ways to exploit its technology (Rieck & Dickson, 1993, pp. 400,401).
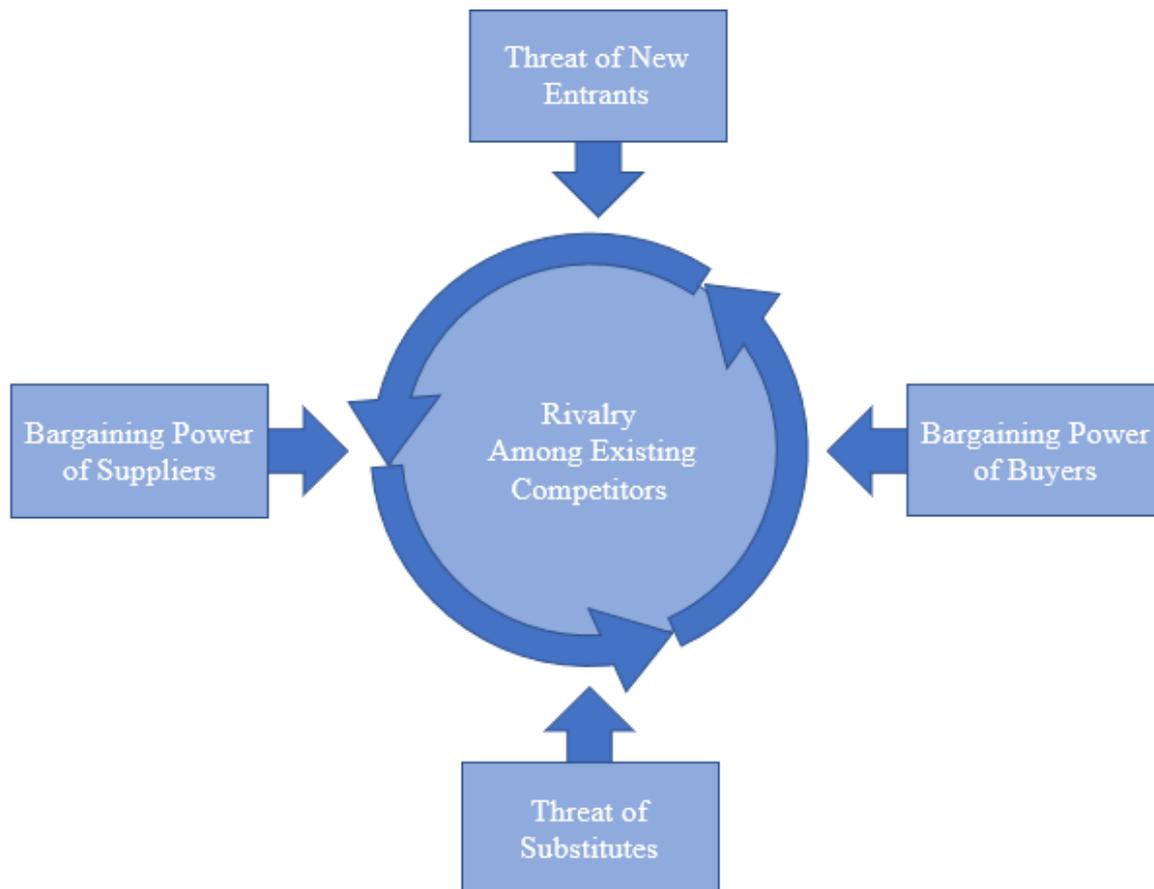
Figure 32: The five forces framework (Porter, 2008)

3.2.5.2. Forecasting the industry

In the previous step of the development of a technology strategy, the focus was to define in which industries the organisation should be competing in. When the scope of the industry has been defined, the next step is to forecast how the industry will unfold in the coming years. The organisation must try to predict what forces are likely to impact the industry in the long term, and how these are likely to alter the direction of industry. To do this, it is useful to have the *Technology Trajectory* as a starting point for the analysis (Rieck & Dickson, 1993, pp. 401,402).

The technology trajectory was defined in 1982 by the researcher G. Dosi, to represent the problem-solving activities within a technological paradigm. It should be envisioned as multidimensional trade-offs of the technological and economic variables within a paradigm. Every time a trade-off is improved, it is viewed as a progress. It is useful as a tool when trying to understand what direction innovation may take in the future, as all products is a trade-off between a multitude of variables. The research and development efforts will therefore be funnelled to mitigate these trade-offs (Dosi, 1982, pp. 153-156).

When forecasting an industry, a suitable time horizon is 10-20 years. It may seem like a long-time frame, especially in a time of rapid innovation. However, research has shown that in

most cases, the lead time from new knowledge to commercialisation is in the range of 30-40 years. With this in mind, it is likely that the knowledge which will affect the industry the coming 20 years is already known, and to develop a credible industry forecast should be reasonable. Although, in industries which are not mature, forecasting the coming 20 years might be preposterous. In this case, the same methodology should be applied, but with a shortened time frame (Rieck & Dickson, 1993, pp. 401, 402).

3.2.5.3. Positioning of technology

The third step when developing a technology strategy is to define how our organisation should position itself within the market to achieve the best market utilisation. The organisation should focus on how its technology should be exploited in such a way that it generates a competitive advantage. It must try to define in which way the organisation shall compete, as a specialist, market leader, low-cost imitator or as an innovator? The technology position is closely linked to the overall business strategy and can therefore be viewed as an intersection between the technology strategy and firm strategy. In this aspect the time frame is in the range of 5-10 years, as this is a general business cycle time for operations within an organisation (Rieck & Dickson, 1993, pp. 402-404).

3.2.5.4. Determining technological availability

In this step of the process, the organisation shall analyse the availability of the technology which will be needed to be able to compete in the market. The needed technology should be well known by this step, as this revolves around the previous steps in the process of developing a technology strategy. It must then be investigated which technology is available in-house, and if it is not readily available within the organisation, how can it be acquired. For this, the previous mentioned *technology audit* is a helpful tool to gain insights of this. In this step of the process the time frame is of 2-5 years, as this is the time frame to install and optimise a radically new technology in operations. This is needed to be able to balance a multiple of ongoing projects at once, which is needed to ensure that its full potential is reached (Rieck & Dickson, 1993, pp. 404,405).

3.2.5.5. Appropriating technology

When the organisation reaches this step of the technology strategy development it is aware of which technology is needed if it is available internally and how it should be acquired if it is not readily available. The organisation must ensure that the technology is then implemented in an efficient way. Questions to raise include: How can a monetary profit be derived from this technology? Can the technology be protected through intellectual property rights? Etcetera. The time scope is 1-2 years, as this is the time required for significant changes to operations if a new technology is implemented (Rieck & Dickson, 1993, pp. 405,406).

3.2.5.6. Managing technology

Finally, the last step caters for the need of efficient management and administration of the technological assets to ensure that operations are well functioning. Management must promote incremental of operations, as this allows for efficient use of new technology, also this fosters a dynamic mindset among employees. This enables new ways to improve the operations, as staff who are well aware of operations can identify bottlenecks which could be overcome with the implementation of new technology. The timeframe of this step is one year, as data from the previous year should be used to ensure continuous improvement (Rieck & Dickson, 1993, p. 407).

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4. Hypothesized framework (v1.0)

In the following chapter, a hypothesized framework (v1.0) is presented based on the theoretical foundation from the literature review. Notably, the proposed framework includes elements in the intersection between the two theoretical frames, and after the framework is illustrated in its entirety, a discussion concerning the factors follows.

Based on theories and concepts presented in the literature review, some common ground is apparent. By studying the intersection between the two theoretical foundations presented in previous subchapters, it is possible to identify commonalities, thus allowing us to select factors and construct a hypothetical framework as seen in Figure 33. When designing the framework, the key success factors have been grouped into three overarching categories seen in purple in Figure 33. The following subchapters will describe the rationale behind picking the six key success factors.
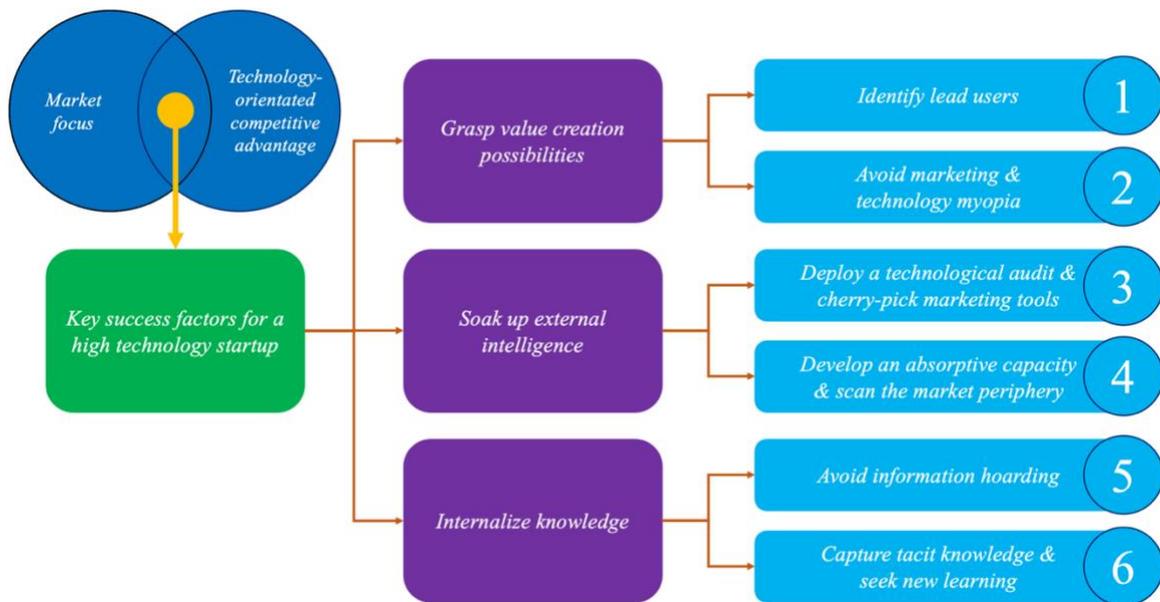
Figure 33: A hypothetical framework (v1.0) based on the literature review

4.1. Identify lead users

The notion of lead users is discussed primarily by von Hippel et. al. (1999), but the value a lead user can bring to a firm's innovation success is further discussed by Desouza et. al. (2015) in the form of customer-driven innovation. Due to the innovative nature of high technology markets, startups are reliant on recurrently being innovative, and von Hippel et. al. (1999) argues an important source of innovation comes from the customers who are in such need of a solution that they decide to innovate themselves, and if a startup can identify these

lead users they can tap into the innovation value they bring. Desouza et. al. (2015) argues that including customers into the improvement processes of products and services is one of six types of customer-driven innovations which is closely linked with the notion of lead users.

4.2. Avoid marketing & technology myopia

Levitt (2004) discusses how firms all too often try to sell products rather than filling a customer need which in the long-term leads to market failure and is a consequence of management failure rather than market saturation. While Levitt (2004) discusses the marketing myopia, Matheson & Matheson (1998) discusses a similar notion but from a technological perspective, a notion we refer to as 'technology myopia'. In their book, *The Smart Organization: Creating Value Through R&D*, they argue about the importance of having a *value creation culture*, suggesting that startups should develop technology solutions by making sure customer value is created and delivered, avoiding myopia. Specifically for high technology startups, the notion of myopia is relevant for turning inventiveness to innovativeness discussed by Potts (1944), thus embrace commerciality. Additionally, the discussion about 'jobs to be done' by Christensen et. al. (2016) also highlights the importance of understanding dynamics of the market, further strengthening the notion of avoiding myopia.

4.3. Deploy a technological audit & cherry-pick marketing tools

The idea of collecting external intelligence is discussed in both theoretical areas in the form of a technological audit by Ford (1988) and various marketing tools by Mohr et. al. (2010). Based on the high technology environment which the incumbent is active in, the type of innovations occurring there (incremental or breakthrough) and internal resources dedicated to the collection of intelligence it is vital to cherry-pick a handful of marketing tools seen in Figure 7. By combining the technological audit with the selected marketing tools from subchapter 3.1.2.1.1, the collected intelligence can then be combined to compare the status of target customers with the incumbent's technological capabilities. Based on generated insights, we argue the startup creates a stable foundation for strategic decision on how to successfully commercialize.

4.4. Develop an absorptive capacity & scan the market periphery

The fourth aspect overlapping the two theoretical frames also concerns a firm's ability to collect intelligence about the competition, rather than customer intelligence as in the third

factor. The market focused theory discusses incumbents' ability to scan its market periphery. Day & Schoemaker (2005) suggests incumbents must be able to identify competitive threats from players who quickly penetrates the market and anticipate the potential damage, a notion which is exemplified by Christensen (1997) when discussing how large companies can fail when facing disruption from startups. Day & Nedungadi (1994) adds that scanning activities must be restricted to market forces which directly affects the incumbent due to the difficulty in exhaustively scanning high technology markets. The technology focused theory discusses the importance of having an outside-in strategic perspective. Matheson & Matheson (1998) discusses how firms must understand the competition and how it adapts to market changes to be able to lead rather than follow, a notion also known as having an 'absorptive capacity'.

4.5. Avoid information hoarding

The fifth key success factor for commercialization correlates with the organizational culture and how information is shared among employees. Caruso (2017) and Matheson & Matheson (1998) both argue that information hoarding should be avoided and instead create structures and cultures which promote intelligence sharing and informal learning, as part of intelligence dissemination by Mohr et. al. (2010) in Figure 5. Moreover, it is especially important to establish effective communication between the R&D and marketing departments in a high-technology environment as discussed by Gupta et. al. (1985) and Gupta et. al. (1986) and adjust it according to the organizational strategy presented by Miles et. al. (1978). A free flow of knowledge and insights between employees allow for organizational alignment discussed by Matheson & Matheson (1998) and better market orientation, thus leading to higher probability of commercialization success.

4.6. Capture tacit knowledge & seek new learning

The knowledge intensity in high-technology environments must be internalized in a company to create a knowledge foundation and allow for continued learning. Since explicit knowledge can easily be stored (Inkpen & Dinur, 1998), the difficulty lays in storing tacit knowledge due to its origin from experience and difficulty in being reproduced (Howells, 1996). However, by asking the three questions presented by Mohr et. al. (2010) and utilizing the techniques presented by Sampath (2018), organizations can store both explicit and tacit knowledge and thus create a knowledge foundation for continued learning, which is one of the nine principles discussed by Matheson & Matheson (1998). The notion of continuously learning and improving is also discussed by Rieck & Dickson (1993) in their final time frame of *Managing technology*. By capturing tacit knowledge and constantly seek new learning, we believe it is a sustainable success factor for being commercially focused in the longer run.

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5. Empirical results

In the following chapter, the theoretical findings are evaluated by applying the hypothesized framework (v1.0) to the case company and by collecting insights from external experts. Firstly, the case company is described including a technological audit (part of the appendix) based on three interviews with chosen employees. Secondly, the semiconductor market is described to give further context. Thirdly, data collected from interviews with four chosen employees at the case company and two external experts is presented, including key findings.

5.1. Introduction to partner company

'The Company' is a Swedish Limited Company (Aktiebolag) semiconductor hardware IP provider founded in 2017. The company is founded on the research results of a researcher at the *Department of Electrical and Information Technology at Lund University* (CEO of 'The Company', 2021). The researcher, who has been the assigned *CEO* from the very start, together with the *Chairman of the Board,* who is an experienced entrepreneur in deep technology, co-founded and laid the foundation for '*The Company'*. The firm has since its foundation been specialized in providing power efficient semiconductor design IPs, which are tailored according to specific customer needs. There are multiple benefits with the firm's offering. Firstly, the power consumption of the complete chip is lowered by 70-90% implying that existing performance levels can be obtained with greatly improved energy consumption. Secondly, the performance of the chip can be greatly improved, with retained energy consumption. Thirdly, the tailored chip implies a chip which is physically more compact (CEO of 'The Company', 2021).

During its first year of operations in 2018, *The Company's* focus was mainly to develop the tools which are needed for development of the memory intellectual property. Also, a great effort went in to develop a functional organization and finding presumptive partners and customers. During 2018 the number of employees rose from 1.2 full-time employees in the beginning of the year to five full time employees in the end of 2018 (CEO of 'The Company', 2021).

Since 2018, *The Company* has been on a growth journey and at the time of writing the number of full-time employees was thirteen (CEO of 'The Company', 2021). During late 2020, *The Company* announced its greatest milestone to date, when a large international sensor provider, selected *The Company* as the provider of low power semiconductor design IPs for their sensor solutions. In the near future, the focus of the organization is to establish new partnerships and customer relations and deliver to existing customers in accordance to stated requirements (CEO of 'The Company', 2021).

Complementary to the introduction, the reader can find a technological audit of *The Company* in subchapter 8.1. The technological audit is based on interviews with three employees at the partner company, but a more detailed description is given in the appendix.

5.2. Overview of the semiconductor market

The market in which *The Company* operates is both complex and multi-faced. The expression *'semiconductor market'* accommodates a multitude of products and applications, with thousands of suppliers. In 2020, the whole market was valued at $433 billion (Semiconductor Industry Association, 2021). When discussing the semiconductor market in broad terms, it is interesting to present the market size and its leading actors, illustrated in Figure 34.
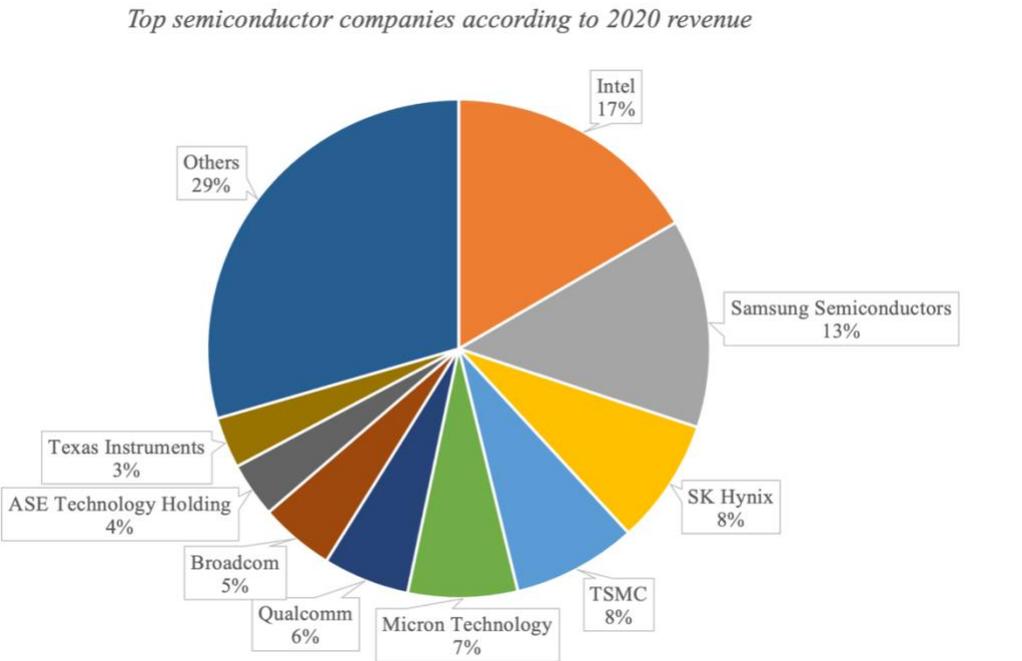
Figure 34: Top semiconductor companies ranked after revenues in 2020 (Semiconductor Industry Association, 2021)

What is also important to understand is that even if there are thousands of companies involved in the semiconductor market, there are just a few companies which can produce the actual wafer, or in other words, the physical product. These manufacturing companies are known as *foundries*. The main reason for the concentration to a small number of producers are due to large investments in production technology needed to produce wafers. These companies are responsible of the production for close to all semiconductor circuits in the world (CoB of 'The Company', 2021). In total, the foundry market was valued at $42 billion in 2020 (Mordor Intelligence, 2021). An illustration of the market share split is provided in in Figure 35.

Figure 35: Foundries by market share (Statista, 2021)

The market in which *The Company* is competing is a niche market focusing on low power SRAMs (Static random-access memories), a subset of the total SRAM market, which in turn is a subset of the whole semiconductor market. In 2019, the market for SRAMs was valued at €420 million (360 ResearchReports, 2021). The applications for SRAMs are many, and includes microelectromechanical system (MEMS) sensors, complementary metal oxide semiconductor (CMOS) sensors, digital signal processors and automotive sensors (CoB of 'The Company', 2021).

5.3. Applying the hypothesized framework

5.3.1. Case company

In total four interviews were conducted with employees at *The Company*. In a mutual agreement between the authors and the case company to anonymize, we only present the work title of all interviewees and allocate a reference (IP1-4). The reference is allocated in chronological order and is thus not connected to the job title.

Work title	Duration of employment at 'The Company'
CEO & Co-founder	Since founding in 2017
Chairman of Board	Since founding in 2017
Senior Analogue Design Engineer	9 months
Lead Engineer in Software Development	3 years

Interviewee	Date	Interview duration
IP1	April 26 & 27, 2021 (split in two sessions)	3 hours + 3 hours
IP2	April 27, 2021	1 hour & 15 min
IP3	April 29, 2021	1 hour
IP4	May 3, 2021	3 hours

The presentation of the interviews will follow *Interview guide 2: Hypothesized framework tested at partner company* in the appendix, and the responses from each interviewee will be presented together under the same subcategory as follows below. The dotted line distinguishes answers to different questions in the interview guide.

5.3.1.1. Startup success factors

According to IP1, a mix of competence, hard work and luck is critical for startup success in general, but puts extra emphasize on having the right competence in a high-technology environment resembling the one *The Company* operates in. More specifically, IP1 associates competence with having unique people who can make a difference, who live by the trial-and-error principle, who has a deep-rooted passion for what he or she does and who constantly challenge him or herself. Concerning luck, IP1 mentions the importance of timing since you cannot affect all parameters in a marketplace.

IP2 also mentions the aspect of having the right people but instead puts more emphasize on having people with the devotion of "getting things done", i.e., having the right drive and grit. To penetrate the market, you need people who can create a product or service which significantly exceeds the value of offerings from the well-established competition, and you need people who can convince customers to take the risk of purchasing our product. Additionally, IP2 believes it is important to employ generalists, suggesting that people cannot have too defined roles in a startup and rather must be able to complete a wide variety of tasks.

IP3 lists the following success factors for startups: (1) ownership and responsibility, (2) good people, (3) management support and recognition, (4) an international recruiting base and (5) the support for testing out new ideas. More specifically, IP3 says that generally it is vital to have good people in a startup who cares deeply for the success of the firm and truly believes in the vision, described as: *"It is quite cheesy, but good people".* Moreover, IP3 complements aforementioned by emphasizing the need of management support to make employees feel comfortable in taking responsibility, trying out new ideas and recognizing the contribution of

every employee. For high technology startups, IP3 puts extra emphasize on having an international recruitment base, referring to the need of having specialist and thus needing to headhunt globally.

Finally, IP4 summarizes the "recipe for startup success" into the need of having the right team. Broken down, IP4 mentions the team at *The Company* has diverse competences and complements each other well and result in, as quoted from IP4: *"things getting put together by different team members. It is not only for the high technology side, but the product must also be sellable, and we need to be aware of what is happening in the market"*. Furthermore, IP4 emphasizes the need of mentorship from people or organizations with experience from previous startup engagements, and exemplifies how the chairman of the board inter alia acts as a coaching resource due to his previous startup experience. Finally, IP4 discussed the value of meeting customers directly and thus learn from the market.

5.3.1.1.1. Key findings concerning startup success factors

- All interview persons highlight the importance of having good people in a startup but interpret good people in various ways.

- The interpretation of good people include: (1) people willing to try, (2) has a deep-rooted passion for what they do and genuinely care about the success of the firm, (3) the competence to create value and convince stakeholders and (4) having people who can complement each other.

- Other factors mentioned include luck, hard work and timing.

- There is a scattered opinion about the importance of having people who are generalists versus specialists.

5.3.1.2. Investigative questions before presenting the hypothesized framework

5.3.1.2.1. Grasp value creation possibilities

When asked about *The Company's* approach to identify and deliver customer value, IP1 explains that currently there is no overarching expressed strategy for determining customer value at *The Company*, explaining that the whole firm is founded on the notion of power consumption being a large problem in integrated circuits, whereof the memory constitute a major part of the power consumption. Hence, *The Company* creates customer value by lowering the power consumption, improve circuit performance and decrease circuit area. However, IP1 adds that there is an unarticulated approach of including employees in customer meetings to learn about needs, thus gaining insights to further improve the firm offering.

In general terms, IP2 confirms what was said by IP1 and refers to the unexpressed strategy of speaking directly to B2B customers and learning their preferences from these meetings. All products are always developed based on customer specification, or as explained by IP2: *"we are going to develop a test chip, which specs would you like to see?"*.

IP3 was not certain whether there was a specific strategy in place for capturing and understanding customer value, but instead referred to employee experience as the main factor for determining customer value, and adding *"we are selling adapted products, if the customer keeps talking to us, we are doing something right"*.

In line with previously said, IP4 mentions customer meetings as the primary source for identifying customer value, further elaborated as: *"We set up a lot of meetings. First, we identify companies which are interesting for us. The first meeting is about trying to figure out what the customer needs. Customer feedback is how we know if we do the right thing. Secondly, we ask ourselves: how can we fix the problem which the customer is having?"*.

When asked about whether customers help *The Company* innovate and further improve the product offering, IP1 confirms and describes how customer meetings act as a major source of inspiration for further development, explained by IP1 as: *"By sort of piggybacking on our customers, we eventually are able to altogether get a larger knowledge base compared to a single customer"*. IP1 further describes the example of single versus dual port memory, where *The Company* realized customers did not have complete solutions to dual port, and thus the firm was forced to develop these solutions inhouse, leading to the firm focusing on the single port memory technology. As mentioned by IP1: *"customer meetings sow many seeds, helping us navigate and innovate"*. IP2 describes an occasion when the firm managed to produce a fast chip in a relatively slow-paced technology which were triggered solely on customers need of a faster performance. IP3, like IP2, confirms the notion of customers triggering innovation at *The Company* adding that he, at the time of the interview, was working on such a project. Since the firm is selling a tradeoff between performance and battery time, it is not common, but occasionally it happens that they need to innovate based on customer needs to meet specifications. Resembling to the example presented by IP2, IP4 gives two examples of how customers have helped *The Company* innovate and further expand its product offering by demanding a solution for faster chip memory performance, which forced '*The Company'* to deliver a solution not previously tested.

Concerning the difficulty in understanding what customers really want and whether the need differs from what is communicated to *The Company,* IP1 described how oftentimes customers do not know what they want and how *The Company* knows the technology better than customers themselves. Hence, customers are not always aware of what could solve their problem which makes it more difficult to identify the real customer need. Unlike IP1, IP2 instead says customers are straight forward when formulating their needs and oftentimes have a clear idea on the specifications they want *The Company's* product to achieve. On the other hand, IP3 describes how the difficulty in understanding actual customer needs oftentimes is the case since the projects sold are very complex in nature. IP4 argues most customers know

exactly what they want, suggesting that power is the problem. Instead, the difficulty lays in convincing the specific customer that *The Company* can solve their problem due to the lack of trust toward smaller companies.

5.3.1.2.1.1. Key findings on grasping value creation possibilities

- Customer meetings are the primary factor for understanding customer value and how *The Company* can deliver this value, by evaluating project specifications which are unique to each customer case.

- Customers occasionally act as a spark for further innovation, mainly by describing their specifications for a specific technology generation which triggers innovation at the partner company. In these cases, if the customer would not have expressed this need it is not certain *The Company* would have innovated in that specific direction.

- There is non-distinctiveness concerning the difficulty in understanding the real customer need. In some cases, the partner company knows the technology better than the customer and customers are not always aware of what could solve their problems, making it harder to identify the real customer need. Additionally, the projects' level of complexity add to the difficulty. On other occasions, customers are straight forward when formulating their needs and specifications, hence making it easier to understand their needs.

5.3.1.2.2. Soak up external intelligence

When asked about whether *The Company* recurrently analyze its inhouse technology and knowledge and compare it to competition, IP1 says this is achieved indirectly through customer meetings where *The Company's* own specifications in power, circuit leakage and area is benchmarked toward customers' other alternatives. Additionally, IP1 mentions how employees, who previously have been employed by a competitor, joins *The Company* with knowledge about the technology status of his or her previous employer (at least the information which can be legally shared). IP1, as previously mentioned by IP2, must perform significantly better than competition due to customers unwillingness to bet on a risky alternative unless it performs much better. Like IP1, IP2 says customer specifications from current or previous projects acts as a benchmarking. Collecting these specifications allow for an aggregative picture and thus *The Company* indirectly knows the status of its inhouse technology capabilities. IP3 highlights the secretive nature of the semiconductor industry, resulting in the impossibility of knowing what the competition is doing at this very moment. However, like IP1, IP3 mentions *The Company's* advantage of having experienced employees explained as: *"We have experienced people, which means that we have a feeling for how we are doing in comparison to competition".* IP4 confirms aforementioned, saying it is necessary to survive as a startup but difficult to do due to industry secrecy. However, through customer meetings IP4 says *The Company* can detect whether they are performing under or above competition and can act accordingly.

Concerning identification of competitive threats, IP1 says this information is primarily collected through partners and customers but if new-to-the-world technology or research is presented *The Company* quickly gets aware of this through industry forums and journals. IP2 suggest the same as IP1, saying that the only way to retrieve this information is if customers tell *The Company* their specifications do not beat current benchmark. However, IP2 mentions they are aware of direct competitors, e.g., one competitor from Britain and one from the United States. IP3 argues *The Company* is too small to bother about competitive threats, but says conferences and industry rumors are two alternatives for collecting this type of intelligence. IP4 says there is rarely any threats on a technological level due to the fixed technology generations.

Whether "soaking up" external intelligence to develop the inhouse knowledge base is important or not, IP1 confirms it is of high importance and refers to the customer meetings as the primary source of (1) new knowledge and (2) understanding the prerequisites to solve the right problem. IP2 instead mentions new recruits as a source of "soaking up" external knowledge, saying: *"Employees are encouraged to find out things on their own, learn about internal processes and recurrently scan the market".* In line with IP1, IP3 mentions partnerships, e.g., foundries, as an important alternative to "soak up" information. Likewise, IP4 agrees on the importance of having the ability and explains how *The Company* are dependent on aforementioned to be able to stay up-to-date and adapt to new technologies and tools. Adding to this, IP4 says employees bring in new knowledge from their previous experiences and *The Company* also collects intelligence by attending as many industry-specific events as possible.

When asked about having any marketing tools in place, IP1 says *The Company* applies an ad hoc approach and refers to the utilization of external status reports and *YouTube.* IP1 adds *The Company* operates according to the principle that if it does not need to be complicated, they do not make it complicated, but in the future the process of collecting market intelligence will probably be more structured by implementing marketing tools. IP2 confirms IP1's answer about not having a standard, saying: *"our primary contact with reality comes from the desire and contact with customers, e.g., by delivering a test chip from which they can provide us with feedback".* IP3 and IP4's answers are in line with aforementioned answers, giving prototyping and the participation in trade shows as two examples of collecting market intelligence.

5.3.1.2.2.1. Key findings on soaking up external intelligence

- *The Company* analyzes its in-house knowledge and technology mainly through customer meetings, trade shows and employees' previous experiences. Through customer meetings the firm can indirectly know the status of its technology capabilities by comparing its own specifications to customers (and therefore also competitors) and employees can compare *The Company's* knowledge with their previous employer(s).

- The semiconductor industry is heavily affected by intellectual property and secrecy which make it difficult to collect intelligence about competitors and thus compare technology status.

- There is uniformity on the importance of having the ability to "soak up" external intelligence, and intelligence is collected mainly through customers and partners, but also by having a culture of employees actively scanning the market.

- Currently, there are no standardized marketing analysis tools in place, but instead a more ad hoc approach is applied with the usage of prototyping, customer visits and public reports. However, *The Company* anticipate there will be standards applied in the future, but currently there is no need due to cost and time restrictions.

5.3.1.2.3. Internalize knowledge

The question regarding how information flows between employees at *The Company*, IP1 says that the sharing mechanism happens primarily through the weekly meetings with the intention that at least one member of each team will attend, to later communicate the meeting discussions to every non-attending team member. Additionally, IP1 adds that *The Company's* CRM-system functions as another knowledge-sharing mechanism, but once the firm reaches 20+ employees there will arise a need for formal information processes. IP2 adds to the statement of IP1, saying that the exchange happening between teams is noticeable due to the need of coordination, but occasionally the exchange is inhibited due to the degree of team specialization and lack of knowledge about the value of a certain piece of information. IP2 explains the latter as *"sometimes information is not actively shared because the person sitting on the information does not realize the value of that piece of information to another team"*. IP3 explains the information flow at *The Company* as *"like a soup, were everyone is soaking up the same information"*. IP3 adds to previously stated that information flows in an unstructured manner, highlighting that *The Company* are soon growing too large and hence needs to implement structured information flows. IP4 mentions the firm's principle of creating functional teams to encourage frequent discussions, but also highlights the need of having more information exchanges since this spark innovation.

Concerning mechanisms to trigger knowledge sharing at *The Company*, IP1 mentions the intraweb used by employees to connect, the product management software *Jira* and the weekly meetings. IP2's answer is in line with the answer of IP1, but also adding that due to a lack of formal information sharing there can sometimes be a misunderstanding why a certain task needs to be solved by a certain employee. IP3 points to the mechanism of employee curiosity and willingness to explain concepts. IP4 highlights management's encouragement to promote office discussions but also refers to the weekly meetings as a primary mechanism to ensure knowledge sharing.

Upon being asked about mechanisms in place to ensure knowledge stays at *The Company* even if an employee decides to leave the firm, IP1 mentions how all constructions developed is saved on a central server and thus not saved locally on each computer which leads to codified knowledge being saved at the firm. IP1 discusses the importance of documentation but also highlights the importance of not "over-documenting" due to the time investment being too large. Furthermore, IP1 would like to see more knowledge sharing through code inspections, meaning that developers review a selected portion of each other's code blocks to internalize knowledge. IP4's answer is similar to IP1, arguing the internal documentation is *The Company's* approach to internalize knowledge while also promoting team discussions to mitigate the risk of having only one employee knowing a certain piece of information.

As the concluding question before proceeding to direct questions concerning our hypothesized framework, we asked how *The Company* ensures employee knowledge is up to date, upon which IP1 told us the firm employs people who are curious by nature who themselves search for answers. Moreover, *The Company* hire people who bring in a fresh view from their area of expertise who are encouraged to recurrently reflect what they have learnt and how they can keep learning, referring to the recruiting process as the underlying mechanism. IP2 also discusses the mechanism of recruiting, arguing newly graduated PhDs bring in fresh intelligence from academia. Additionally, IP2 mentions how *The Company* ensures knowledge is up to date by solving real customer problems rather than solely relying on academia. IP3 mentions similar reasons as IP1, but also adds *The Company's* board members have a good understanding of the market and thus represent a mechanism. IP4 explains how *The Company* is one of the fastest firms in the industry to adopt to new technologies since employees are forced to continually work with these technologies in customer cases. IP4 adds that knowledge is gained by employing students, having master thesis students write their paper at the firm and trying to include as many employees as possible in sales activities to enable them to keep their knowledge up to date.

5.3.1.2.3.1. Key findings on internalizing knowledge

- *The Company's* primary source of intelligence sharing happens during the weekly meetings where specific customer cases is presented and each employee presents his or her work streams.

- Knowledge sharing happens to a large extent through informal discussions between employees, but due to varying expertise information and lack of actively spreading information, exchange activities may be inhibited.

- Mechanisms to trigger knowledge sharing include intraweb, project management software, weekly meetings and overall employee curiosity and willingness to learn.

- There is a focus on code documentation, and the need becomes larger once the firm grows, but the cost-benefit analysis currently suggests not extending the documentation activities. There is a willingness to expand the knowledge sharing activities.

- Mechanisms to ensure firm knowledge is up to date include recruiting, collecting intelligence from connections to academia, including employees in marketing activities to enable learning about the market and having a board with good knowledge about the market and upcoming technologies.

5.3.1.3. The hypothesized framework

After letting the interviewee study the framework followed by a presentation by us, we asked if he or she believes the hypothesized framework accurately describes important aspects of commercial success at *The Company*, if he or she would like to add, remove, substitute, or rephrase anything.

IP1 believes all factors are relevant for commercial success in a high technology environment but suggests adding a few aspects to make the framework more accurate. IP1 believes the framework misses an understanding for the value of *The Company's* offering, adding that there needs to be a foundational idea about the commercial value. Moreover, IP1 says he would like to add how the framework should be implemented at *The Company* to make it more practical, e.g., by taking inspiration from the *Plan, do, check, act (PDCA) cycle model* and add an economic audit. The factors IP1 believes are most important for *The Company* is *Identify lead users* and the factor IP1 provided himself concerning having a unique selling point. To *Identify lead users* IP1 says: *"Lead users help us run in the right direction with limited resources"*.

IP2, like IP1, believes the framework is relevant and succinct, and does not include any redundancy. He recognizes a lot of the factors from what is being pursued at *The Company* and believes the framework is apparent and representative, adding that the framework presents factors which are important no matter the life cycle of *The Company*. IP2 further explains the model in isolation can seem unclear, but once we explained the rationale behind the framework IP2 says: *"the framework gets very clear"*. Moreover, IP2 highlights the importance of merging engineers with sales and marketing to ensure all developers are aware of customer needs, but adds he believes it is already imbedded in the framework. The factors IP2 believes are most important to *The Company* are *Avoid information hoarding* and *Capture tacit knowledge & seek new learning*, requesting more information spread between employees to increase knowledge redundancy in case employees get sick or likewise. Concerning *Avoid information hoarding*, IP2 suggests hoarding is not the problem at *The Company* but rather that information is not actively shared.

Similarly, IP3 believes the framework accurately mentions important aspects at *The Company* saying *"I am confident in saying that the framework is not wrong"*. IP3 believes the

framework is clear but adds that (1) "cherry-picking" in factor three might be biased and thus suggests rephrasing and (2) change *Identify lead users* to *Identify interested parties.* Additionally, IP3 mentions the importance of employee-management relations, highlighting that people should be recognized as important assets to the firm, but mentions it is imbedded in the framework already. IP3 believes the most important factor for *The Company* is *Identify lead users* explaining that *"without this factor you are going nowhere".* Other factors important for *The Company* during the time of the interview are *(2) Avoid marketing & technology myopia, (5) Avoid information hoarding and (6) Capture tacit knowledge & seek new learning.* For (2), IP3 explains that *The Company* is at the tipping point where customers approach them and therefore the firm must focus its efforts on creating the demanded customer value. For (5) and (6), IP3 explains it is important to share knowledge internally since *The Company* is approaching more of an execution phase where they must deliver.

IP4, like previous interviewees, believes the framework accurately presents factors important to *The Company* and finds it easy to grasp without the need of removal or substitution. However, when asked about the need of adding anything to the framework, IP4 mentions team culture and employing good people, meaning people who can collaborate, have a passion for their work and are committed to the success of the firm. Moreover, IP4 says the team must have a "startup mindset" which suggests everyone must be able to learn and teach. Hence, IP4 would like to highlight the importance of good people even more in the framework. IP4 also believes *Identify lead users* is the most important factor in the framework referring to grasping value creation possibilities and saying, *"you must be able to sell".* When asked about factors important to *The Company* where they are right now in their life cycle, IP4 mentions *Capture tacit knowledge & seek new learning.* He explains it as *"Today we have customers, we have a product, we have the latest technology, and we have a good absorptive capacity. Information hoarding is a minimal problem, but we must keep learning to be first to deliver a memory in the latest technology".*

5.3.1.3.1. Key findings from testing our hypothesized framework

Category	Feedback
Add	- Value proposition & USP - How to implement the framework practically, taking inspiration from the PDCA cycle - Complement technological audit with an economic audit - Importance of engineers getting exposed to market to understand to whom they are developing products - The employee-management relationship - Highlighting "need of good people"
Rephrase or substitute	- Extend *Information hoarding* to also include active information spreading *Identify lead users* to include all interested parties - Consider not using "cherry-picking"

Remove	No interviewee had anything they suggested removed
Most important factor (no time consideration)	• Identify lead users • (Value proposition & USP from IP1)
Most important factors (right now)	Factors #1, #2, #5 & #6

5.3.2. External experts

In total two interviews were conducted with external experts: one representative from the corporate world and one from academia. In a mutual agreement between us and one of the interviewees, this person's identity will be anonymized and will thus be referred to as IP5.

Interviewee	*Work title*	*Selection of experiences*
IP5	Serial entrepreneur	• Worked for 10+ years at two large vehicle manufacturers and was responsible for its business in Africa and the Nordics. • Was part in forming an oil company and co-founded a management consulting company. • Have worked with the development of micro gas turbines to generate electricity. • Currently active in building up a wind power facility in Mongolia.
Ove Granstrand	Professor in industrial organization & management at *Chalmers University of Technology*	• Engaged in consulting projects for the industry parallel to the academic career. • His research area has been in technology strategy.

Interviewee	*Date*	*Interview duration*
IP5	May 5, 2021	2 hours
Ove Granstrand	May 5, 2021	1 hour

The presentation of the interviews will follow *Interview guide 3: Hypothesized framework evaluated by external experts* in the appendix, and the responses from each interviewee will be presented together under the same subcategory as follows below. The dotted line distinguishes answers to different questions in the interview guide.

5.3.2.1. Startup success factors

Upon being asked about the general "recipe" for success for a startup no matter the industry, IP5 responds by saying timing and gives examples from his own entrepreneurial career; explaining how he invested in electric bicycles and microturbines, but he was too early to market, and the products did not take off commercially until years later. Moreover, IP5 mentions two other factors which are necessary for success: market potential and capacity. Concerning market potential, IP5 says *"assuming you have a ready product, you must be able to show there is a market. Once you have a paying customer you can get financing"*. Concerning capacity, IP5 says the firm must be able to quickly multiply its capacity, saying *"if you have one customer demanding x, then maybe next customer demands 10x and you must be able to meet this new demand"*. *Ove Granstrand*, on the other hand, responds by saying: *"I would say it is 80% luck and 20% skill"*. He continues explaining that most startups fail, and the notion of luck is heavily involved in determining the faith of the startup. There will always be factors which you have no control over no matter how skillful you are as an entrepreneur. Hence, Granstrand says you must be willing to experiment with different ideas until luck acts in your favor. While you are experimenting with ideas, you must quickly realize when your company is heading in the wrong path and consequently change your business model, product, or customer relations to avoid failure.

When asked whether these factors differ for a high technology startup, IP5 adds the importance of being able to demonstrate a product or production that works. Additionally, IP5 mentions how technology startups must be able to explain the feature, the benefit (to customers), and the advantage (compared to competition) of the product to customers and investors. Granstrand puts more emphasize on the notion of luck, saying that in low technology environments it is easier to early on realize if you are heading in the wrong direction. Granstrand adds *"In software you can quickly change, but in hardware it can take 5-10 years before you reach the market with longer life cycles"*.

5.3.2.1.1. Key findings on startup success factors

- The notion of luck is a heavy determinant of startup success or failure.

- Other success factors include: (1) an addressable market, (2) capacity (either in production or manpower), (3) willingness to experiment with ideas (risk taking) and (4) ability to quickly adapt by changing the business model, including product and customer relations, if the startup is heading in the wrong direction.

5.3.2.2. The hypothesized framework

After letting the interviewee study the framework followed by a presentation by us, we asked if he or she believes the hypothesized framework accurately describes important aspects of

commercial success at *The Company*, if he or she would like to add, remove, substitute, or rephrase anything.

IP5 says the framework have caught factors both from academia and the business world but proposed some adjustments. Concerning addition of elements, IP5 suggests adding an economic aspect to the framework, saying *"could we make money by taking this specific action?"*. On the other hand, IP5 believes all six factors we proposed are relevant and does not suggest any removals. Concerning substitution and rephrasing, IP5 proposes the theoretical areas (represented as two circles intersecting) should be positioned differently, suggesting *Market focus* should be positioned above *Technology-orientated competitive advantage* to clarify that the intersection entails market-driven innovation instead of technology-driven innovation. Moreover, IP5 suggests changing lead users to lead producers depending on the type of customer. He also argues that the phrasing myopia is too much of a buzzword which leads to confusion among readers, and that the concept of marketing tools can be made more accurate to clarify that it is analysis tools and nothing else. Additionally, IP5 also thinks market periphery implies an outgoing motion rather than incoming, and since our concept implies incoming, he suggests it can be clarified in the framework. As a final suggestion, IP5 suggests *Grasp value creation possibilities* and *Soak up external intelligence* should switch place to follow the chronological order of a startup, starting off by collecting intelligence before grasping the value. However, IP5 agrees that *Internalize knowledge* is an extension of the aforementioned and hence should be placed at the bottom as it is. Upon being asked which of the six factors are most important, IP5 answers *Identify lead users,* explaining *"as a startup you must know what needs to be delivered, what are we doing better than the competition and find the right niche"*. IP5's opinion about lead users does not change when the startup operates in a high technology environment but adds that *Avoid marketing & technology myopia* is extra important compared to low technology environments.

Granstrand says the following about the framework: *"I am logically oriented, and it is not possible to ignore any aspect of the model"*, suggesting no factor is redundant. But like IP5, Granstrand proposes some adjustments to the framework. Concerning addition of elements, Granstrand proposes the framework should illustrate the process of coming up with the six factors as this notion is relevant to the result of key success factors. More specifically, Granstrand proposes the framework should illustrate the literature review and empirical studies, and how the circle intersection should act as a "filter" when coming up with success factors. Concerning substitution and rephrasing, Granstrand suggests the six factor boxes and the corresponding categories (illustrated as purple boxes) should switch position to clarify how we first came up with the six factors and secondly categorized them. Additionally, Granstrand mentions how two factors; *Avoid marketing & technology myopia* and *Avoid information hoarding* are categorized as "failure" factors compared to success factors, and hence he proposes we should add the "failure" element to the framework to create a balanced analysis. Moreover, Granstrand compliments the factor preciseness, saying that some obvious factors could be included which would not add much value. He exemplifies by saying *"it was a good choice to not include value proposition factors since these are undeceived and do not add true insight"*. When asked about which of the six factors he believes is most important,

Granstrand mentions *(4) Develop an absorptive capacity & scan the market periphery* with a reservation for *(3) Deploy a technological audit & cherry-pick marketing tools* saying that the category *Soak up external intelligence* is of high importance. Granstrand's answer changes when asked if aforementioned also is most important to a high technology startup, saying that the two factors switch place in prioritization. Additionally, Granstrand adds that *(2) Avoid marketing & technology myopia* gets extra weight in high technology environments due to the risk of getting stuck in bad technologies.

5.3.2.2.1. Key findings concerning the hypothesized framework

Category	Feedback
Add	• Adding an economic aspect, e.g., an economic audit. • Include work process of coming up with key success factors, including literature review, empirical studies, and "filter".
Rephrase or substitute	• Position of circles representing theoretical areas to highlight market-driven innovation. • Include lead producers into lead users. • Rephrase (1) marketing tools to marketing analysis tools, (2) myopia and (3) periphery. • Change order of purple categorization boxes. • Switch position of six factors and purple categorization boxes. • Distinguish between key success and failure factors.
Remove	No interviewee had anything they suggested removed
Most important factor (industry general)	• (1) Identify lead users. • (4) Develop an absorptive capacity & scan the market periphery. (close second: (3) Deploy a technological audit & cherry-pick marketing tools).
Most important factors (high technology environment)	• (1) Identify lead users • (2) Avoid marketing & technology myopia • (3) Deploy a technological audit & cherry-pick marketing tools • (4) Develop an absorptive capacity & scan the market periphery

6. Discussion & framework revision

In the following chapter, the empirical results are discussed with the purpose of justifying or editing the hypothesized framework (v1.0). The discussion follows a combined structure of Interview guide 2: Hypothesized framework tested at partner company and Interview guide 3: Hypothesized framework evaluated by external experts. The discussion leads to a revised framework (v2.0) which later goes through a quality assurance test, leading to a concluding framework (v3.0).

6.1. Startup success factors

The importance of having good people has been a topic discussed by several interviewees as an important factor for startup success and in previous research by Wallin et. al. (2016). However, the definition of good people varies between (1) having people willing to try, (2) has a deep-rooted passion for what they do and genuinely care about the success of the firm, (3) the competence to create value and convince stakeholders and (4) having people who can complement each other. (1) is a consequence of having an absorptive capacity and continuously seeking new learning which has already been covered in the hypothesized framework. (2) and (4) will not be included in the framework due to its elementary nature for any startup success and thus not directly located within the theoretical boundaries of this master thesis. This reasoning also holds for the factor *hard work* mentioned by IP1. (3) is already encapsulated by *Avoid marketing & technology myopia.*

Another factor discussed by the interviewees is the notion of being lucky. While it is a significant determinant of startup success as discussed by both IP1 and Granstrand, they both argue it cannot be controlled no matter the level of management skills. The framework is actionable and hence we decide to disregard this factor due to its unmanageability. Additionally, it is not directly located within the theoretical boundaries of the master thesis.

The notion of *timing,* discussed by IP1 and IP5, seems to be an important success factor, not least after the failed electric bicycle initiative experienced by IP5. We find the presented arguments behind IP5's bicycle experience to partially correlate with the ideas presented by Gourville (2006), suggesting that the behavioral change of electric bicycles was indeed too significant. Moreover, while timing seems to be of great importance to startup success, it is already considered in the hypothesized framework; we argue the correct timing is a consequence of offering the right product for a specific need, which is a consequence of implementing factors 2 and 4 from the hypothesized framework.

Moreover, other factors mentioned by the external experts include (1) an addressable market, (2) capacity (either in production or manpower), (3) willingness to experiment with ideas and (4) ability to quickly adapt by changing the business model, product, or customer relations if the startup is heading in the wrong direction. (1) is covered under *Avoid marketing & technology myopia* in the framework. (2) was mentioned by IP5 and we consider this as part of grasping value creation possibilities in the framework, but it is not directly covered in the hypothesized framework. However, having the right capacity is an important aspect, but we believe it is rather part of the implementation of the framework once you have customer traction, and thus not a key success factor to become commercially focused. The same conclusion applies for (3) as for aforementioned factor of having people with a willingness to try. (4) is a consequence of fulfilling factors #2, #3 and #4 in the hypothesized framework.

Concerning success factors unique for high technology startups, the answer from IP5 gave us "food for thought" to the framework. Firstly, IP5 argues the importance of being able to demonstrate a product or production that works. At first sight we realized our model lacked this notion, but upon further analysis we conclude the notion is not within the time frame of the framework. Since this master thesis studies key success factors for turning a high technology startup into a commercial success, we assume the 'core' of the product is working but lacks commercial feedback. The notion presented by IP5 covers products currently in technology development and hence not sellable. For this reason, we conclude the notion will not be added to the framework. Furthermore, IP5 explained how technology startups must be able to explain the feature, the benefit, and the advantage of its product to the customer which we find add an additional commercial dimension to the framework. We conclude the IP5's notion can be translated to effective communication of your value proposition and thus is in the core of commercial focus. Conclusively, this notion will be added to the framework.

6.2. Investigative questions before presenting the hypothesized framework

6.2.1. Grasp value creation possibilities

It seems to be a large consensus among employees on how *The Company* identifies customer value followed by how the value can be delivered - which is primarily done by evaluating project specifications describing the expected performance of the delivered solution. But there is not an agreement among the interviewees whether it is easy to identify the specific customer need or not, even though everyone agree on its value to *The Company*. E.g., while IP4 says it is quite easy to identify the real customer value since it is straight-forward in the specifications, IP3 suggests it is harder due to high project complexity and customers' lack of understanding for how a solution can be created. Nevertheless, having the customer meetings to gain insights into customer value is essential to know what to deliver, thus confirming the importance of the category *Grasp value creation possibilities*. More specifically, factor #2, *Avoid marketing & technology myopia,* is confirmed as an outcome by having the customer

meetings as explained by IP4: *"The first meeting is about trying to figure out what the customer needs. Customer feedback is how we know if we do the right thing. Secondly, we ask ourselves: how can we fix the problem which the customer is having?".*

Moreover, it was mentioned by the panel of interviewees how customers indirectly help *The Company* decide in which direction the firm should focus its innovation, also achieved primarily through customer meetings. Firstly, as explained by IP1, customers have a clear idea in which technology they want a solution for, which on one occasion made *The Company* realize it should focus on single port instead of dual port (dual port showed promising results but lacked real customer need). Secondly, demanding customer specifications have triggered further innovation at *The Company*, which IP2 exemplified by explaining how *The Company* designed a fast chip in a slow technology purely triggered by specifications. Without these specifications *The Company* might not have innovated in this specific direction. Altogether, it suggests *The Company* uses customers to innovate. However, whether these specific customers act as lead users or producers as discussed by von Hippel et. al. (1999) remains unanswered due to confidentiality. Nonetheless, the notion of using customers as a strategy for innovating, as discussed by Desouza et. al. (2015) and given that lead users have this function as well, we believe the empirical data from this paragraph confirms the hypothesized factor #1 *Identify lead users*, and altogether factors in category *Grasp value creation possibilities* in the hypothesized framework seem to be confirmed by our empirical studies.

6.2.2. Soak up external intelligence

The panel of interviewees from *The Company* all agree on the importance of having the ability to "soak up" external intelligence, and this is once again mainly achieved through customer meetings but also to some extent from employees actively scanning the market. Through the customer meetings, *The Company* indirectly gets an understanding on how they stand compared to competition, thus giving them an understanding for the firm's inhouse technology and capability status. Nonetheless, there are currently no intelligence generation standards in place, and information collection is conducted through an ad hoc approach. There are reasons behind this lack of standard. Firstly, the level of secrecy in the semiconductor industry prohibits extensive intelligence generation activity. Secondly, IP1 mentioned the need of efficiency and effectiveness for startups in high technology environments, thus arguing all information gathering actions must be relatively fast and cheap.

Altogether, we conclude when combining insights from the literature review and the empirical studies that the notion behind soaking up external intelligence is relevant. There is consensus among interviewees that soaking up information is prioritized at *The Company*, primarily though customer meetings, employees' experiences, and their ability to scan the semiconductor market and attending trade shows or conferences. Having employees participate in aforementioned suggest *The Company* is focusing on building up an absorptive capacity among its employees, and along with ability to scan the market, suggest they are working to achieve factor #4 *Develop and absorptive capacity & scan the market periphery,*

thus strengthening our hypothesis. Moreover, we retrieved insights concerning factor #3 *Deploy a technological audit & cherry pick marketing tools* which was undetected before the empirical study. While the panel of interviews confirm the importance of having marketing analysis tools in place, they are adapting an ad hoc approach rather than applying standardized principles due to industry secrecy limitations and cost and time restrictions. Hence, we conclude factor #3 lack aspects of time, capital, and secrecy. Firstly, we disregarded the essence of time in a high technology environment and the need for fast-paced actions in our hypothesized model. Secondly, given that capital is a limited resource in the startup sphere, the demand of cost-effective tools is essential. Thirdly, due to levels of secrecy, the possibility to gather market data can be limited and thereby the need for data collection tools.

6.2.3. Internalize knowledge

Referring to the empirical study, the panel of interviewees seem to agree on the fact that information sharing is important to *The Company*. Simultaneously, there is a willingness to expand these types of knowledge sharing activities. Currently, *The Company* spreads information primarily through the weekly meeting where every team is encouraged to share knowledge and insights about their area of expertise. Additionally, information is shared though various technological aids, e.g., CRM-systems and the intraweb. However, as explained by IP2, a large part of the information sharing happens informally through employee discussions due to the need of work stream coordination, but occasionally the exchange is inhibited due to the lack of employees actively sharing information. Therefore, the problem at *The Company* is not information hoarding but rather that employees are not actively sharing information. Hence, we realized that factor #5 *Avoid information hoarding* must be expanded to also include actively spreading information among one another.

Moreover, as discussed in the empirical study, *The Company* has systems in place to capture explicit knowledge, e.g., a central server where all code is stored for every employee to see. Additionally, IP1 and IP4 discussed how code documentation is a priority at the firm and promotes internalization of knowledge. However, IP1 argues that code documentation should be kept at a reasonable level to avoid investing too much time away from employee's main work streams. Similar to the editing made to factor #3, we conclude the argument by IP1 suggests completing a cost-benefit analysis on employee code documentation, and depending on the size of the startup, the available resources for code documentation varies. In the case of *The Company,* the startup has not enough manpower to conduct extensive documentation, suggesting the cost benefit analysis is not in favor for extended code documentation. Altogether, we conclude the need to store explicit knowledge is also a result of economic factors, further strengthening the idea behind having an economic evaluation to weigh the gains against the costs. But as mentioned by IP1, once *The Company* grows the need for more code documentation might arise.

As opposed to explicit knowledge, *The Company* lacks systems for capturing tacit knowledge. As explained by IP4, the company could handle loss of competence better today than one year ago, but knowledge-wise it would still be a significant loss. However, IP4 suggests the weekly team meeting mitigates the risk of losing expertise since it eventually leads to multiple people having expertise in the same area. Likewise, IP1 also agrees on the lack of mechanisms to capture tacit knowledge, and therefore plans to implement 'code inspection' drills to promote the capturing of tacit knowledge.

Another finding from the empirical investigation concerns the importance of actively seeking new learning. Both IP1 and IP4 discuss this topic, where IP1 highlights how the firm seeks to recruit people with a drive to reflect on their current knowledge and find possibilities to learn more, while IP4 argues *The Company* must have a 'startup mindset', suggesting employees must be able to teach and continuously learn.

Altogether, there seems to be a consensus among the interviewees on the importance of internalizing knowledge, and while factors #5 and #6 of the hypothesized framework are not entirely fulfilled at the time of writing, there is ambition to strive for fulfillment, thus consenting with findings from literature and confirming its importance to *The Company*. Conclusively, factor #5 needs editing to also include active information sharing.

6.3. The hypothesized framework

When asked about the applicability of the hypothesized framework for *The Company*, IP1 provided us with some interesting additions. Firstly, he argues the framework lacks focus on the value of *The Company's* offering, suggesting the framework should include a foundational idea about the commercial value. We find this notion interesting, and it connects with the notion of feature, benefit and advantage discussed by IP5. Hence, IP1 and IP5's respective notions lead to the same conclusion; we need to add a value proposition dimension to the framework. On the opposite, Granstrand commended the model for not including any "too certain" factors, exemplifying with the ambiguousness of having a well-defined value proposition. Altogether, we conclude the value proposition element needs to be included, but not as a core element in the framework, but rather as a complement. Without a clear understanding of your firm's value proposition, we contend the framework loses value.

Furthermore, IP1 argues the model lacks a practical dimension, suggesting it should include a *Plan, do, check, act (PDCA) cycle.* We agree on this feedback since the key success factors of the framework need continuous monitoring to evaluate whether they are fulfilled or not. Hence, we conclude this element of continuous evaluation needs to be included in the framework.

Another distinction we make from the interviewees is the agreeability of not wanting to remove any aspect of the framework, suggesting it does not include any redundancy. This notion is further strengthened upon asking the interviewees which factor they find most

important for a (high technology) startup out of the six presented in the framework. Even though a clear majority of the votes was put on factor #1 *Identify lead users,* all factors were mentioned at least once, once again confirming its non-redundancy. Additionally, IP2 argues that all factors are relevant no matter the stage of the life cycle, further strengthening their relevance. Moreover, there seems to be a consensus among interviewees on compendiousness of the framework, but all interviewees express that the rationale behind the framework needs explanation to be fully grasped. Hence, we reckon a need to include a descriptive aspect of the work process to develop the framework. This notion was also suggested by Granstrand.

Furthermore, as briefly discussed earlier, both IP1 and IP5 suggest the framework lacks an economical dimension, e.g., completing cost-benefit analysis whether implementing a new marketing analysis tool worth the investment considering the gains it provides. While this master thesis limits itself to not include capital injections of any kind, we believe having this cost-benefit mindset is crucial for always making sure to effectively spend the scarce resources of a startup, and it is not categorized as a capital injection. We conclude the category of soaking up external intelligence needs to include an economic aspect to complement the technological audit and the marketing analysis tools.

Interviewees from *The Company* agree on the importance of letting engineers receive customer exposure, and this notion was especially highlighted by IP2 arguing that it will create an understanding of whom the engineers are developing the products for and what creates value. However, we argue this notion has already been covered in factor #2 *Avoid marketing & technology myopia.* If engineers receive market exposure the firm will remove the gap between R&D and marketing discussed by Gupta et. al. (1985) & (1986).

Moreover, there was suggestions from IP3 and IP5 concerning factor #1, *Identify lead users.* IP3 argues the concept of lead users is too narrow and thus suggests it should be expanded to include all interested parties. While we do not necessarily disagree with this statement by IP3, we argue the notion behind having lead users - that is to act as a source of customer focused innovation - is removed by including all interested parties. On the other hand, IP5 agrees with us on the relevance of having 'lead users' to further innovate but argues the concept of 'user' is industry specific and can in other cases be 'producers'. We agree with this statement, and to ensure we include all parties who are considered 'lead' we decide to rephrase the factor to *Lead customers*, thus including both users and producers.

Another aspect we found interesting to discuss was mentioned by IP3 and considers the management-employee relationship. IP3 argues it is vital employees feel encouragement and recognition from the startup management. While we agree, and believe it is an important aspect for startup success, it is outside the boundaries of this master thesis and thus we decide to not include it in the framework. While it is discussed in the market focus theoretical area by Mohr et. al. (2010), it is not mentioned in the technology-orientated competitive advantage.

Concerning the illustration of the theoretical areas intersecting, IP5 suggested a different positioning of the circles as presented in the empirical results. Since we want to highlight the

transformation from a technology-driven to a market-driven startup, IP5 suggests we should place the market focus circle above to easier grasp the underlying rationale. We agree with this suggestion even though it does not have a major effect on the framework as whole, but intuitively we conclude it makes sense. Moreover, IP3 and IP5 had suggestions on the following phrasings:

- "Myopia" from factor #2, *Avoid marketing & technology myopia.*
- "Cherry-pick" and "marketing tools" from factor #3, *Deploy a technological audit & cherry-pick marketing tools.*
- "Periphery" from factor #4, *Develop an absorptive capacity & scan the market periphery.*

IP5 believes "myopia" is a modern concept and questioned whether this wording can be substituted for easier communication, and IP3 believes "cherry-picking" suggests bias. However, based on our literature review, we reckon these phrasings are acknowledged in the academia and thus do not need to be changed. E.g., Levitt (2004) uses the terminology "myopia" extensively and given the author's title as professor emeritus at *Harvard Business School*, we are confident in using "myopia". Moving on, IP5 suggests "marketing tools" is too vague and does not accurately describe the purpose of collecting customer needs. We agree with this statement, and hence the phrasing will be changed to "marketing analysis tools". Finally, according to IP5, the wording "periphery" suggests an outgoing perspective, and in the case of factor #4 we want to highlight an incoming perspective of new competitors. For this reason, we agree with the statement by IP5 even though "periphery" is used extensively by Day & Schoemaker (2005). To clarify, we substitute the wording to "frontier" since it more accurately describes the incoming perspective.

Moreover, IP5 explained his concern over the order of the purple categorization boxes, saying that the chronological order of the boxes is misleading. The rightful order should be to first soak up external intelligence before grasping value creation possibilities and finally internalizing knowledge and insights. On a similar note, Granstrand suggests, as part of the inclusion of the work process of coming up with the framework, that the six factors should be presented before the categorization boxes since we formulated the six factors before categorizing them. We have no objections to the suggestions by IP5 and Granstrand, thus adding a chronological dimension to the framework.

As a final note, Granstrand expressed concerns whether factor #2, *Avoid marketing & technology myopia* and factor #5, *Avoid information hoarding* are success factors or should instead be categorized as failure factors to avoid. We decided to reject this suggestion due to two reasons. Firstly, this master thesis is restricted to study key success factors and thus adding "failure factors" is outside of the boundaries of this report. However, it can be considered as further research and expansion of the findings from this master thesis. Secondly, whether avoiding a failure factor can be considered as a success factor is up for debate, and hence there is no clear right or wrong answer.

6.4. Revised framework (v2.0)
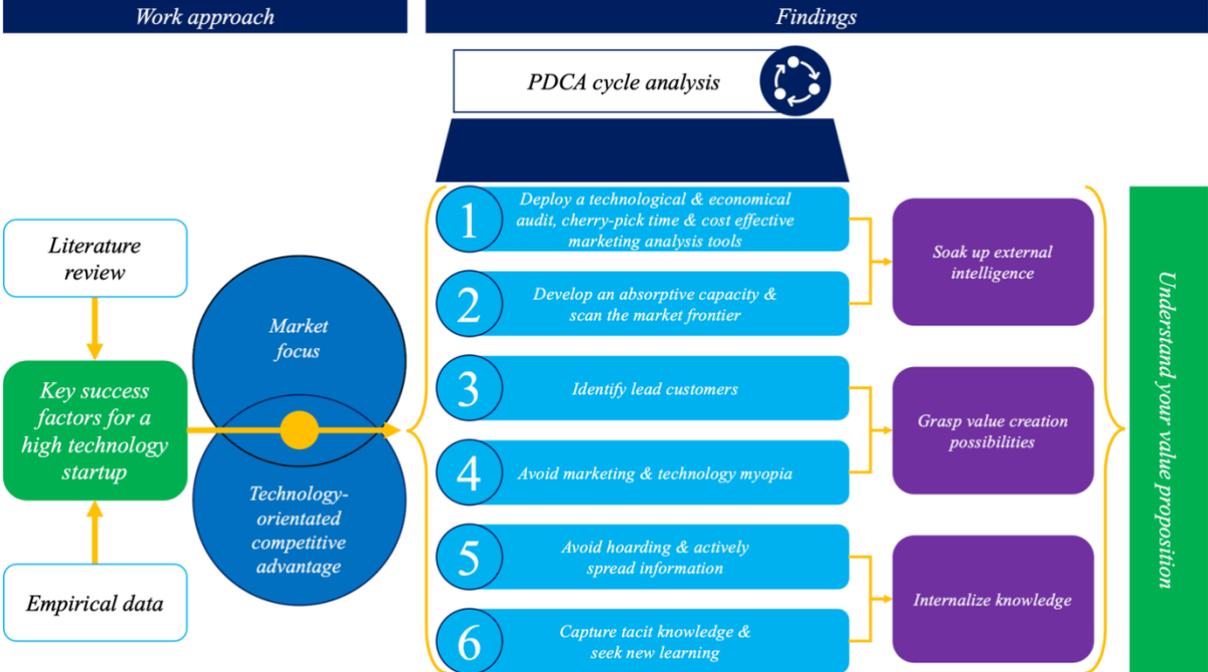
Figure 36: The revised framework (v2.0)

Combining insights from the literature review and the empirics has led to the development of *the revised framework (v2.0)* seen in Figure 36. The revision of the hypothesized framework is based on analysis of the empirical results along with strengthening arguments from the literature review when possible.

The revised model is divided into two parts: the *work approach* and the *findings.* The work approach was an idea suggested by Granstrand which illustrates how we used input from the literature review together with the empirical study to learn about key success factors in a high technology environment. Further, the intersecting circles represents the "filter", or in other words, the theoretical frame of this master thesis. Since we suggest key success factors for a high technology environment should be in this intersection, we disregard factors not discussed in both the market focus and technology-orientated competitive advantage theoretical areas.

The 'findings' section encapsulates aspects we suggest are key success factors for turning a high technology startup into a commercial success. The empirical study validates the importance of all factors due to the model's non-redundancy and each factor being selected as the most important one at least once. While the factors have been adjusted according to insights from the empirical results and the analysis, there are elements which need further explanation. Firstly, the *PDCA cycle analysis* is a representation of the continuous factor status evaluation by the high technology startup. According to IP2, and as tested empirically, the factors are not specific to a certain period of the startup life cycle, and thus each factor

needs to be evaluated continuously to confirm or deny its fulfillment. This represents the first step in the practical application of the revised framework as requested by IP1.

Moreover, our intention is that each factor should be tested by applying models and concepts written in the theory, but the general practical applicability of the framework is unique to each high technology startup and the industry it operates in. Thus, we reckon the revised framework and material from the literature review to act as a starting point for choosing tests and continuously evaluate the factor status. Nevertheless, in a mutual agreement with *The Company* we will use the model to develop such a practical application to the startup, but due to confidentiality, it cannot be disclosed in this master thesis.

Moreover, the new factor #1, *Deploy a technological & economical audit, cherry-pick time & cost-effective marketing analysis tools,* includes an economical factor as suggested by IP1 and IP5. The economical audit is a synonym for having a cost-benefit analysis concerning all decisions in the startup. E.g., as discussed by IP1, should we extend the degree of code documentation? Depending on the extra time it consumes compared to gains it might be worth it or not. Furthermore, the marketing analysis tools need to consider cost and time aspects too. Some tools, such as customer visit programs or meetings, are easy to implement, but on the contrary, building a prototype requires a larger time and cost investment.

Finally, an understanding of the startup's value proposition encompasses all six factors as illustrated in the framework. As discussed in the analysis, without a clearly defined value proposition the high technology startup cannot become commercially focused, and thus the main objective with studying the six key success factors becomes ambiguous. However, based on input from Granstrand, the value proposition should not be considered a key success factor due to its self-explication and general tenor.

6.5. Quality assurance

As a final step in the review of the revised framework, we want to conduct a quality assurance. Some frameworks, e.g., *the BCG growth share matrix* and *McKinsey's 7S model*, create long lasting impact on business strategy and practice while others do not. In a paper by *David Gray* in the *MIT Sloan Management Review* from 2021, he discusses what distinguish the best frameworks from the rest and presents seven criteria for evaluating business frameworks. These criteria are used to verify our framework, and it is presented in the following six subchapters.

6.5.1. Comprehensiveness

To fulfill this criterion, a model should cover a broad spectrum, and either be empirically comprehensive (encompassing a wide array of elements whom observations have implied are essential) or logically comprehensive (structured to not miss any aspects and considered MECE) (Gray, 2021). Our framework is by no means an exhaustive list of success factors and

can thus be expanded, leading to a non-fulfillment of logical comprehensiveness. Furthermore, our empirical data originates from a high technology startup, an independent serial entrepreneur and a professor who has researched technology strategy, and thus the framework includes elements originating from multiple stakeholders. Additionally, our framework's foundation is based on literature review covering aspects from both theoretical frames in the literature review. However, the literature review is extensive but by no means exhaustive, once again suggesting our framework is not logically comprehensive.

6.5.2. Utility

Gray (2021) suggests the utility criterion assesses if the framework provides useful insights which one can act from and if it can be tailored to apply in different situations with different circumstances. We believe our framework provides niche factors to consider when turning commercial, and thus avoids being too general and not insightful. Each factor provides feedback whether it is fulfilled or not, and if it is not fulfilled, the incumbent can focus resources to fulfill the factor. However, as previously discussed, the practical outcome of our framework is achieved by studying the literature review, and thus the framework alone does not suggest practical actions, similarly to the BCG growth share matrix or McKinsey's 7S model. Moreover, we believe our framework can be applied in different situations due to empirical data suggesting the framework is applicable no matter the stage of the startup life cycle. Furthermore, while this master thesis focuses on high technology startups, the framework can be applied to any startup who has some form of technology in their offering.

6.5.3. Validation

Concerning validation, Gray (2021) suggests the validity of the framework should be supported by empirical evidence and observable data, and argues the best frameworks produce reliable insights that originates from observable information. We conclude our framework fulfills this criterion, since our hypothesized and literature-based framework is tested empirically by conducting six interviews with stakeholders with various backgrounds and interests (even within *The Company*). Notably, our framework guides practical outcomes since it has been tested on a real high technology startup.

6.5.4. Clarity

The notion of clarity refers to familiarity, simplicity, and parsimony. Gray (2021) explains familiarity is achieved by using common-sense language to avoid any misunderstandings and address a larger audience, simplicity by illustrating facts and relationships in an intuitive manner, and parsimony is achieved by limiting the number of explanations to a minimum. Upon reviewing our framework, we conclude it can be revised to achieve more clarity. Firstly, we believe the phrasing in factor #2 can be revised since it includes concept which are not commonly known to most people, not even in the business world. Thus, we update the

phrasing in factor #2 to *Develop a capacity to absorb & filter external knowledge, scan the market frontier.* Secondly, we conclude the lower intersecting circle can be rephrased to better link its connection to the above circle, and thus the phrasing is changed to *Technology focus.* Otherwise, we believe the framework uses as short phrasings as possible to deliver the intended message and thus we conclude there is no language excess. However, we conclude the work process is an excessive element, and will be removed to make our framework parsimony and more succinct.

6.5.5. Memorability & integration

Memorability, as explained by Gray (2021), assesses if the framework is easy to remember and apply, including intuitive guidance concerning visual depictions. E.g., *BCG growth share matrix* is known for its animal symbols (dog, star, question mark and cow) and *McKinsey's 7S, the 3C's or 4P's* are memorable for starting with the same letter. On the other hand, integration, evaluates if the model is consistent and hangs together logically. Reviewing our model, we conclude it lacks clear memorability features and how the model is intended to be studied is not intuitive enough. Firstly, our framework needs to include guiding elements, e.g., guiding arrows, to make it more intuitive to read and increase the level of integration. Secondly, we reckon the *PDCA cycle analysis* needs to be illustrated differently to make it easier to grasp. Thirdly, the number of boxes can be decreased as illustrated below in the concluding model. Fourthly, we conclude our model needs a proper name to make it memorable.

6.5.6. Differentiation

A model can be different in two ways; by recombining already recognized elements in a unique manner or by proposing new elements enabling novel perspectives and actions (Gray, 2021). We conclude our framework fulfills this criterion since it combines two theoretical areas and identifies key success factors in their intersection. Even though an extensive search of previous research papers has been conducted before writing this master thesis, we cannot conclude it is exhaustive, but to our knowledge and given the preciseness of our success factors, we believe our framework can be considered different.

6.6. Concluding framework (v3.0) - *The six factors of high technology commercial success*

Based on the discussion from the quality assurance, we adjust our framework accordingly to come up with *the concluding framework (v3.0)*, seen in Figure 37, with the name *'The six factors of high technology commercial success'*.
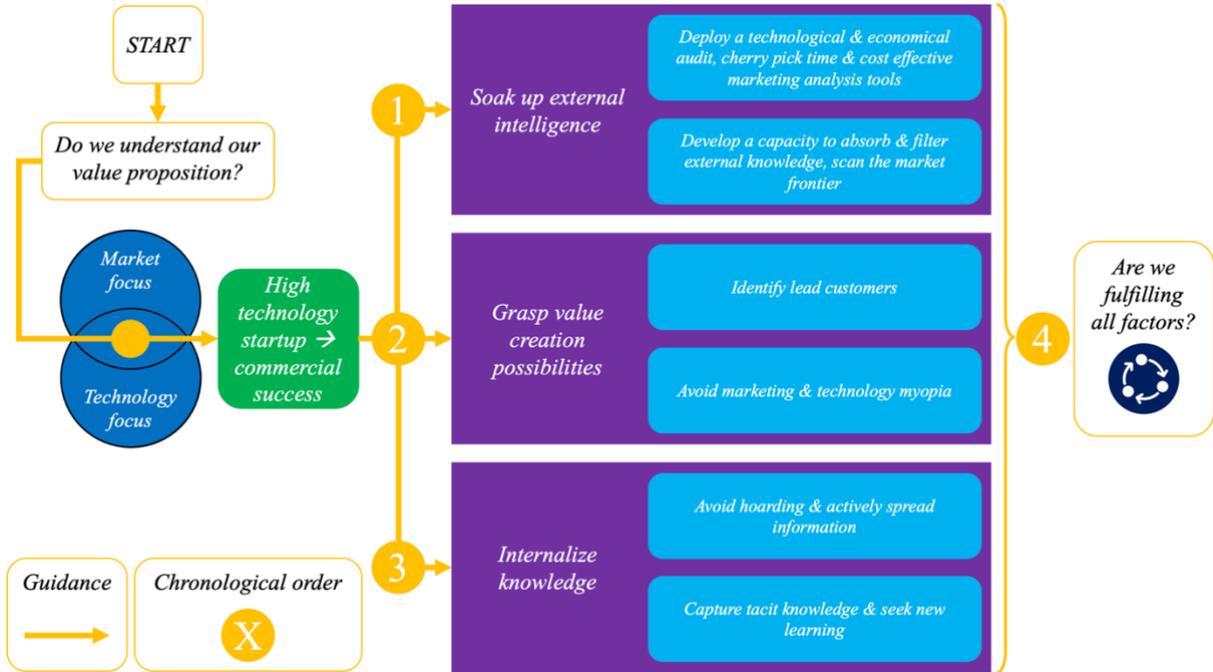
Figure 37: The concluding framework (v3.0) for turning a high technology startup into a commercial success

6.6.1. Final remarks

It is essential to stress, as discussed in the quality assurance, that the concluding framework is by no means a non-exhaustive and final list of success factors and thus it can be expanded. The purpose is to describe, explain and create an understanding of how high technology startups become commercially focused, and by expanding the literature review and the empirical sample, there is the possibility of extending the list of key success factors. It is also noteworthy that the framework is theoretically rooted. Hence, to achieve practical applicability, the framework should be used in combination with material presented in the literature review.

7. Conclusion

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In the following chapter, the findings for the main and secondary purpose of this master thesis are presented along with suggestions for improvement, further research, and the thesis' contribution to academia, the case company, and the authors themselves.

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7.1. Key success factors for high technology commercial success

The main purpose of this master thesis is to identify, categorize and understand key success factors of transforming a high-technology startup from a pure innovation focused firm to a market and technology focused organization to ensure a sustainable competitive advantage. The study was conducted in collaboration with a high technology startup in Sweden who designs tailormade semiconductor IPs with an extraordinary low energy consumption. The secondary purpose is to develop an applicable framework, encapsulating the key success factors, to help high technology startups evaluate their commercial position.

After an extensive literature review of two theoretical areas, namely market and technology focus, we were able to identify six factors for commercial success for a high technology startup. These factors originate from the intersection between the theoretical areas and further lead to the development of the hypothesized framework (v1.0). Later, the hypothesized framework was tested empirically through interviews with employees at the case company and external experts, with the purpose of confirming or editing elements of the model, leading to the development of the revised framework (v2.0). Finally, we conducted a quality assurance test on the revised framework, according to seven predefined criteria, which lead to the development of the concluding framework (v3.0) named *the six factors of high technology commercial success.* Below is a representation of the six success factors in the concluding framework:

1. *Deploy a technological & economical audit, cherry pick time & cost-effective marketing analysis tools*
2. *Develop a capacity to absorb & filter external knowledge, scan the market frontier*
3. *Identify lead customers*
4. *Avoid marketing and technology myopia*
5. *Avoid hoarding & actively spread information*
6. *Capture tacit knowledge & seek new learning*

7.2. Suggestions for improvement

Due to important deliverables for *The Company* during the conducting of the empirical study, employees had limited time over for participation in our interviews and thus we were unable to conduct all intended interviews. Hence, we conclude a larger sample of interviews would provide us with more nuance and additional input to stated success factors and the developed framework, and these interviews could have been conducted outside of the case company to further increase the generalization of our conclusions. Moreover, as discussed in the quality assurance, our developed framework lacks logical comprehensiveness due to the unexhaustive list of success factors. While the chosen success factors are motivated and tested, our research cannot definitively conclude we have found the most important success factors originating in the intersection of the theoretical frames. Hence, another suggestion for improvement is to structure the findings of the success factors differently, meaning the intersection can be "broken down" into thematic and MECE categories before identifying success factors, instead of the other way around as we did. This will lead to a higher degree of logical comprehensiveness as discussed by Gray (2021).

7.3. Suggestions for further research

Limitations of this master thesis can act as a good starting point for further research. Firstly, our study focuses solely on 'success factors' for turning an innovation focused high technology startup into a commercial success, but insights from the empirics suggest 'failure factors' are also important to present. In our research we define avoidance of failure factors as success factors, but a suggestion is to conduct further research on avoidance of failure factors, e.g., adding the research question: *what are the key failure factors to avoid when turning an innovation focused high technology startup to a commercial success?* Secondly, this master thesis is restricted to one case company only and to validate the presented success factors (and the developed framework) further empirically, one can expand the empirical investigation to include more high technology startups in other industries. Hence, it would strengthen the general application of the findings of our master thesis. Thirdly, the boundaries of this master thesis limit us to study only high technology startups, but further research can be conducted to investigate our success factors and the framework's applicability in "not so high" technology environments, to further expand the applicability of our findings.

7.4. Contributions to authors, academia & case company

Having written this master thesis, we applied acquired knowledge from academia to a real-world case in a structured and objective manner. As a result, we are now able to draw

valuable parallels between obtained knowledge from academia and its usefulness in a future career, either as a continuation in a postdoctoral program or in the business world.

There are numerous research projects and papers discussing successful features of a high technology startup, ranging from economical to cultural aspects in either a firm internal or external setting. Even though extensive research has been conducted in the discipline, our intention is to contribute to the research area by specifically identifying key success factors, encapsulated in a developed framework, concerning the transition from an innovation focused high technology startup to become a market focused entity while sustaining a technology-related competitive advantage in the marketplace. Additionally, by completing a deep-dive case study on a high technology startup, we intend the practical element of this master thesis gives further insight to the research discipline.

Finally, the company-specific study conducted in this master thesis intends to give *The Company* an independent view of their status in becoming a market focused entity. E.g., the compiled framework can be utilized to identify which factors have or have not been fulfilled by the firm, and hence act as a tool supporting their journey of developing both a market and technology focus. Also, the empirical study serves as a status report of each interviewee's knowledge concerning market orientation, implying how this notion can be strengthened in the firm. Moreover, the technological audit acts as a benchmark on *The Company's* technology status, suggesting how the technology can be further developed and exploited.

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8. Appendix

8.1. Interview guide 1: *Technological audit*

Introduction

Before we begin the interview, we would like to give you some background information to why we are conducting this interview with you today. As part of our empirical study, which is solely based on interviews with employees at *The Company,* we want to give the reader an understanding of your current technological position, meaning your current technological state compared to competition and future technological aspirations.

Technological audit

1. What are the technologies and know-how on which the business depends?

1.1. What are your views on the state of technology; are you market leading or rather the opposite?

1.2. What are the basic technologies (technology necessary to gain market access)?

1.3. What are the distinctive technologies (technology which sets you apart from competition)?

1.4. Are there any external technologies (technology acquired externally)?

2. What are the origins of the technology in the organization?

3. How broad is the field of application for the technology in the organisation?

4. What is the state of the technology in relation to where the organisation wants it to be? What are the hurdles to reach the desired state of technology?

5. How new is your technology?

New product technology

1	2	3	New to the company
4	5	6	New to the market
7	8	9	New to the world
Company	Market	World	

(Left axis label: New product)

6. What is the life cycle position of the technologies on which the company depends (technology development, technology application, application launch, application growth, technology maturity or degraded technology)?

7. Are there emerging or developing technologies both inside and outside your company which could affect your current or prospective markets?

8. Are the company's strengths in product technologies, production (process) technologies or both?

9. Do you apply any of the following methods for acquiring technology?

Methods for acquiring technology
Internal R&D
Joint venture R&D
External R&D (including subcomponents)
Licensing?
Alliances
Mergers & acquisition (M&A)
Use of lead users

10. What is the state of the internal 'absorptive capacity'? The organisation must have an existing technological knowledge base to realize potential from new information or technology.

11. Does your company achieve the optimum exploitation of the technologies you have (e.g., could you utilize intellectual property, technology lock-in or technology licensing)?

Conclusion of interview

Thank you [Interviewee] for taking the time to take part in our research. Please contact us if you have any further questions about our research.

- *In case we have any follow-up or clarifying questions, would it be okay if we contact you?*
- *Is there any information you shared with us today which is confidential and hence should not be included in the master thesis?*
- *Can we include your name and title in our master thesis, or do you prefer it to me anonymized?*

8.2. Interview guide 2: *Hypothesized framework tested at partner company*

Introduction

Let us begin this interview by giving you some background concerning our research. Our goal is to confirm which factors are most important for turning a high technology startup into a commercial success by studying the intersection between *being market focused* and *forming a technology-orientated competitive advantage.* Based on previous research we have seen a lot of reports studying these theoretical areas separately, but we believe these areas need to be combined. Thus, we hypothesis these areas are inseparable to commercially succeed as a high technology startup.

Hence, our research is looking into key success factors which intersects the two aforementioned theoretical areas.

General questions

1. Could you start by briefly explaining your academical and professional journey?

2. Please explain your role at the firm and for how long you have been with the firm?

Startup success factors

3. Generally speaking, according to you, what is the "recipe" for success for startups no matter the industry? Anything else?

4. Would you say the aforementioned recipe differs for a high technology startup like 'The Company'?

5. If you were to list these success factors, what would they be? Anything more?

Investigative questions before presenting the hypothesized framework

Grasp value creation possibilities

6. Do you have a certain strategy to determine what customers value and how The Company can bring that value? Anything else you would like to add?

7. Does it happened customers help you innovate and improve your offering (e.g., you find inspiration to improve products by talking to customers who describe a problem with no commercial solution)? Can you exemplify?

*8. Is it difficult to know what customers **really** want? Does it differ from what they say they want?*

Soak up external intelligence

9. Do you recurrently analyze your technology and inhouse knowledge to know where you stand compared to competition (e.g., auditing your competences)?

10. Do you have strategies for detecting competitive threats on the market?

11. Would you say it is important to "soak up" knowledge externally to develop the knowledge base?

12. Do you have any marketing tools to analyze the semiconductor market? Anything else?

Internalize knowledge

13. Can you explain how information and knowledge flows between teams?

14. Do you have any mechanisms in place to ensure knowledge sharing between employees? Anything more?

15. (This question is only applicable for chair of board, CEO and product owner) Do you have any mechanisms in place to ensure knowledge stays at the firm if an employee leaves the company?

16. How does the firm make sure employee knowledge is up to date? Anything else?

The hypothesized framework
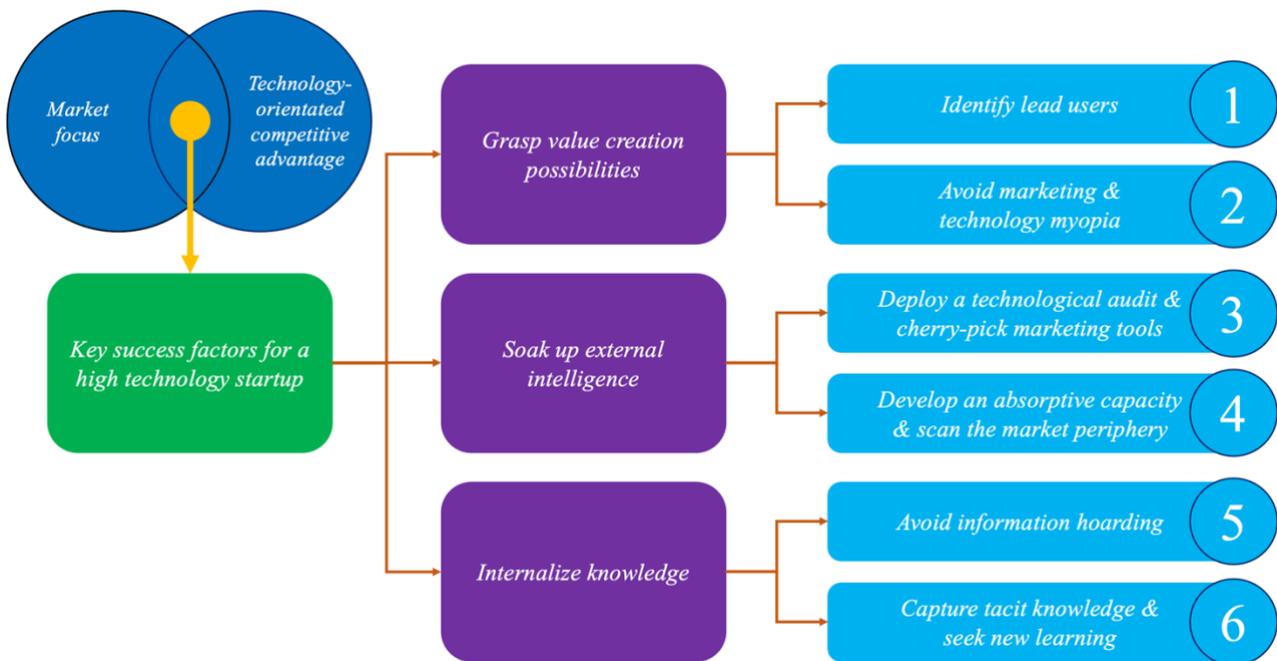
Please take a moment to grasp the model. [Afterwards, we will walk through the model together with the interviewee and clarify concepts if needed before moving on with the questions below].

17. When you see this framework, do you believe it accurately presents aspects important for commercial success at 'The Company'?

18. Is there anything you find unclear with the model? Anything else?

19. Would you like to add anything? Anything more?

20. Would you like to remove anything? Anything more?

21. Would you like to substitute or rephrase anything? Anything else?

22. Out of the six presented factors, which one do you think is most important for the firm?

23. Which 2-3 key success factors do you think is the most important right now for the firm?

Conclusion of interview

Thank you [Interviewee] for taking the time to take part in our research. Please contact us if you have any further questions about our research.

- *In case we have any follow-up or clarifying questions, would it be okay if we contact you?*
- *Is there any information you have shared with us today which is confidential and hence should not be included in the master thesis?*
- *Can we include your name and title in our master thesis, or do you prefer it to me anonymized?*

8.3. Interview guide 3: *Hypothesized framework evaluated by external experts*

Introduction

Let us begin this interview by giving you some background concerning our research. Our goal is to confirm which factors are most important for turning a high technology startup into a commercial success by studying the intersection between *being market focused* and *forming a technology-orientated competitive advantage.* Based on previous research we have seen a lot of reports studying these theoretical areas separately, but we believe these areas need to be combined. Thus, we hypothesis these areas are inseparable to commercially succeed as a high technology startup.

Hence, our research is looking into key success factors which intersects the two aforementioned theoretical areas.

General questions

1. Could you start by briefly explaining your academical and professional journey?

2. What is your current role and for how long have you been in this role?

Startup success factors

3. Generally speaking, according to you, what is the "recipe" for success for startups no matter the industry? Anything else?

4. Would you say the aforementioned recipe differs for a high technology startup?

5. If you were to list these success factors, what would they be? Anything more?
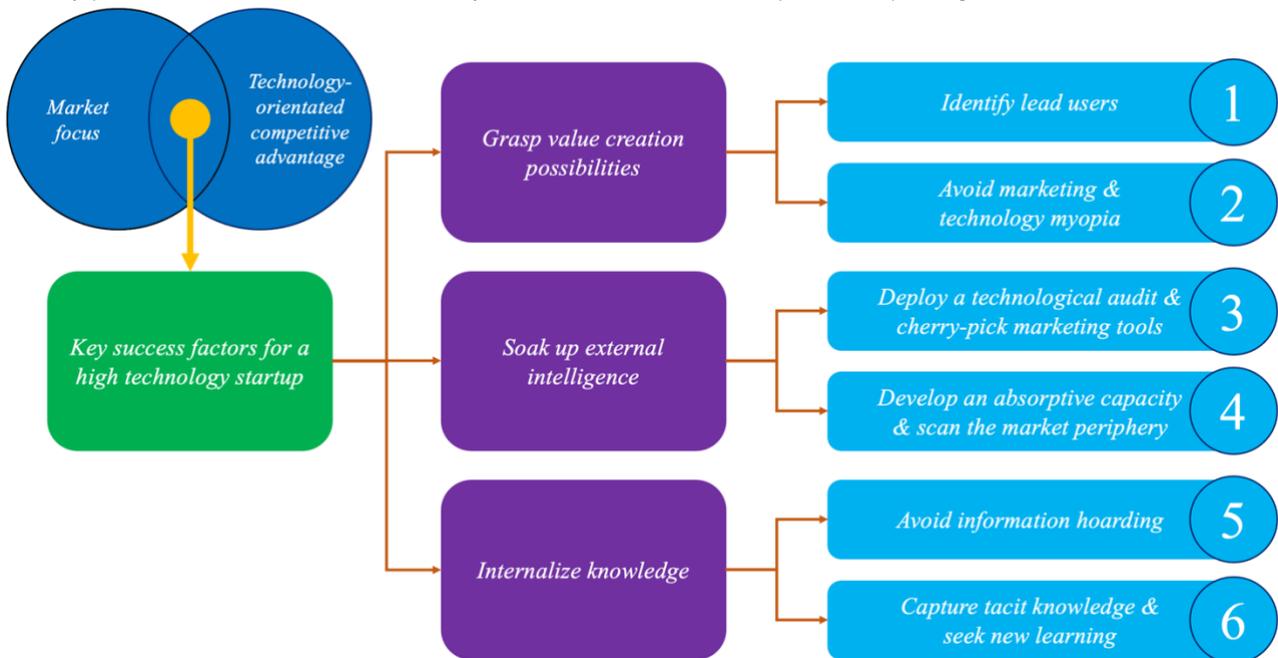
The hypothesized framework

Please take a moment to grasp the model. [Afterwards, we will walk through the model together with the interviewee and clarify concepts if needed before moving on with the questions below].

6. When you see this framework, do you believe it accurately presents aspects important for commercial success for a startup no matter the industry?

7. Do your opinion change or stay the same if the startup operates in a high technology environment?

9. Is there anything you find unclear with the model? Anything else?

10. Would you like to add anything? Anything more?

11. Would you like to remove anything? Anything more?

12. Would you like to substitute or rephrase anything? Anything else?

13. Out of the six presented factors, which one do you think is most important for a startup no matter the industry?

14. Does your opinion change or stay the same if the startup operates in a high technology environment?

Conclusion of interview

Thank you [Interviewee] for taking the time to take part in our research. Please contact us if you have any further questions about our research.

- *In case we have any follow-up or clarifying questions, would it be okay if we contact you?*
- *Is there any information you have shared with us today which you prefer would not be included in our master thesis?*
- *Can we include your name and title in our master thesis, or do you prefer it to me anonymized?*

8.4. Technological audit

As part of the introduction to the case company, we conducted a technological audit of *The Company,* based on the employees' own view, to gain a better understanding of the firm's present technological position. To do this, we conducted three interviews with employees of different technological backgrounds and competencies. In a mutual agreement between us and the case company to anonymize, we present only the work title of all interviewees and allocate a reference (IP1-3). The reference is allocated in chronological order and is therefore not interconnected to title.

Work title	Duration of employment at 'The Company'
Product Owner	1 year
Senior Analogue Design Engineer	9 months
Lead Engineer in Software Development	3 years

Interviewee	Date	Interview duration
IP1	April 8, 2021	1 hour & 5 min
IP2	April 8, 2021	1 hour & 15 min
IP3	April 14, 2021	1 hour & 30 min

The presentation of the interviews will follow *Interview guide 1: Technological audit* in subchapter 8.1, and the responses from each interviewee will be presented together under the same subcategory as follows below.

What are the technologies and know-how on which the business depends?

IP1 believes *The Company* is a market leader, the high level of technological competency within the organisation ensures *The Company* is always at the forefront of the technological development. IP1 also states that the firm's product, a design tool for automatic design and verification of the semiconductor IP, is the main distinctive technology which sets *The Company* apart from the competition (the product will later be referred to as *'The Product'* and its real name will not be disclosed in this master thesis due to interests of anonymization). The basic technology is the knowledge and ability to understand and construct circuits which work well. Also, the external technologies mainly consist of design and simulation tools needed to create and test the memory IP.

Also, IP2 thinks *The Company* is a market leader. Just as IP1, IP2 believes that the basic technology is the knowledge and ability to understand and construct memories which work well, however the opinion on what is the distinctive technology differs slightly. In this case the distinctive technology is *" the best memory for energy consumption which cuts off unnecessary parts"*. The external technologies are very much in line with IP1.

IP3 differs somewhat in the view of market leadership, it is stated that the product which is delivered to customer is market leading, however the process is not finished, making the process somewhat inefficient. Overall, this makes for a position in between leader and follower. IP3's views on basic and external technologies are aligned with the other interviewees' view. However, the view on distinctive technologies differs, where IP3 believes the distinctive technologies are an advanced simulation tool developed in-house, and the process in which the memory design is generated (*the Product*).

What are the origins of the technology in the organization?

IP1 responded swiftly by stating the technology originates from the collective thoughts and ideas of the people within the organisation. IP2 responded that the technology of importance is developed in-house by the team, which possess vast amounts of expertise and, IP3 responded it is a mixture of the CEO's research and development in the organization.

How broad is the field of application for the technology within the organization?

IP1 replies by saying that the scope of the technologies is very broad. Some of the technologies used in simulations might be applicable to statistical analysis. IP2 says that the field of application is broad, as everything with a processor has a SRAM. IP3 believes that IoT is something which is interesting for *The Company*, although it has not quite taken off as expected. The automotive industry is also something where *The Company* can cover most of the electronic products. Imaging sensors are also something which is interesting. Aside from these specific examples, IP3 concluded the application field is wide.

What is the state of the technology in relation to where the organisation wants it to be? What are the hurdles to reach the desired state of technology?

IP1 states that *the Product* is new and needs development. It is presently used in customer projects, but the results need some manual tuning before reaching the desired state. The hurdle is time, as further development of the *the Product* equals man hours, something which is hard to find in a startup. IP2 believes the organization must ask itself if the process should be completely automated or if the product should be completely bespoke. The hurdle is a trade-off between these two extremes. Moreover, IP3 believes the product which is delivered to customers is where the organization wants it to be. However, regarding *the Product,* further development is needed.

How new is our technology?

IP1 believes the product is new to the world, but the technology is new to the company. Likewise, IP2 also believes the product is new to the world, but the technology is new to the company as SRAMs have been around as quoted *"forever"*. IP3, on the other hand, believes both the technology and the product are new to the world.

What is the life cycle position of the technologies on which the company depends?

IP1 believes that the position is somewhere in between *technology application* and *application launch.* IP2 states the same as IP1. IP3, on the other hand, believes the product lies in *application launch,* but the process technology lies in *technology development.*

Are there emerging or developing technologies both inside and outside your company which could affect your current or prospective markets?

IP1 answers that the industry is very secretive, making it difficult to know for certain. But customers are very impressed by our performance, indicating we are unmatched in our market segment. IP2 mentions that there is always a risk of new technology emerging, but due to the secrecy in the industry we can never know. A risk would be if foundries decide to internalize all architecture. IP3, on the other hand, answers that the only probable risk would be if Apple decides to open a SRAM centre in Germany. However, as Apple are unlikely to sell their technology, this would only make the market smaller as Apple would produce their own SRAMs.

Are the company's strengths in product technologies, production (process) technologies or both?

According to IP1, it lies equally in both. The firm's product is very strong, but the process (which is also included in *the Product*) is also a strength. IP2, on the other hand, answers that today the strength lies only in the product technology. The product delivers outstanding performance, but the production requires a lot of manpower. In the future however, when *the Product* is refined, both the product and process technology will be equally strong. IP3's answer is in line with IP2.

Do you apply any of the following methods for acquiring technology?

IP1 believes most of the technology is developed in-house. However, one example of lead users and alliance/joint venture R&D is given. IP2 agrees with IP1. IP3 believes most of the technology is developed in-house, but also gives examples of where lead users have been involved.

What is the state of the internal absorptive capacity?

IP1 says that this is a field of excellence for *The Company*. All employees are very quick to learn of new technologies and solutions. When recruiting, the organization actively looks for people with an ambition to learn rather than experience. This ensures employees never stop being curious. IP2 believes this is something which *The Company* is good at. The employees are both experienced enough and sensitive to what is going on in the industry, which means they know what to "pick up". IP3 agrees with both IP1 and IP2.

IP1 states that *The Company* is looking to apply its technology in new applications, but there are some limitations to what can be done as the foundries set the rules. In IP2's opinion, *The Company* is far from achieving the optimum exploitation and the first step would be to get the process technology working according to preferences. IP3 thinks that in the SRAM application, *The Company* is close to maximum exploitation, however if more architectures were added even more user cases can be exploited. This does however have an upper limit of feasibility.

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